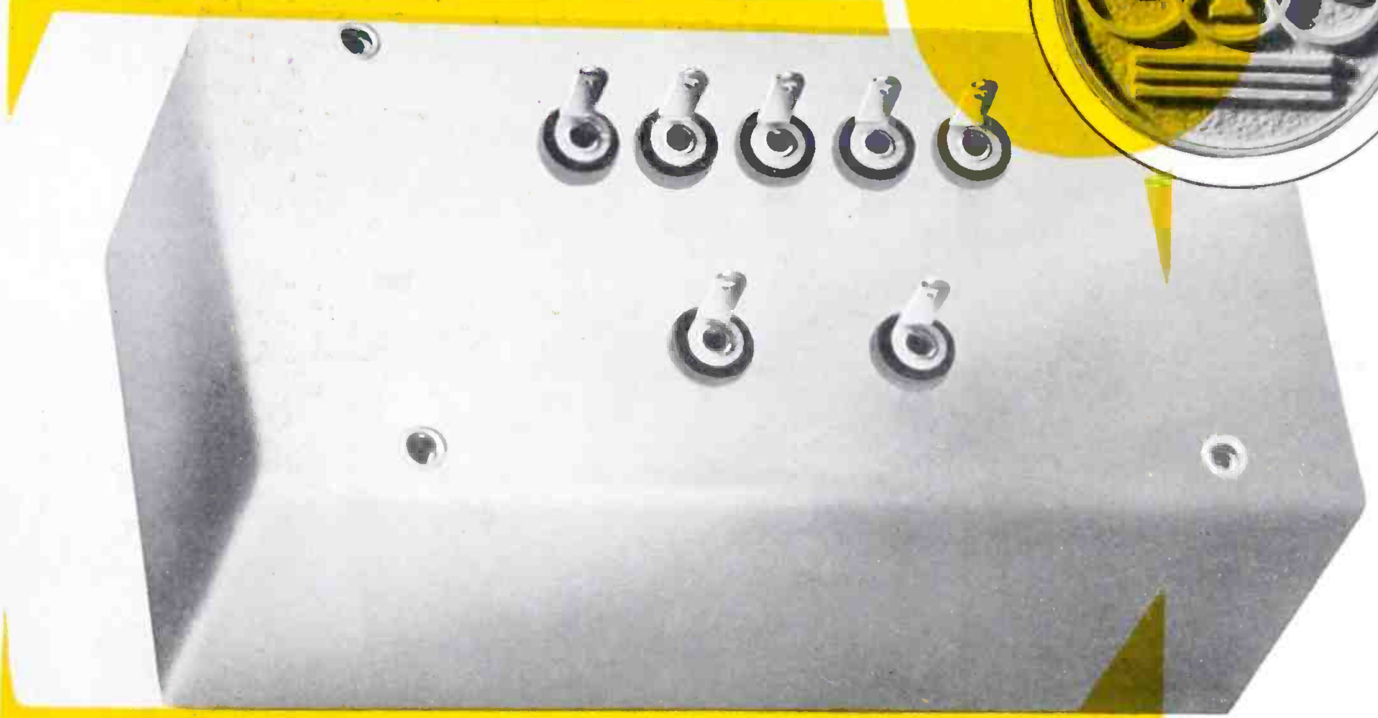
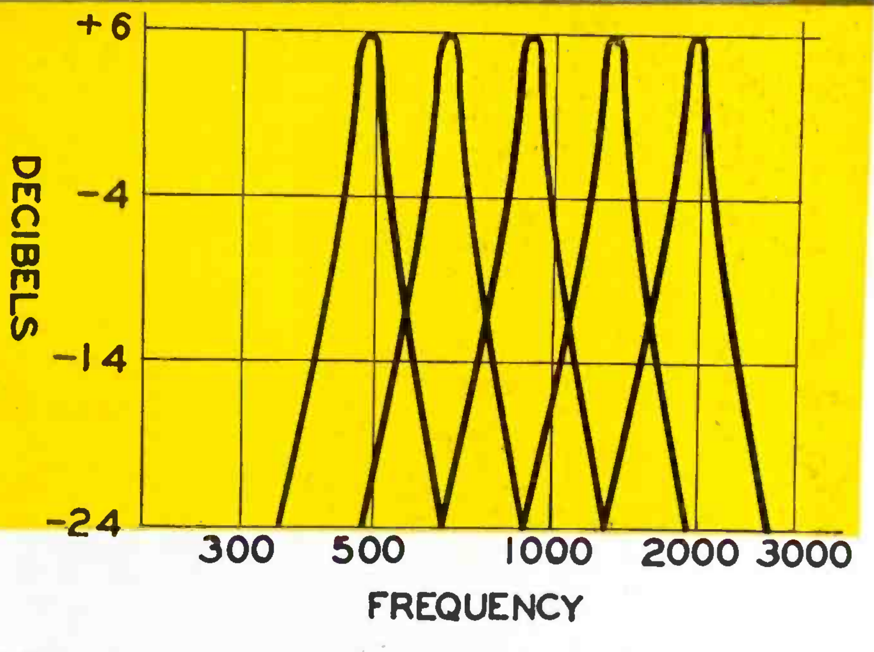
SEPTEMBER · 1944

electronics

A McGRAW-HILL PUBLICATION

MULTI-CHANNEL FILTERS BY...





Multi-Channel Filters lend themselves to remote control apparatus employing frequency selection. The unit illustrated is a five channel band pass filter of the interstage type with the inputs in parallel and 5 separate output channels designed to feed into open grids. This circuit arrangement provides a 2:1 stepup ratio, with a band pass attenuation of approximately 30 DB per half octave. The dimensions of this unit in its hermetically sealed case are 2½" x 3" x 6". Filters of this type can be supplied for any group of band pass frequencies from 200 to 7000 cycles.

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

United Transformer Co.

150 VARICK STREET NEW YORK 13, N. Y.

EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y., CABLES: "ARLAB"

electronics

SEPTEMBER • 1944

KEITH HENNEY, *Editor;* W. W. MacDonald, *Managing Editor;* Beverly Dudley, *Western Editor;* John Markus, *Associate Editor; Assistant Editors*—Vin Zeluff, Frank Haylock, J. M. Heron and M. L. Mattey; G. T. Montgomery, *Washington Editor;* Donald G. Fink *(on leave);* Harry Phillips, *Art Director*

H. W. MATEER, *Publisher;* J. E. Blackburn, Jr., *Director of Circulation, Electronics;* Wallace B. Blood, *Manager*

DISTRICT MANAGERS, D. H. Miller, H. R. Denmead, Jr., *New York;* R. H. Flynn, *New England;* F. P. Coyle, *Philadelphia;* C. D. Wardner, A. F. Tischer, *Chicago;* E. J. Smith, *Cleveland*

McGRAW-HILL PUBLISHING COMPANY, INCORPORATED
JAMES H. McGRAW, Founder and Honorary Chairman

PUBLICATION OFFICE 99-129 North Broadway, Albany, 1, N. Y., U. S. A.
EDITORIAL AND EXECUTIVE OFFICES 330 West 42nd St., New York, 18, N. Y., U. S. A.

James H. McGraw, Jr., President; Howard Ehrlich, Executive Vice President for Business Operations; John Abbink, Executive Vice President for Editorial Operations; Curtis W. McGraw, Vice President and Treasurer; Joseph A. Gerardi, Secretary. Cable address: MCGRAW-HILL, New York. Member A. B. P. Member A. B. C.

ELECTRONICS, September, 1944. Vol. 17: No. 9. Published monthly, price 50¢ a copy. June Directory Issue $1.00 Allow at least 10 days for change of address. All communications about subscriptions should be addressed to the Director of Circulation, 330 W. 42nd St., New York 18, N. Y.

Subscription rates—United States and possessions, Mexico, Central and South American countries, $5.00 a year, $8.00 for two years, $10.00 for three years. Canada (Canadian funds accepted) $5.50 a year, $9.00 for two years, $11.00 for three years. Great Britain and British possessions, 36 shillings for one year, 72 shillings for three years. All other countries $6.00 for one year, $12.00 for three years. Entered as Second Class matter August 29, 1936, at Post Office, Albany, New York, under the Act of March 3, 1879. BRANCH OFFICES: 520 North Michigan Avenue, Chicago 11, Ill; 69 Post Street, San Francisco 4; Aldwych House, Aldwych, London, W.C. 2; Washington, D. C. 4; Philadelphia 2; Cleveland 15; Detroit 2; St. Louis 8; Boston 16; Atlanta 3, Ga.; 621 So. Hope St., Los Angeles 14; 738-9 Oliver Building, Pittsburgh 22.

A McGRAW-HILL PUBLICATION

DEPARTMENTS

CHANGE OF ADDRESS

McGRAW-HILL PUBLISHING COMPANY,
330 West 42nd Street, New York 18, N. Y.

Director of Circulation:
Please change my address on Electronics

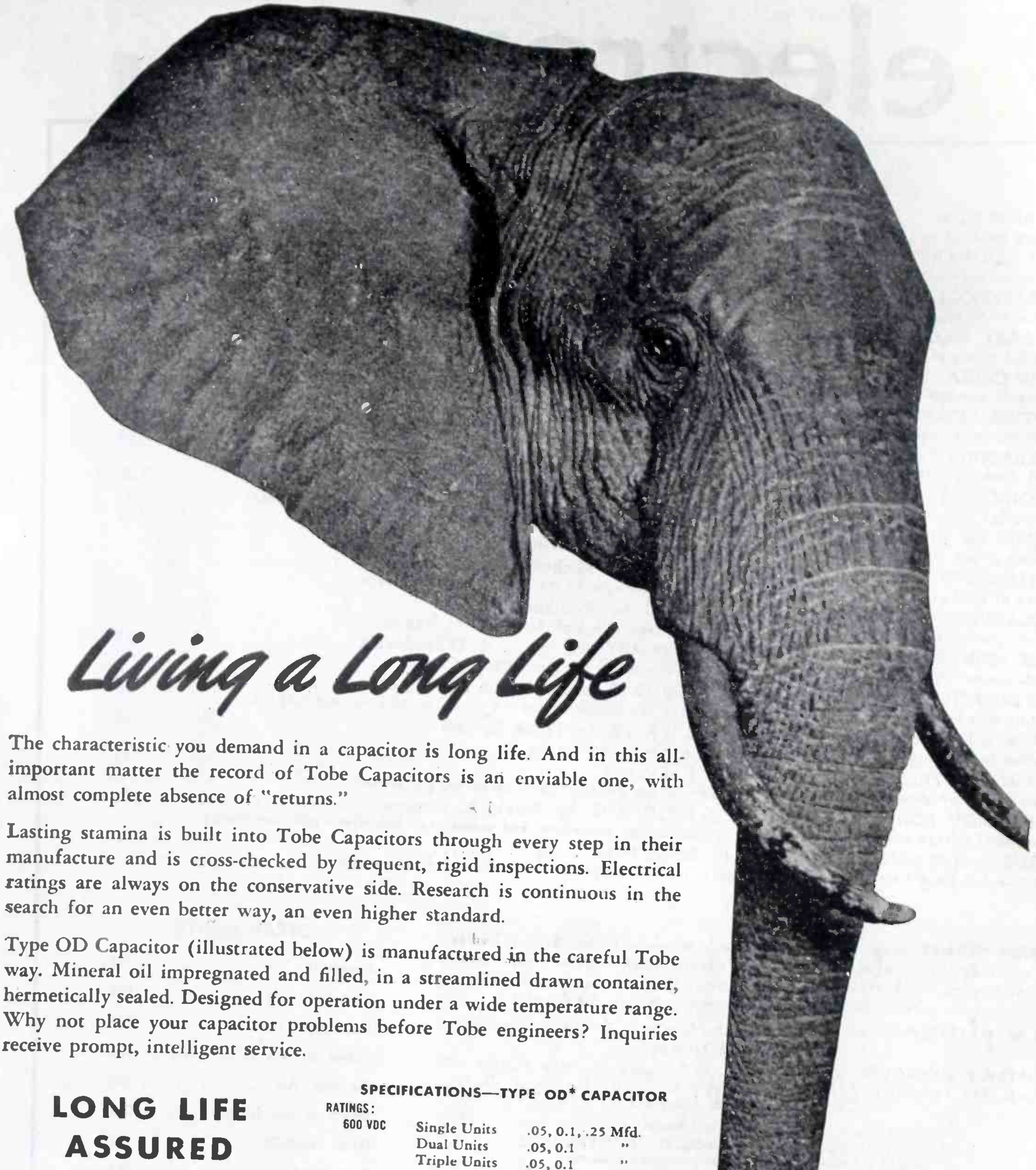
From ....

....

To ....

....

Signed ....



Living a Long Life

The characteristic you demand in a capacitor is long life. And in this all-important matter the record of Tobe Capacitors is an enviable one, with almost complete absence of "returns."

Lasting stamina is built into Tobe Capacitors through every step in their manufacture and is cross-checked by frequent, rigid inspections. Electrical ratings are always on the conservative side. Research is continuous in the search for an even better way, an even higher standard.

Type OD Capacitor (illustrated below) is manufactured in the careful Tobe way. Mineral oil impregnated and filled, in a streamlined drawn container, hermetically sealed. Designed for operation under a wide temperature range. Why not place your capacitor problems before Tobe engineers? Inquiries receive prompt, intelligent service.

LONG LIFE ASSURED

SPECIFICATIONS—TYPE OD* CAPACITOR

RATINGS:

600 VDC	Single Units	.05, 0.1, .25	Mfd.
	Dual Units	.05, 0.1	"
	Triple Units	.05, 0.1	"
1,000 VDC	Single Units	.05, 0.1	Mfd.
	Dual Units	.05, 0.1	
	Triple Units	.05	

STANDARD CAPACITANCE TOLERANCE—plus or minus 20.%**

TEST VOLTAGE—twice DC rating

GROUND TEST—2,500 Volts DC

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

SHUNT RESISTANCE:

.05 to 0.1 Mfd.—20,000 Megohms
.25 Mfd. —12,000 Megohms

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

CONTAINER SIZE:

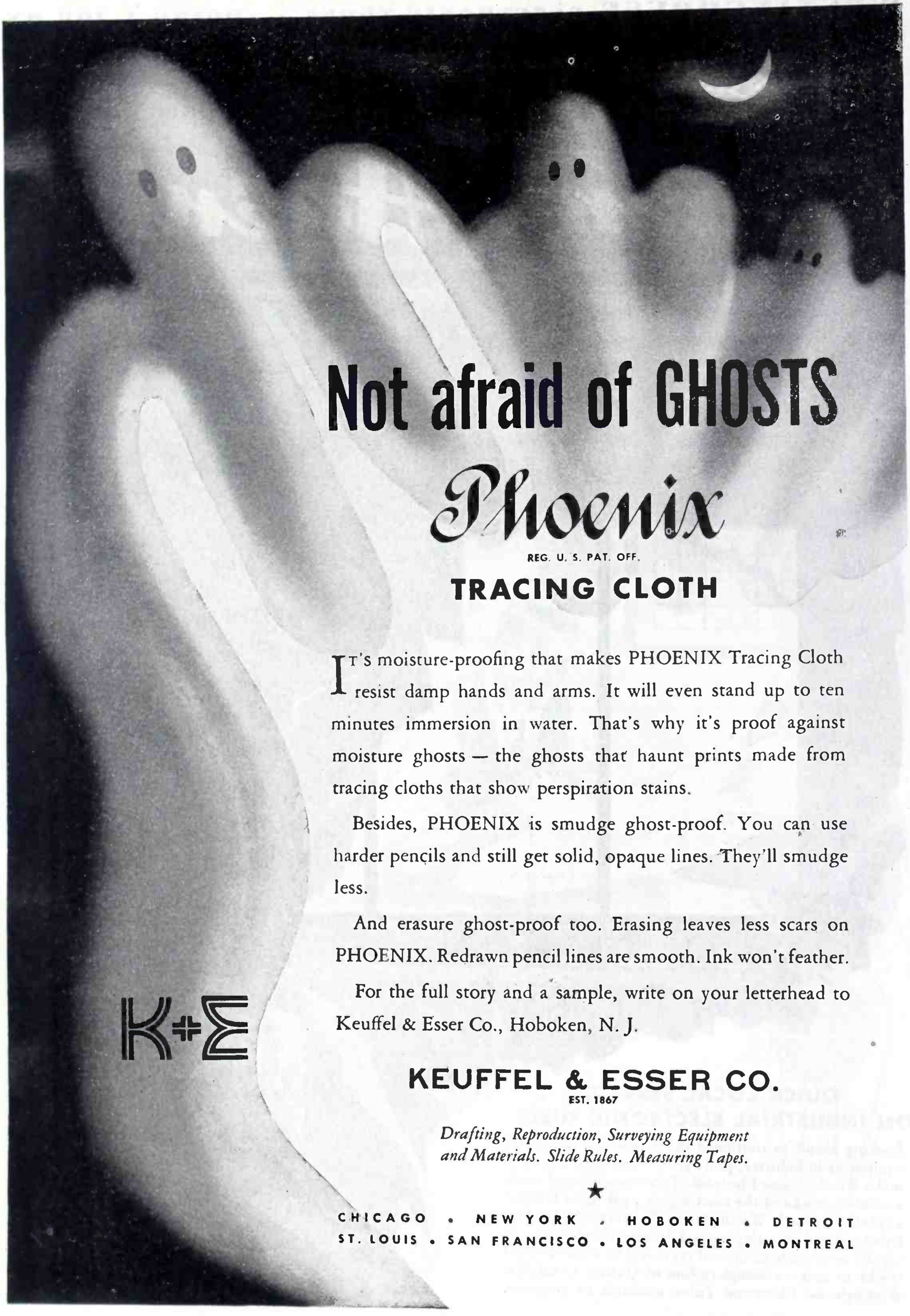
Width 9/16", length 1-11/16", height 1-17/32"

MOUNTING HOLE CENTERS—2-1/8"

Illustration shows capacitor with bottom terminals. Capacitors also available with top terminals.
*Data sheets showing complete code number for units having a specific capacitance value and voltage ratings available on request. **Other tolerances available.

TOBE DEUTSCHMANN CORP.
TOBE
CANTON · MASSACHUSETTS

a small part in victory
TODAY
a big part in industry
TOMORROW


Not afraid of GHOSTS
Phoenix
REG. U. S. PAT. OFF.
TRACING CLOTH
It's moisture-proofing that makes PHOENIX Tracing Cloth resist damp hands and arms. It will even stand up to ten minutes immersion in water. That's why it's proof against moisture ghosts — the ghosts that haunt prints made from tracing cloths that show perspiration stains.
Besides, PHOENIX is smudge ghost-proof. You can use harder pencils and still get solid, opaque lines. They'll smudge less.
And erasure ghost-proof too. Erasing leaves less scars on PHOENIX. Redrawn pencil lines are smooth. Ink won't feather.
For the full story and a sample, write on your letterhead to Keuffel & Esser Co., Hoboken, N. J.
K+E
KEUFFEL & ESSER CO.
EST. 1867
Drafting, Reproduction, Surveying Equipment and Materials. Slide Rules. Measuring Tapes.
CHICAGO • NEW YORK • HOBOKEN • DETROIT
ST. LOUIS • SAN FRANCISCO • LOS ANGELES • MONTREAL

EVERY FRONT, IN EVERY BATTLE, IN EVERY WAR INDUSTRY

WOULD GIVE THEIR EYE-TEETH TO KNOW

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

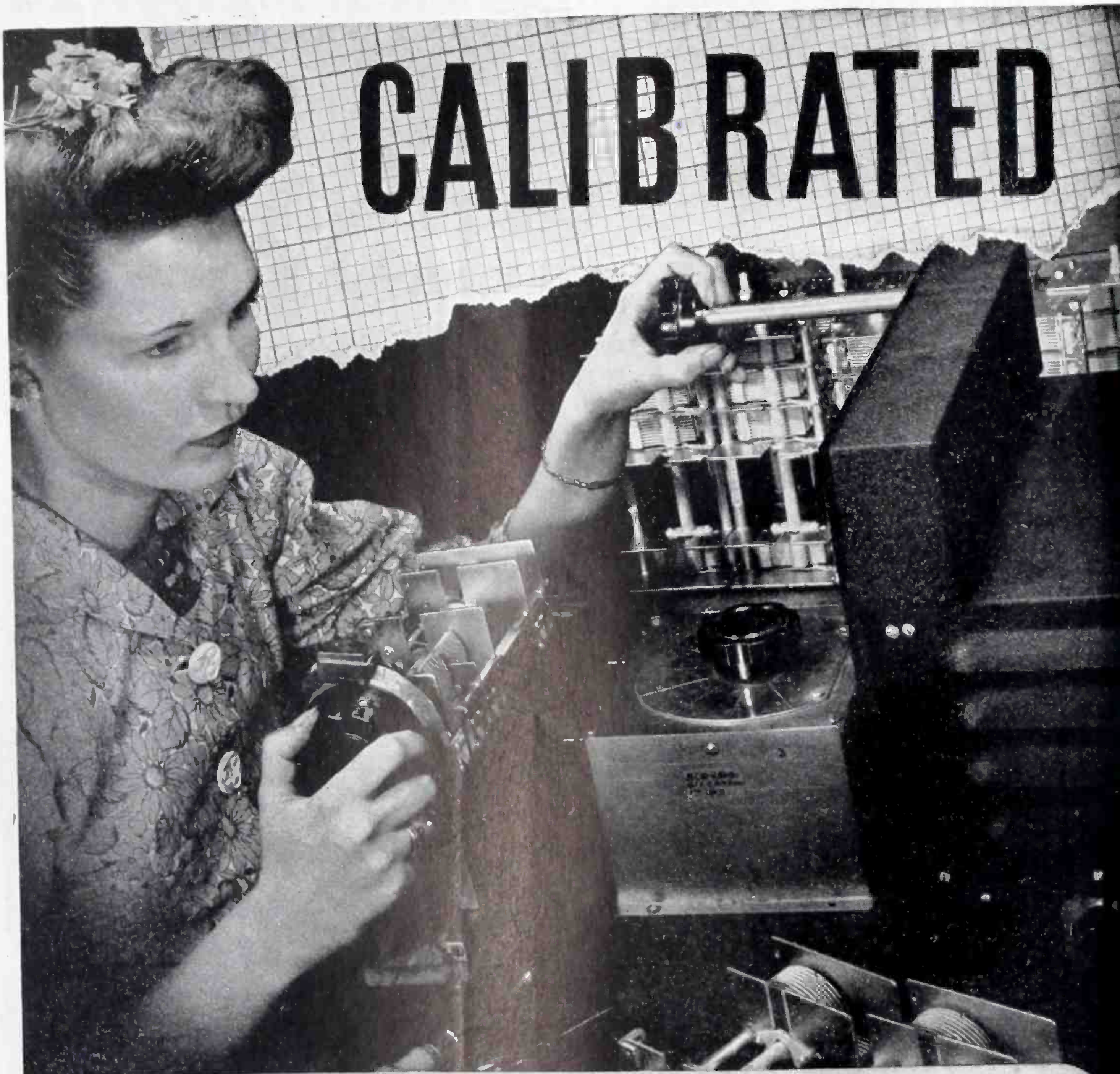
To meet the enormous demands for Westinghouse Electronic Tubes—from the armed forces as well as war industry, we've increased floor space 20 times, trained 28 new workers for each one formerly employed, multiplied output 30 times! And now we're not only meeting time and quality musts on all Government contracts—we're also continuing to supply the heavy demands of war industry. Your nearest Westinghouse Office or Distributor will be glad to receive your inquiries for Westinghouse Tubes. Westinghouse Electric & Manufacturing Company, Bloomfield, N. J.

Westinghouse

PLANTS IN 25 CITIES OFFICES EVERYWHERE

Electronic Tubes at Work

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



Through the development of our own highly specialized calibrating equipment Hammarlund engineers have made possible mass production of variable capacitors with accuracies comparable to laboratory standards.

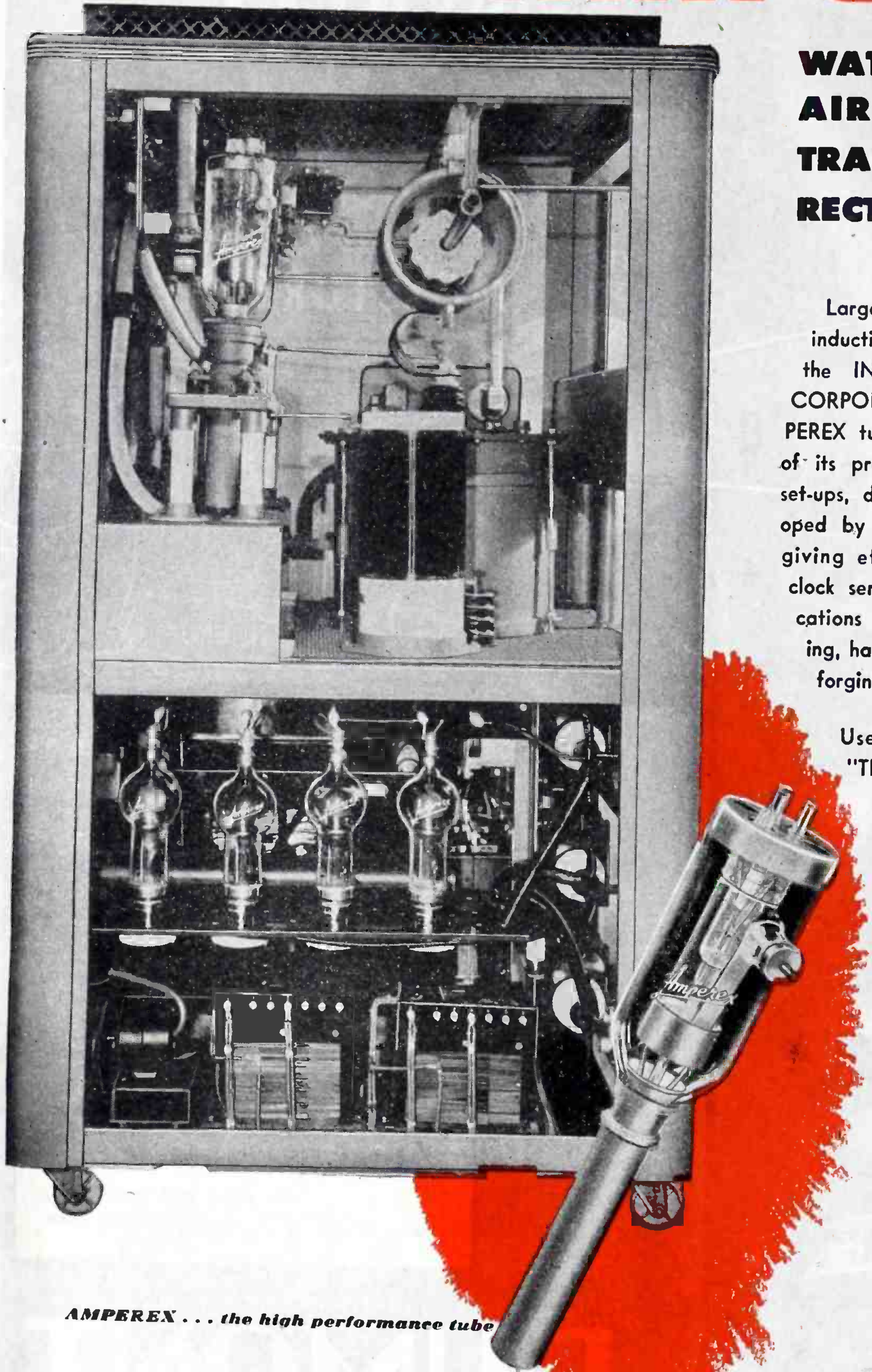
HAMMARLUND

ESTABLISHED 1910

THE HAMMARLUND MFG. CO., INC., 460 W. 34TH ST., N. Y. C.

MANUFACTURERS OF PRECISION COMMUNICATIONS EQUIPMENT

Why AMPEREX



WATER AND AIR COOLED TRANSMITTING AND RECTIFYING TUBES

Largest producer of electronic induction heating equipment, the INDUCTION HEATING CORPORATION utilizes AMPEREX tubes for the "heart" of its products. "Thermonic" set-ups, designed and developed by this company, are giving efficient round-the-clock service in such applications as brazing, annealing, hardening, melting and forging.

Used ever since the first "Thermonic" unit was marketed, AMPEREX tubes have provided consistently satisfactory service in all assignments. This, then, is another high endorsement for the performance of AMPEREX tubes. Consult an AMPEREX engineer for the solution to your present or peacetime problem.

ARMY E NAVY

AMPEREX . . . the high performance tube

AMPEREX ELECTRONIC CORPORATION

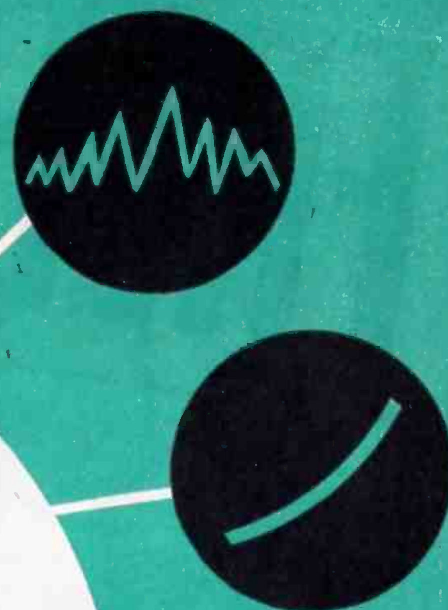
79 WASHINGTON STREET • • • • • BROOKLYN 1, N.Y.

EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N.Y., CABLES: "ARLAB"


The TINYMITE
SMALLEST PAPER CAPACITOR . . . yet 100% MOISTUREPROOF
TYPE P5N
TYPE P4N
FEATURES
1. Bakelite Resinoid Ends. Lead wire cannot pull out, even under hot conditions.
2. Non-Inductive.
3. Excellent Temperature Coefficient.
4. Very high leakage Resistance.
5. Fine Power-Factor.
6. Range from 20 MMFD to .25 MFD. From 150 volts to 600 volts.
7. Types P4N, P5N for 100% humidity operation.
8. Types P4, P5 for 95% humidity operation.
Samples and price list on Request
BUY EXTRA WAR BONDS . . .
. . . 'Til THE WAR IS OVER.
Pat. Pend.
DUMONT
ELECTRIC CO.
MFR'S OF
CAPACITORS FOR EVERY REQUIREMENT
34 HUBERT STREET NEW YORK, N. Y.

Instantaneous Panoramic Presentation of Conditions!

ELECTRONIC METERING for PRODUCTION TESTING



SHERRON TEST UNITS

The Use of Cathode Ray Tubes in Modern Test Equipment Offers 5 Definite Advantages.

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

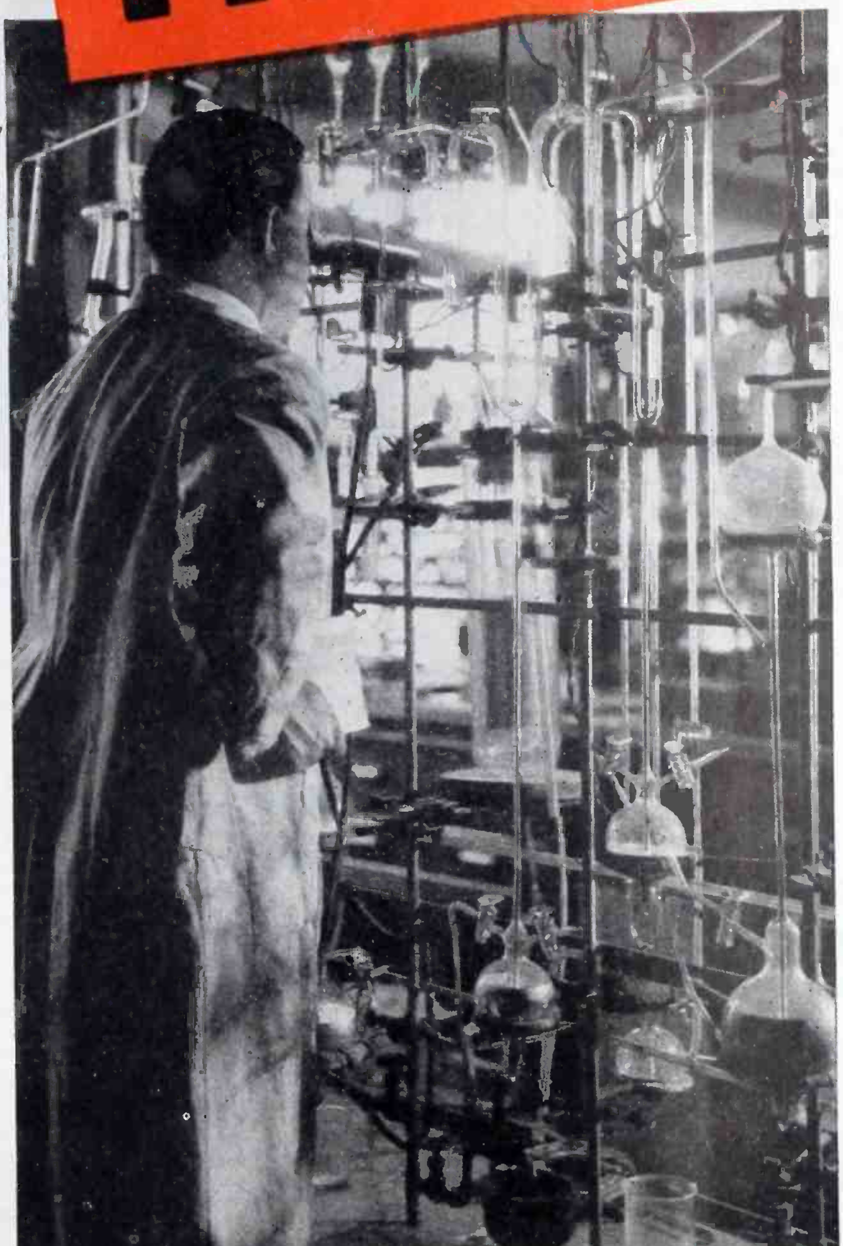
Sherron Electronics

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

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

SHERRON METALLIC CORP.

1201 Flushing Ave. Brooklyn 6, N. Y.



A NEW COMPACT, SHOCK-PROOF IMPULSE-INITIATED TIMER

. . . . . . 71.8% smaller than previous conventional units used for similar applications, Struthers-Dunn Type PSEH-1 impulse-initiated timer has the added advantages of rugged shock-proof construction, easily-accessible contacts, and dust-proof cover. Made in both AC and DC types, it operates the contacts at the end of a delay interval after power has been applied, or after receipt of a momentary impulse from a push-button, limit switch, or other source. The adjustable timing range is 20-to-1. The mechanism is immediately recycling. A double-pole, double-throw auxiliary relay is built in to provide a variety of circuit arrangements common to, or isolated from the control circuit. It can be supplied for AC operation on 110 V. 60 cycles or 25 cycles; 220 V. 60 cycles or 25 cycles; or for DC operation at any specified voltage from 6 to 120 volts. Size of a typical PSEH-1 Timer is 3½" x 3⅝" x 3¾".

WRITE *for copy of the Struthers-Dunn Catalog and Relay-Timer Data book.*

•

For details on the Timer illustrated above, please specify Type PSEH-1.

STRUTHERS-DUNN, Inc., 1321 Arch St., Philadelphia, Pa.

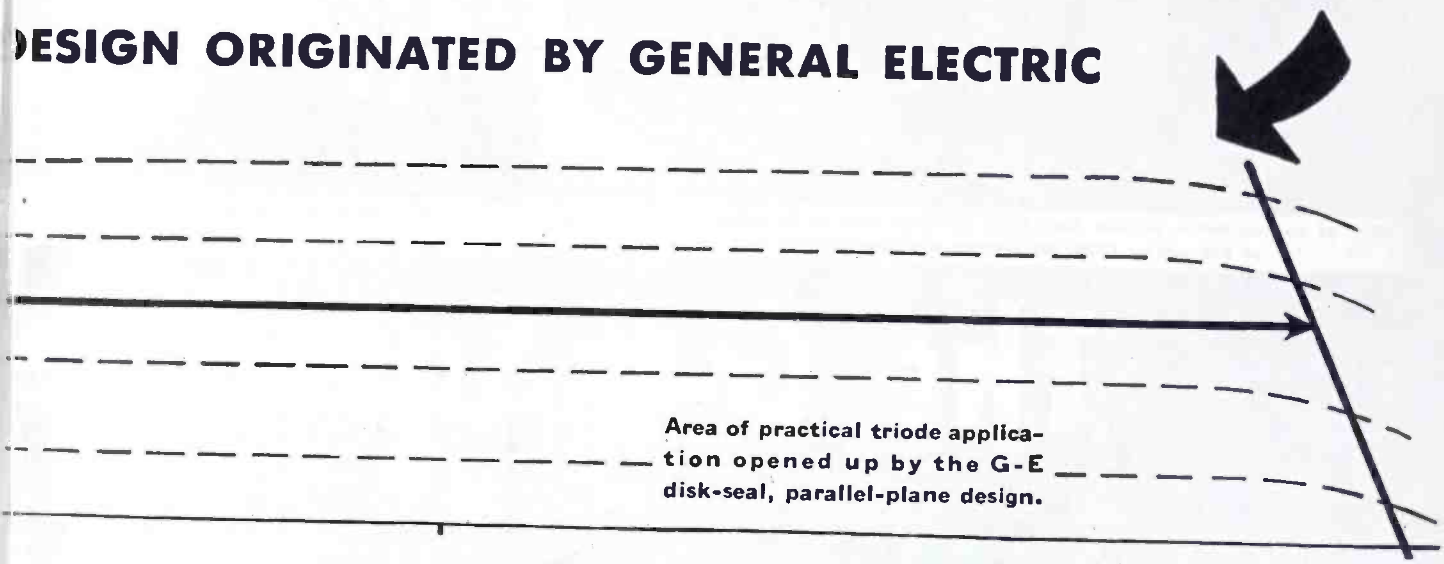
STRUTHERS-DUNN

5,288 RELAY TYPES

DISTRICT ENGINEERING OFFICES: ATLANTA • BALTIMORE • BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND DALLAS • DENVER • DETROIT • HARTFORD • INDIANAPOLIS • LOS ANGELES • MINNEAPOLIS • MONTREAL NEW YORK • PITTSBURGH • ST. LOUIS • SAN FRANCISCO • SEATTLE • SYRACUSE • TORONTO • WASHINGTON

G-E LIGHTHOUSE TUBE

AN EXAMPLE OF THE NEW DISK-SEAL, PARALLEL-PLANE DESIGN ORIGINATED BY GENERAL ELECTRIC



HIS new tube is one of the most impor-
nt developments in electronic-tube
story — ranking with such other G-E
ectronic firsts as the screen-grid tube,
te high-vacuum tube, the mercury-
por rectifier, and the thyratron.

The new G-E disk-seal, parallel-plane
sign*—developed by engineers of the
E Electronics Laboratory — opens up
ast new field of radio frequencies for
actical use. It extends the top fre-
encies at which electronics engineers
n work . . . thus reaching into hitherto
touched segments of the ultra-high
quency spectrum.

The advent of this extraordinary new
e will make it possible to build greatly
proved electronic devices for impor-
t post-war applications.

*GATRON IS THE GENERIC NAME ASSIGNED TO
S OF THIS DESIGN

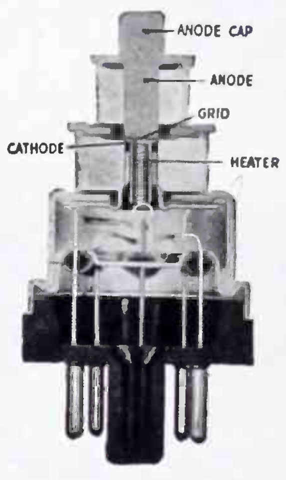
It will, for the first time, enable engineers to take advantage of high frequency channels that could not previously be used to advantage.

It will enable the relay transmitters of FM and television networks to function at even higher frequencies than heretofore anticipated and thus provide more communication channels.

It is quite possible—in fact, probable—that ultimately a large "family" of lighthouse tubes will be available for dozens of applications in the radio, television, and industrial-electronics fields. Thus is added another G-E "first" to support the fact that—

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

For information on electronic tubes, write to *Electronics Department, General Electric, Schenectady, New York.*



CONSTRUCTION AND CHARACTERISTICS

The disk-seal, parallel-plane design of the G-E megatron eliminates the conventional type of grid, anode and cathode. Instead of components being fitted *around* one another, they are constructed in simple, *parallel planes* or layers—with glass and metal fused together to provide a shock-proof construction. This design permits an extremely compact over-all tube structure.

For the first time, it makes possible the use of new circuits with which yesterday's dreams become today's realities.

GENERAL ELECTRIC

178-C6-8850

STOP "Leap-Frog" Corrosion

"Leap-Frog" Corrosion damages underground pipes and cables.

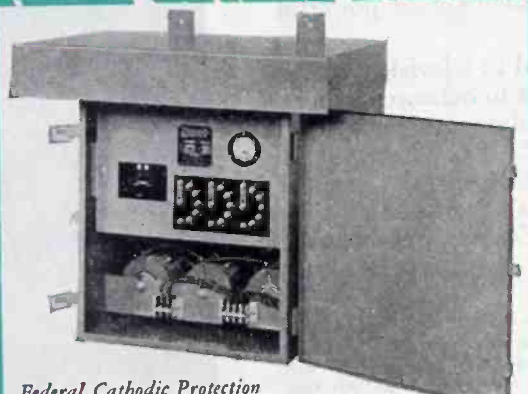
Pipes or other metal structures are in places electro-positive in relation to the soil and due to natural galvanic action corrosion results. Metal is taken away from one section of pipe and deposited somewhere else along the exposed pipe.

By using Federal Cathodic Protection Rectifiers, "Leap-Frog" corrosion is foiled. On constant guard is a direct current charge which cancels the harmful electrolytic corrosive action on oil, gas and water pipelines and underground cables.

These Federal units have no moving parts, so they last indefinitely — with the absolute minimum of attention. In desert heat or torrid dampness they keep on the job day and night.

Proper engineering for the corrosion problem at hand calls for the specialized consulting engineering service which is yours — when you look to Federal. Write today for full details.

FEDERAL TELEPHONE & RADIO FTR



Federal Cathodic Protection Rectifier, Model FTR 5114-S. Output 20 amperes at 10 to 40 volts. Other sizes as required.

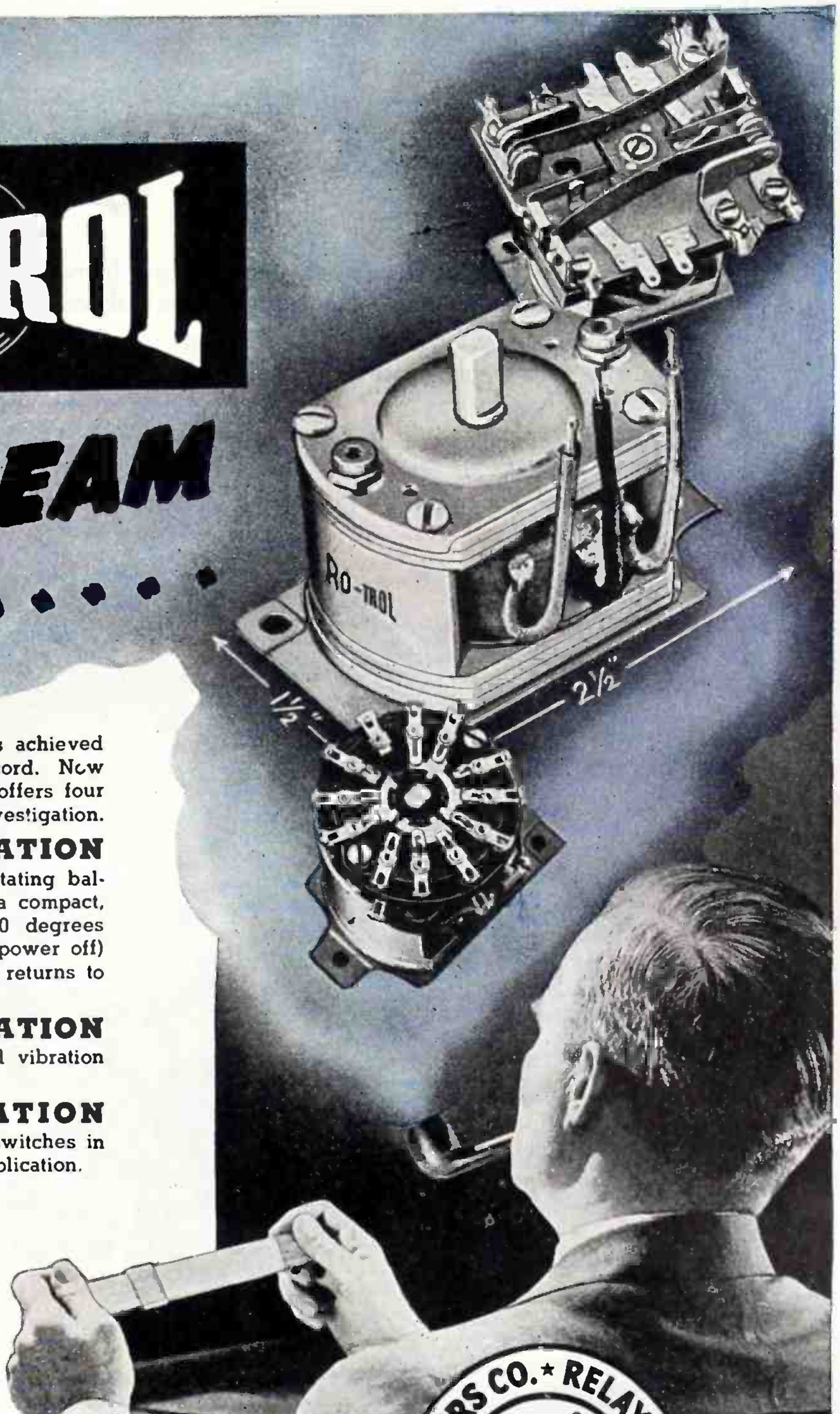
Federal Telephone and Radio Corporation

AN IT&T ASSOCIATE

Newark 1, N. J.

RO-TROL

A RELAY DREAM Come true . . . . .



This new type Rotary Relay has achieved a high military performance record. Now available for commercial use, it offers four advantages worthy of your investigation.

1. IMPROVED METHOD OF OPERATION
Contrary to Conventional Relays, it operates on a rotating balanced principle. The basic unit (center of photo) is a compact, two position driving mechanism providing up to 30 degrees clockwise or counter clockwise rotation from normal (power off) position. The shaft rotates one way under power and returns to normal position by spring action.

2. WITHSTANDS EXTREME VIBRATION
The rotating balanced mechanism makes it shock and vibration proof, under adverse conditions.

3. WIDE RANGE OF APPLICATION
The basic unit is adapted to operate wafer switches, switches in separate compartments, or special built-up switch application.

4. COMPACT & RUGGED DESIGN
The basic unit measures 2½"x1½"x1¾". The relay structure is made of finest magnetic metal accurately machined and properly annealed. The coil is wound to exacting specifications and treated to withstand severe humidity and salt spray conditions. Each part proportioned in size for its specific function . . . a powerful, rugged, space saving device.

Get Catalog E-9

Illustrates "RO-TROL'S" adaptability to unusual and varied relay applications. Complete specifications and detail drawings. Also illustrates other Price Relays for Time Delays, Motor Starting, High Speed Keying, Antenna and Power Contactors. Write today for this Catalog.

PRICE BROTHERS CO. ★ RELAYS CONTROLS
HUSKY

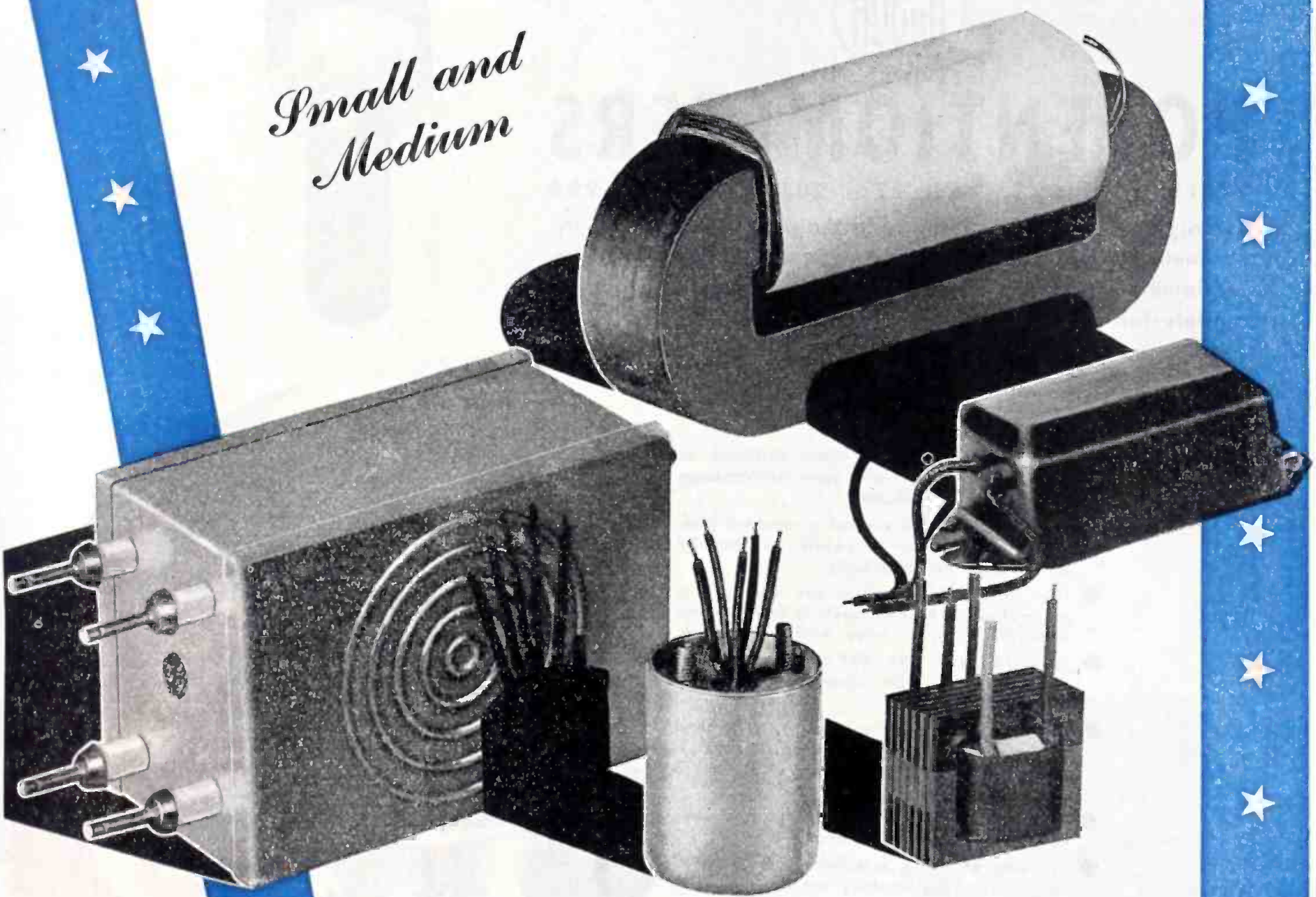
ARMY E NAVY

PRICE Brothers Co. FREDERICK, MARYLAND

RELAYS, CONTROLS, AND MAGNETIC DEVICES FOR ELECTRONIC & INDUSTRIAL APPLICATION

TRANSFORMERS

Small and Medium



Control of all stages of production is the watchword at Consolidated Radio Products Company. That is why Consolidated's products can be depended on for quality, high efficiency, consistent performance and long life. International acceptance is the result of such high standards of production.

Electronic and Magnetic Devices

CONSOLIDATED RADIO

Products Company

350 W. ERIE ST., CHICAGO 10, ILL.

ATTENTION TO DETAIL ADDS UP TO DEPENDABLE PERFORMANCE

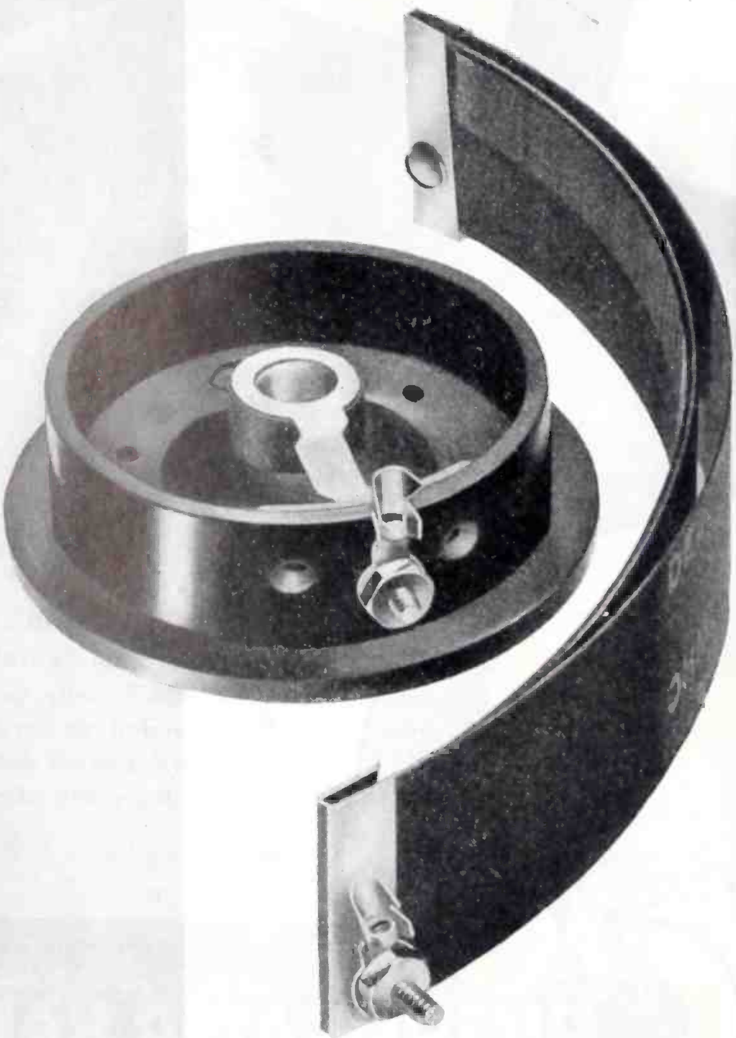
DeJUR U.S.A.

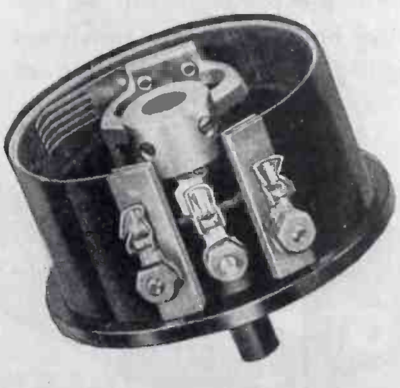
POTENTIOMETERS

TYPES 260, 275, 261, 276, 281, 291, 292, 296

Twenty-five years of experience in the precision electrical instrument field assure quality and dependability in DeJur potentiometers. We have created a wide variety of standard models for practically all applications. Special attention is paid to individual specifications.

- Winding strip is wound on a linen bakelite card which has been carefully sanded before winding.
- Windings are made of either Nichrome or Advance wire, depending upon the resistance of the card to be wound.
- The card, wrapped around a moulded phenolic base, is held in position by heavily plated brass nuts and bolts.
- The wiper, incorporating five contacts, is made of plated bronze, carefully buffed where electrical contact is made with the winding.
- Types 261, 276, 281, 292 and 296 incorporate an "edge" type wiper for closer tolerances.
- The shaft may be either bakelite, cold rolled steel suitably plated, or solid brass, depending on whether the instrument is to have a live or dead shaft.
- The bushing which supports the shaft is made of precision machined brass.
- For ease of wiring installation, the selected terminal lugs are carefully tinned.
- In assembly, the cards are treated by dipping and baking to assure adhesion of the winding to the card; the entire unit is assembled to exacting specifications.





A DEJUR ENGINEER IS AVAILABLE FOR A DISCUSSION OF YOUR PRESENT OR POSTWAR APPLICATIONS

DeJur-Amsco Corporation

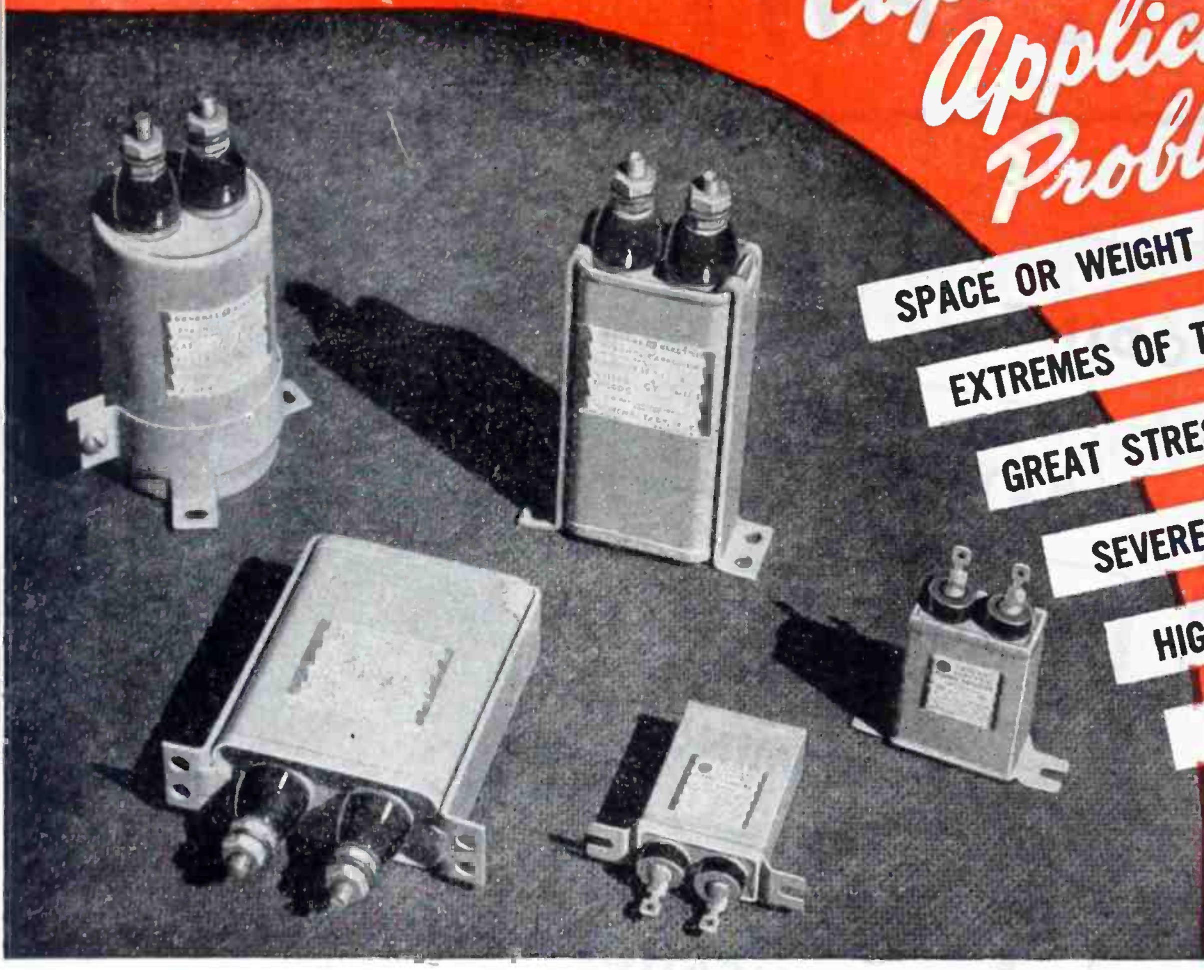
MANUFACTURERS OF DeJUR METERS, RHEOSTATS, POTENTIOMETERS AND OTHER PRECISION ELECTRONIC COMPONENTS

GENERAL OFFICE: NORTHERN BLVD. AT 45th ST., LONG ISLAND CITY 1, N. Y.

SHELTON FACTORY: Shelton, Conn. • CANADIAN SALES OFFICE: 560 King Street West, Toronto

BUY MORE THAN BEFORE . . . KEEP "HOARDING" WAR BONDS

HAVE YOU ANY OF THESE *Capacitor Application Problems?*



SPACE OR WEIGHT LIMITATIONS
EXTREMES OF TEMPERATURE
GREAT STRESS OR SHOCK
SEVERE VIBRATION
HIGH ALTITUDE
HUMIDITY

Whatever your specifications, we're likely to have the answer

WE are in an excellent position to provide you with hermetically-sealed capacitors for wartime applications. Our extensive engineering, research, and manufacturing facilities are at your service.

In some cases there will be no need to look further than our standard line of Pyranol* capacitors for built-in applications.

The line includes more than 350 ratings in space-saving shapes and sizes. Many of the ratings are available in three shapes—oval, cylindrical, rectangular—to make your design problems easier: And they can be mounted in any position.

BE SURE TO GET your copies of our time-saving catalogs on d-c (GEA-2621A) and a-c (GEA-2027B) types. Ask your G-E representative for them by number, or write to General Electric, Schenectady, New York.

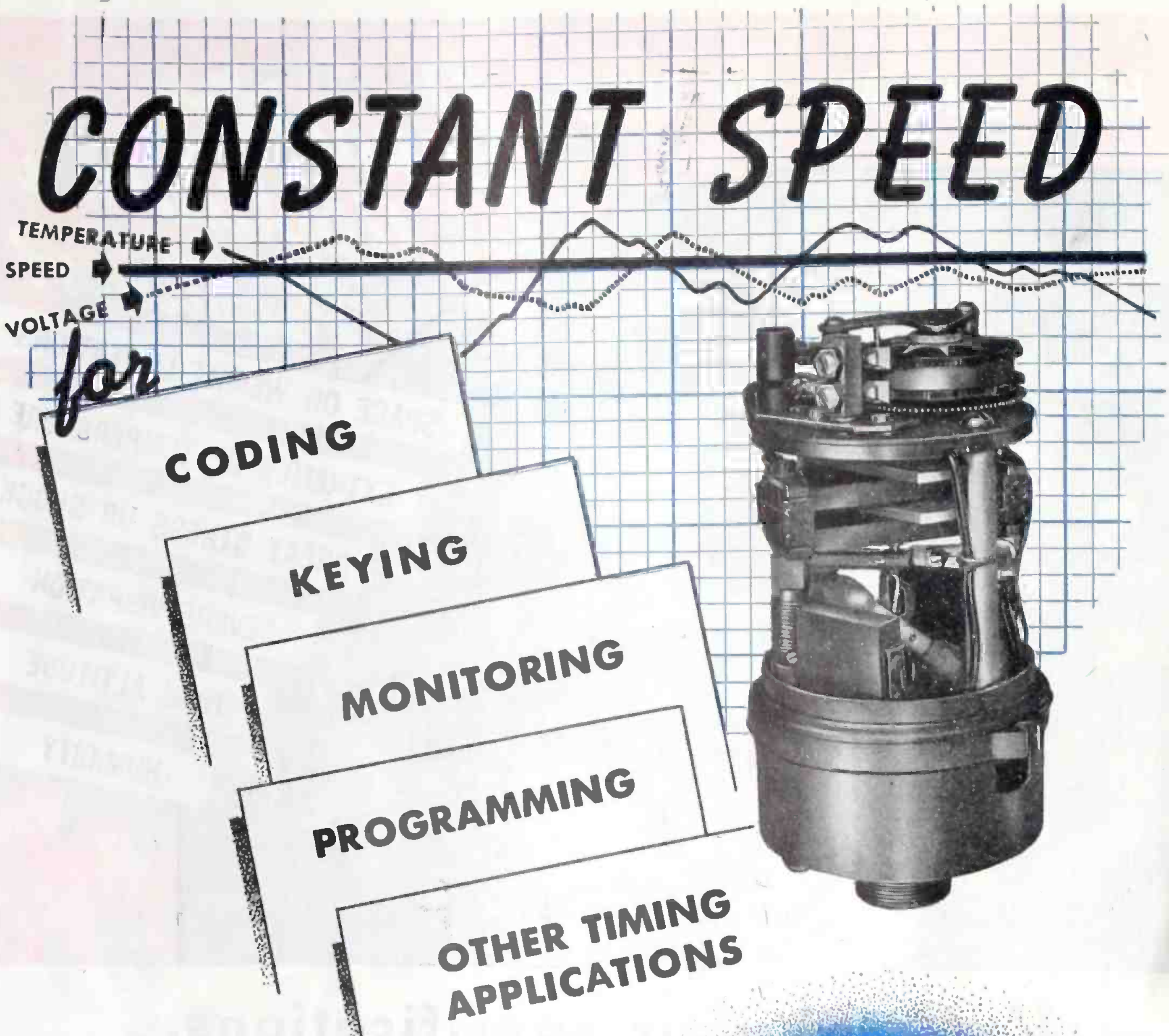
**Pyranol is the G-E trade mark for capacitors and for askarel, the synthetic, noninflammable liquid used in treating G-E capacitors.*

PYRANOL CAPACITORS

BUY WAR BONDS

GENERAL ELECTRIC

407-60-5700



A GOVERNOR automatically compensates for voltage variations of ± 20%.

While the motor normally operates at 450 rpm., the governor is adjustable, allowing a change in speed from 360 to 540 rpm.

The motor shaft drives a gear train which provides an output shaft speed of 5 rpm. This gear train can be modified to meet other speed requirements.

Interchangeable cams permit the use of any desired timing characteristic for two or more separate circuits.

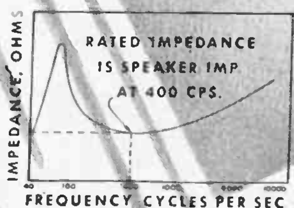
Write for illustrated technical bulletin.

THE W&T CONSTANT SPEED MOTOR MECHANISM

WALLACE & TIERNAN PRODUCTS, INC.

BELLEVILLE 9 — NEW JERSEY

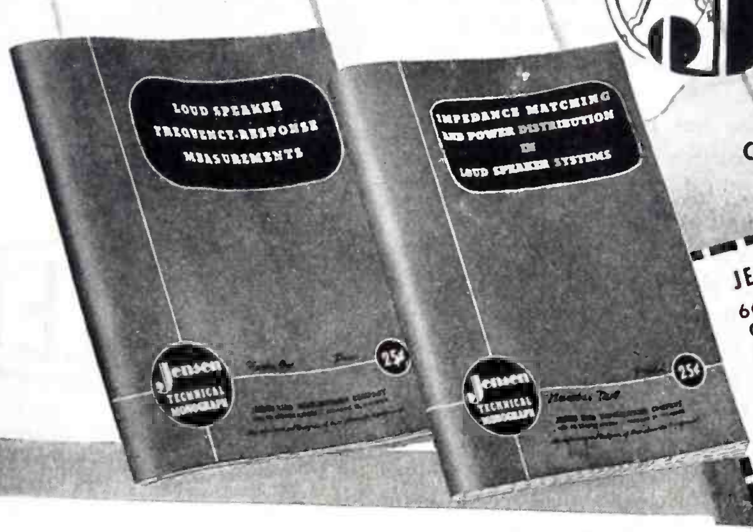
How to Match Impedance and Distribute Power in Loud Speaker Systems



Here is Number 2 in the series of practical, instructive Monographs prepared by the Jensen Technical Service Department. The title, "Impedance Matching and Power Distribution in Loud Speaker Systems," suggests the scope and treatment of a subject in which everyone concerned with loud speakers and the reproduction of sound, is vitally interested. ¶ The reading material is supported by twenty-eight drawings and tables. More than a score of questions are described, illustrated and solved. One of the problems is that of a comprehensive sound system for a military installation. ¶ Like Monograph Number 1—"Loud Speaker Frequency-Response Measurements"—Number 2 is offered by JENSEN in the interest of *improved sound reproduction.* Get either copy, or BOTH, from your jobber or dealer, or fill out the coupon and mail it with 25c for *each* book, to:

IMPEDANCE MATCHING and POWER DISTRIBUTION in LOUD SPEAKER SYSTEMS. The second of a valuable and important series of treatises on the selection, installation and operation of loud speakers.

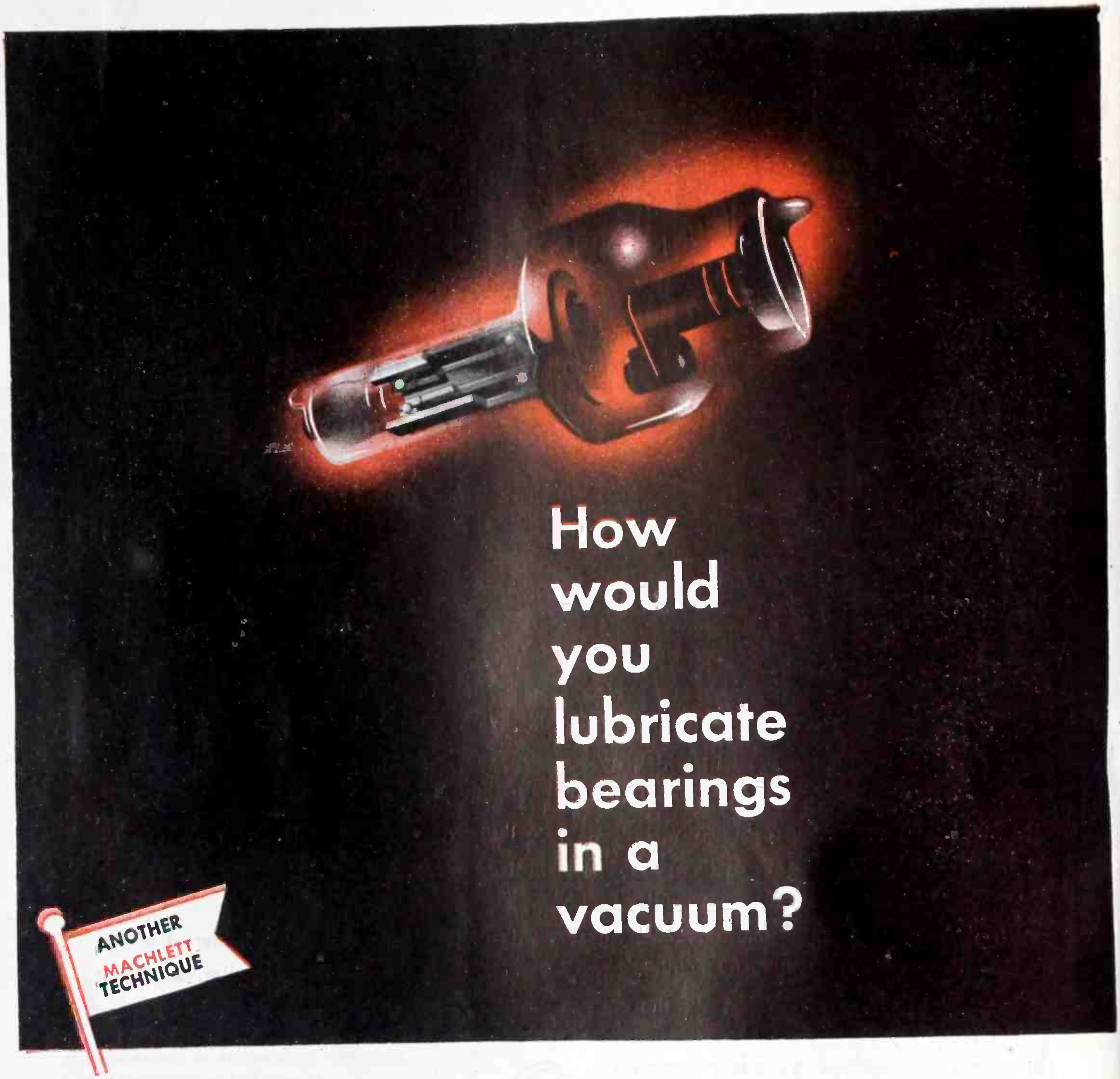
FREE to men in the Armed Services and to Libraries and Technical Schools.



Jensen

RADIO MANUFACTURING COMPANY
6617 SOUTH LARAMIE AVENUE
CHICAGO 38, ILLINOIS

JENSEN RADIO MANUFACTURING COMPANY
6607 South Laramie Avenue
Chicago 38, Illinois
Send me at once:
☐ Impedance Matching and Power Distribution in Loud Speaker Systems.
☐ Loud Speaker Frequency-Response Measurements.
(Check one or both. Send 25c for each book ordered.)
NAME
ADDRESS
CITY ZONE STATE

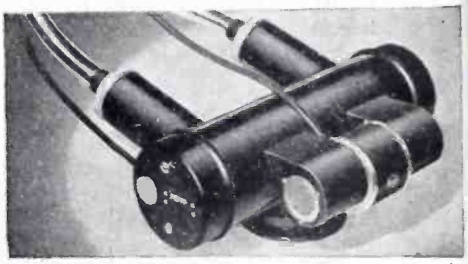


This is a cross-section of the Machlett Dynamax X-ray tube. The ball bearings support the anode, which rotates at 3000 r.p.m., and reaches a temperature of 1000° F. The entire structure is in a vacuum of about 10^{-6} mm. of mercury, or a billionth of an atmosphere.

Conventional lubricants cannot be used, because they would destroy the vacuum and the tube. Machlett's scientific studies showed that a very thin film of certain metals can act as lubricant. Pure silver was found most advantageous. An almost molecular-thin film of it is deposited upon the balls in a vacuum, by a unique method.

So successful was this technique that Machlett, five years ago, guaranteed its Dynamax rotating anode tube for 10,000 exposures. Today it outlasts conventional stationary anode tubes. Some amazing records have been made with it, the best to date being 272,610 exposures, at the Army Examining and Induction Station, Pittsburgh, Pa.

This tube has a focal spot so small as to produce exceedingly sharp pictures, and an X-ray beam so intense as to make possible exposures as short as 1/60th sec. It was the solution of the lubrication problem that added reliability to these advantages. Machlett employs many other advanced techniques in the manufacture of its various types of high-vacuum tubes for medical, scientific and industrial purposes . . . Machlett Laboratories, Inc., Springdale, Connecticut.



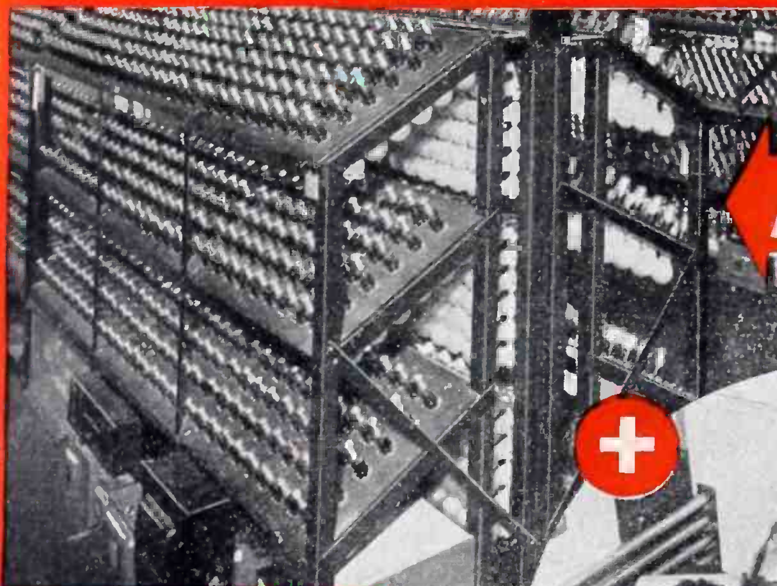
This is the Machlett Dynamax Rotating Anode tube, 100 kilovolts, 50 kilowatts, as supplied in an oil-filled, shockproof housing with air circulator and vapor-proof cable terminals.

MACHLETT

X RAY TUBES SINCE 1898

TODAY THEIR LARGEST MAKER

A+B=X ★★★



RECEIVING TUBE TECHNIQUE

A Oldest manufacturer specializing on radio receiving tubes — the originator of the now standard BANTAM GT — Hytron has been developing skill in high-speed, soft-glass receiving tube technique since 1921.

+

SPECIAL PURPOSE ENGINEERING

B Hytron engineers originated BANTAM JR. hearing-aid tubes—popular U-H-F types HY75, HY114B, HY615—instant-heating beam tetrodes HY65, HY67, HY69, HY1269—and numerous other special tubes.

=X THE ANSWER

Add A to B, and you have the answer Hytron is able to give the Services when they demand special purpose and transmitting tubes in staggering quantities and at economical prices.

1616 Consider a few examples. Substituting soft for hard glass, a mesh for a ribbon filament, Hytron beat the promise by months on requirements for the high-voltage thermionic type 1616 rectifier—through application of mass production methods. Result: The Navy's, "Well done!"

HY65 Typical of Hytron's instant-heating beam tetrodes for mobile communications, the HY65 combines high-speed techniques with a thoriated tungsten filament and special r.f. design features which gave the Services a rugged, power-conserving, all-purpose beam tetrode. (Cf. JAN-1A spec.)

OD3/VR-150 Hytron engineering refinements include new starting electrode, lower starting voltage, painstaking processing. Add to these still-increasing high-speed manufacture. Result: "When we think of the OD3/VR-150, we think of Hytron."*

*Quotation from expediter for one of largest electronic equipment manufacturers.

2C26 Hytron solved a problem for the Services by designing a tube capable of performance and high ratings never before achieved in soft glass. Produced at receiving tube speed and priced at less than a fourth of the cost of tubes replaced, the little 2C26 delivers 2 KW of useful r.f. power under intermittent operating conditions.

WHAT ABOUT POST-WAR? Hytron design, development, and production facilities now serving our fighting men, will be yours to command. The A plus B of Hytron's know-how will supply answers to your special tube problems.

OLDEST EXCLUSIVE MANUFACTURER OF RADIO RECEIVING TUBES

HYTRON CORPORATION ELECTRONIC AND RADIO TUBES

HYTRON RADIO TUBES

ARMY NAVY

SALEM AND NEWBURYPORT, MASS.

BUY ANOTHER WAR BOND

JUST OFF THE PRESS

THE

First Completely Informative Catalog of Crystal Unit Designs and Specifications

Here, in one sensibly organized book, is the specific information you need on oscillator crystal units. Here is the first complete assembly of factual data on crystal unit design, construction, and application. It is yours, without obligation and without cost. Keep this new Crystal Products Company manual in your files. Use it as a workable tool in planning circuits and assemblies for precise radio frequency control.

A USABLE MANUAL FOR ELECTRONICS ENGINEERS

Profusely illustrated, with concise but complete explanatory descriptions, the pages of this book give:

- **Holder Illustrations**
- **Cut-Away Drawings**
- **Technical Specifications**
- **Functional Data**

This is not a treatise on the development of the Piezo-Electric properties of Quartz Crystals; it is a series of specific descriptions of approved Crystal Units that are now accepted and used in all types of practical electronic equipment, and that are available for present and future applications.

TAB-INDEXED FOR READY REFERENCE

Crystal Units are classified according to their fields of use. These include:

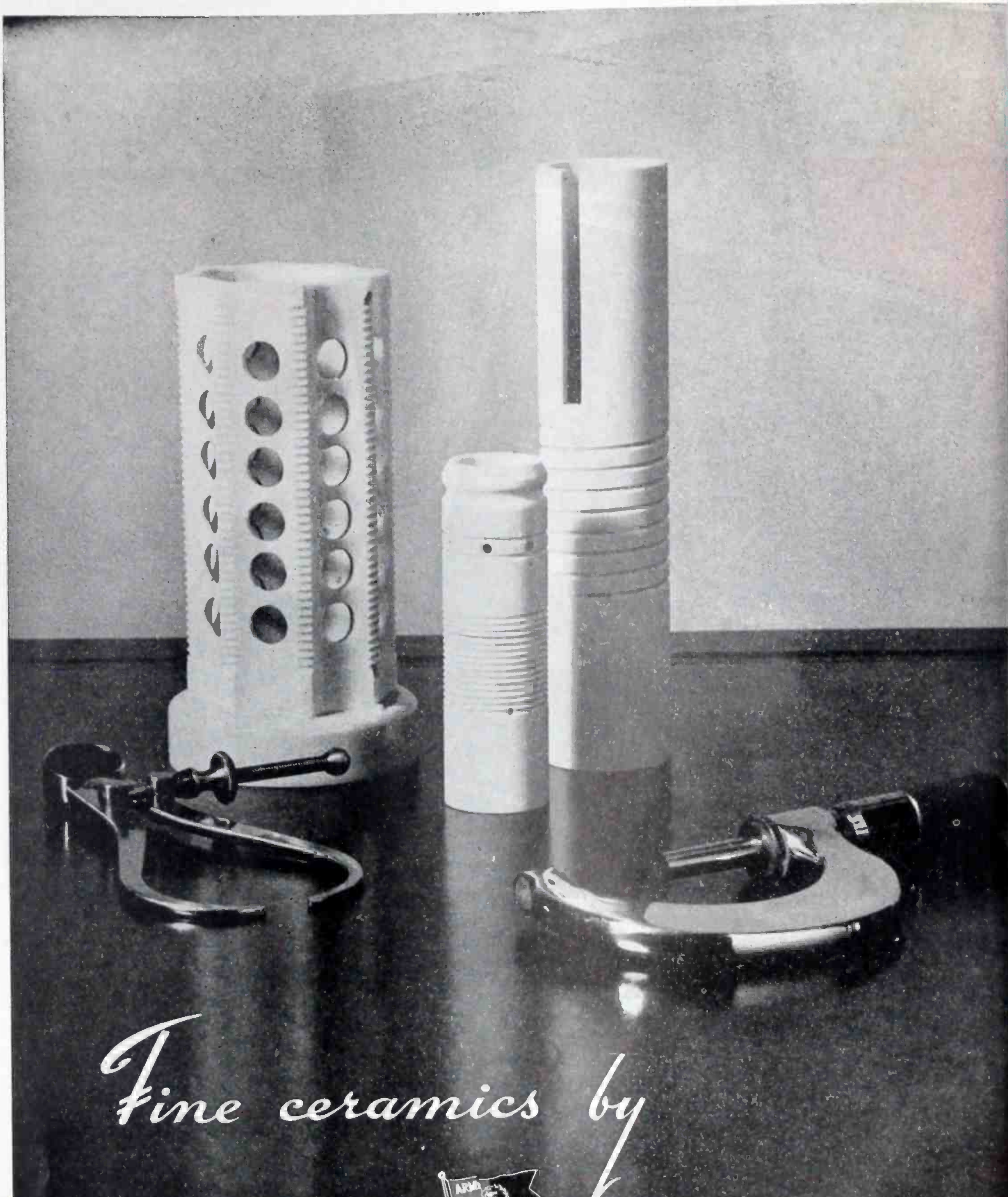
- Broadcasting
- Filter
- Test
- Amateur
- Aircraft
- Police-Marine
- Multiple Units

The latest developments in Crystal Holder design are described, as well as types of Crystal Blanks that can be engineered and finished to your own individual requirements.

WRITE NOW For YOUR FREE COPY

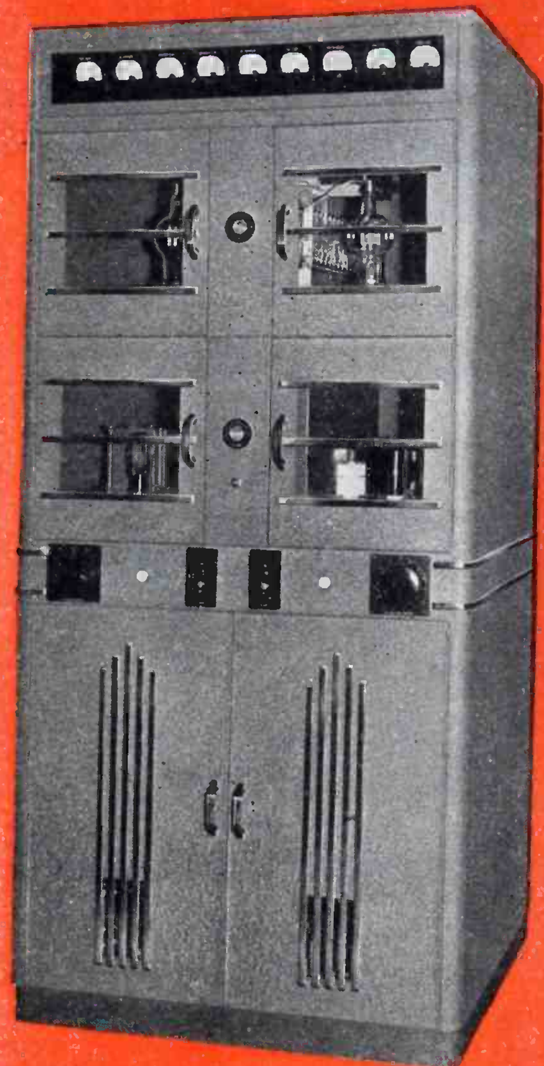
Crystal PRODUCTS COMPANY
1519 McGEE STREET KANSAS CITY, MO.

Producers of Approved Precision Crystals for Radio Frequency Control


Fine ceramics by
ARMY E NAVY
Centralab
CRL
Division of GLOBE-UNION INC., Milwaukee

VHF Signal generator of fractional meter wave lengths

Special custom built 1000 watt transmitter for a State Highway Patrol System.



ENGINEERING *Versatility* achieves variety in Transmitter design

TEMCO is a closely knit organization of versatile engineers, designers and technicians — working as a team — producing in single or volume quantities, transmitters of finer mechanical construction and electrical design in ever-broadening fields of applications.

Vision and versatility of TEMCO engineers meet the challenge of diversified assignments . . . alertly keeping pace with rapid advancements in radio research.

That is why entirely different groups of instruments are constantly emerging from our organization, all possessing the excellent qualities with which TEMCO-built communication equipment is endowed.

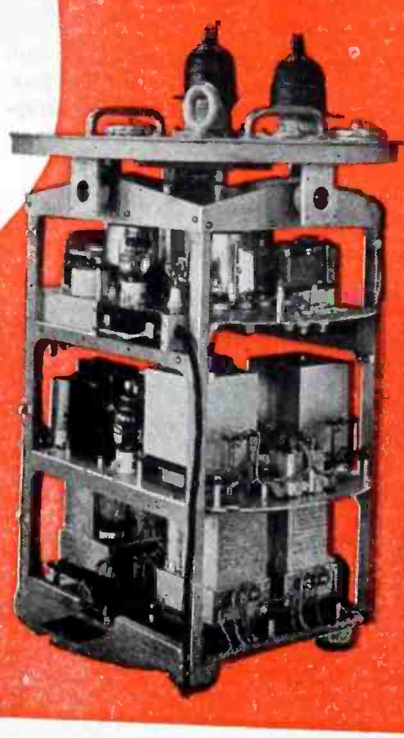
Your problem may be "off the beaten path" — all the more reason why TEMCO can serve you better in arriving at a speedy solution. Let us show you what we have accomplished for others. Write for a copy of the TEMCO catalog.

TRANSMITTER EQUIPMENT MFG. CO., INC.

345 Hudson Street, New York 14, N. Y.

TEMCO

RADIO COMMUNICATION EQUIPMENT



Self-contained buoy transmitter for special marine use.

SILICONES

Newly Developed Silicone Products

Now Available in Commercial Quantities

Dow Corning Fluids possess unique characteristics that warrant their close study by technicians in varied industries—especially those engaged in the current war effort. These water-white permanent liquids are furnished in two series, covering a wide range of viscosities.

DOW CORNING FLUIDS

Dow Corning Silicone Products Include:

RESINS—High temperature insulating varnishes for use with heat stable electrical insulating materials.

GREASES—For lubrication of valves in high temperature or corrosive chemical services. Plugcock Grease—for metal valves. Stopcock Grease—for glass and ceramic valves.

Summary of Characteristics

- Remarkably low viscosity change from subzero to high temperatures.
- Exceptionally inert to metals, rubber and plastics.
- Unusually resistant to chemicals and high temperatures.
- Effective water repellent.
- Lubricant for glass, ceramics, plastics.

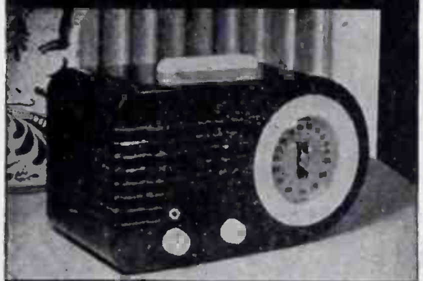
DOW CORNING CORPORATION
BOX 592, MIDLAND, MICHIGAN

DOW CORNING

Catalin

REG. U.S. PAT. OFF.

PLASTICS



Cast Resins

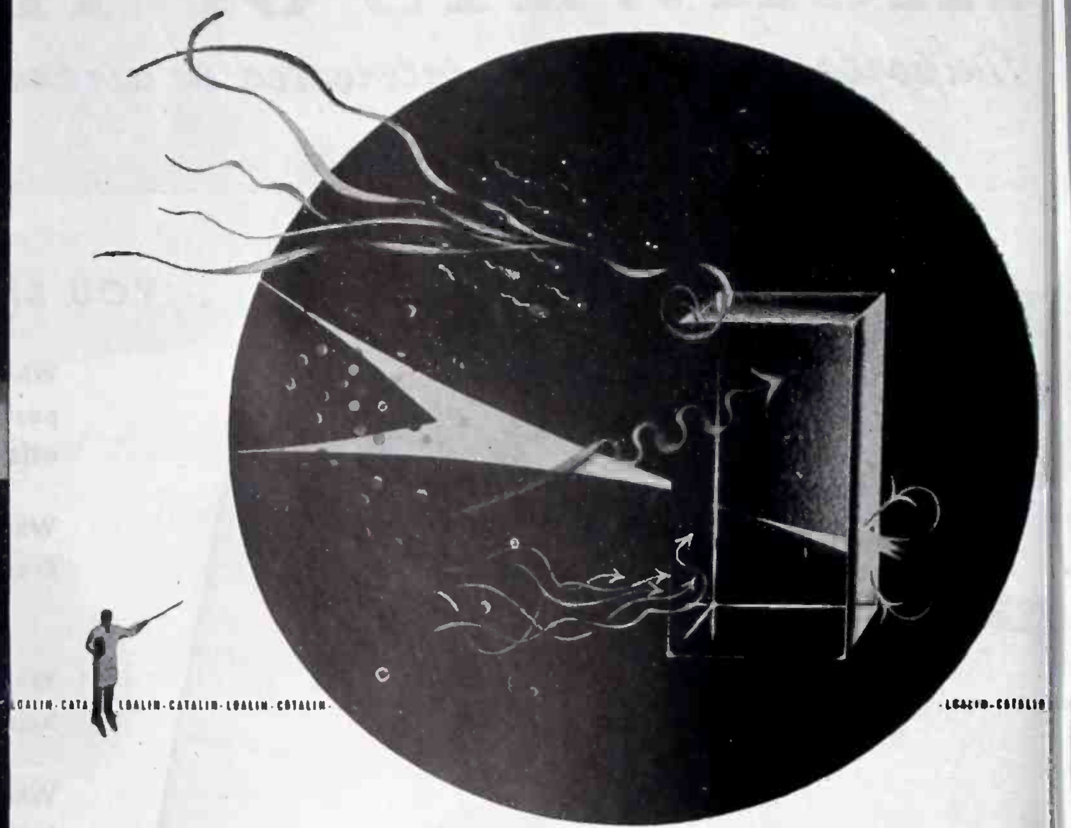
Catalin and Prystal thermosetting cast phenolics offer two important advantages to designers and manufacturers . . . a range and depth of gem-like colors, equalled only by minerals and semi-precious stones . . . and casting techniques which permit the use of inexpensive, quickly constructed molds with neither size nor thickness limitations. The properties of Catalin and Prystal are worth investigation.

Molding Compounds

"Loalin" polystyrene thermoplastic injection molding compounds enjoy a unique position among plastics. It possesses outstanding electrical, chemical and mechanical properties. It has a "zero" water absorption and is unrivalled in dimensional stability. Loalin is the lightest weight of all the plastics and one of the least costly. It is available in a limitless range of brilliant colors.

Liquid Resins

Catabond, Catavar and Loabond identify a wide variety of liquid resin formulations employed for coating, laminating, glueing, impregnating and bonding wood, plywood, abrasives, paper, cork, brake linings, brushes, etc. Several of these formulations now make possible low-cost techniques for the fabrication of aluminum sheets. They can be economically cast at your own plant and excel as drill and saw jigs, router, shaper and hydroform blocks; checking fixtures, stretch press molds and dies.



Chemical Resistance

"Chemical Warfare" is not confined to the battlefield. Under conditions imposed by modern industrial applications, Plastics, along with other materials, are subjected to constant chemical "attack" as they perform their allotted tasks in military and essential civilian uses.

"CATALIN" Cast Resin in the "Chemical Resistant" grade is especially formulated to withstand the effects of most acids, alkalies and lubricants. In addition to this desirable quality, it has a low percentage of water-absorption and the other physical, mechanical and machining characteristics usually associated with all Catalin Cast Resins.

"LOALIN"—Catalin's polystyrene molding compound—offers excellent resistance to all acids, alkalies and alcohols, being soluble only in esters and the aromatic hydrocarbons. Its water-absorption is 0.00% (24 hours immersion at 25° C.) and its reaction to mineral, animal or vegetable oils ranges from excellent to poor, depending upon the particular oil.

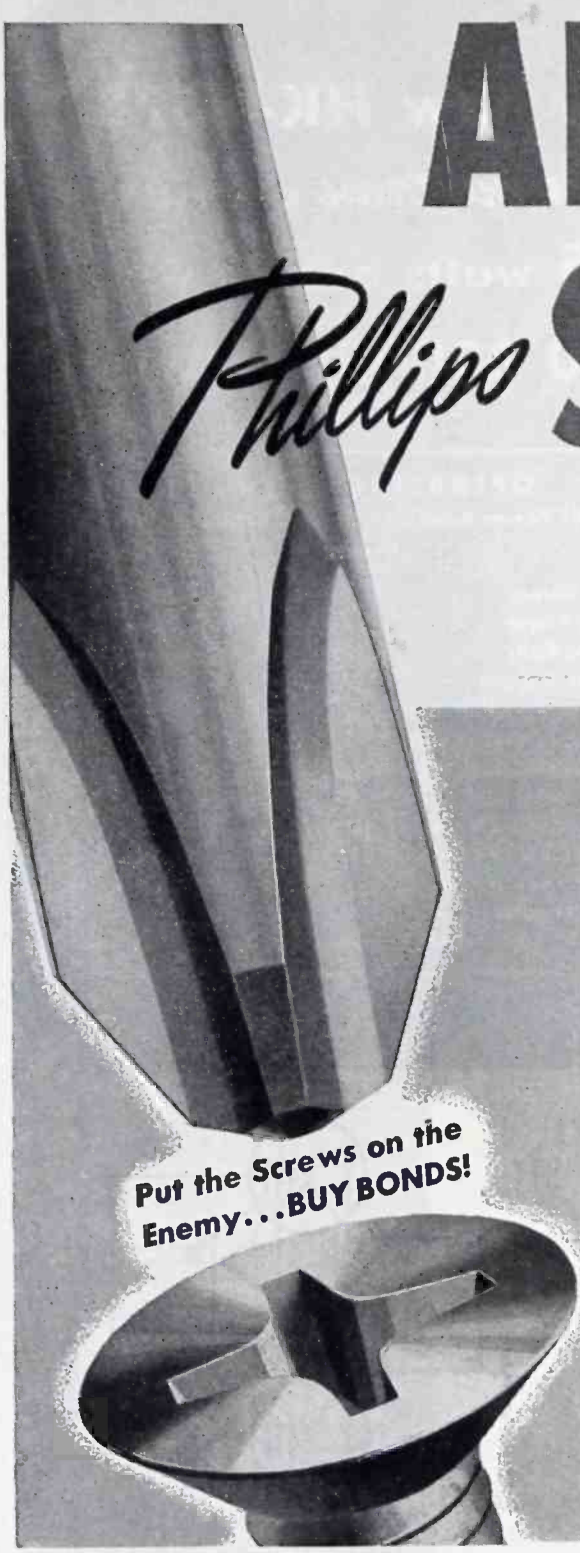
Our chemists and engineers have made exhaustive tests of both Catalin and Loalin under various conditions and covering chemical, electrical, thermal, mechanical, physical and "working" properties. The results of their inquiries and the experience and testimony of fabricators, molders and users in many fields are available to your own technical staff for immediate application or for guidance in "blueprinting" the products of tomorrow.

Catalin — *Cast Resins* / *Molding Compounds* / *Liquid Resins*

CATALIN CORPORATION

ONE PARK AVENUE • NEW YORK 16, N. Y.

AMERICAN



Phillips SCREWS

give you TOP SPEED with Controlled ACCURACY

Enabling you to:—

STOP *waste of time*

There's no fumbling or dropping, with American Phillips Screws. And no wobbly starts, for the recessed screwhead fits firmly onto the 4-winged driver, like a fixed bayonet onto a gun. Power drivers can be used, increasing assembly-speed often as much as 50%.

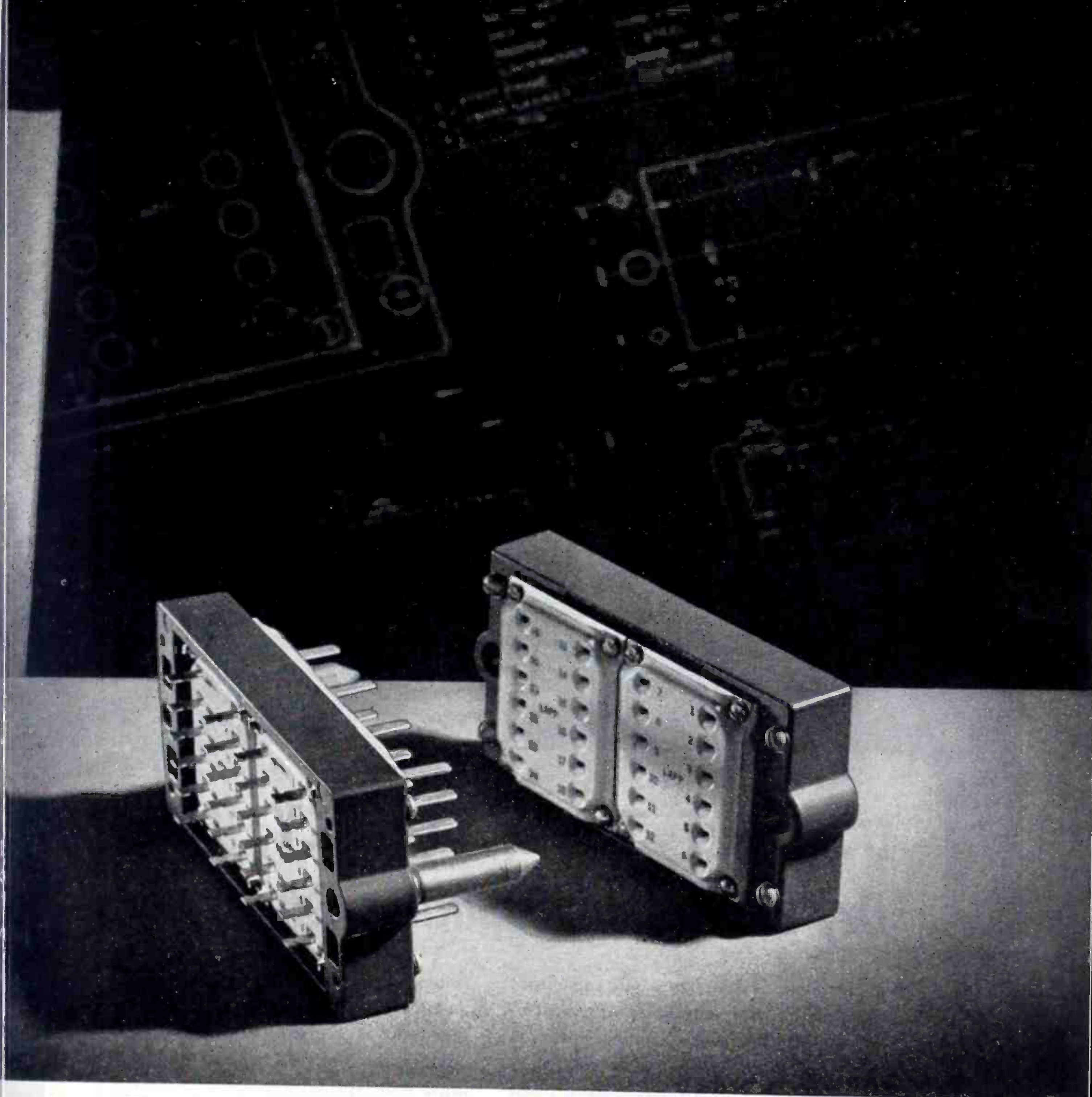
STOP *rejections*

"Controlled Accuracy" means that American Phillips Screws and driver align themselves automatically into one straight-line unit *that can't drive crooked and spoil work.* Nor can the driver ever twist out and slash across the work-surface.

STOP *scrapping of screws*

American Phillips Screws can't be burred or broken like slotted-screwheads. And American Phillips Screws don't have to be backed out and thrown away. Nor do they have to be scrapped for defects of head, thread, or point . . . thanks to American's individual inspection.

AMERICAN SCREW CO. Providence 1, R. I. Chicago 11: 589 E. Illinois St. Detroit 2: 502 Stephenson Bldg.



... GET THIS TIMELY, NEW
Dry Electrolytic Capacitor CATALOG

Every day finds dry electrolytic capacitors establishing new standards of performance in applications formerly reserved for other types. Small, light and inexpensive, dry electrolytics have been steadily improved to a point where they meet the most exacting specifications. These include salt air, reduced pressure, low and high temperature extremes, transients, r-f impedance, sealing, "shelf life," and many more. In addition, Sprague Dry Electrolytics are available in unlimited combinations of capacity and voltage ratings, with special electrical characteristics, and in containers for every mechanical requirement. You will find this big new catalog a handy guide to dozens of standard and countless special purpose types.

SPRAGUE ELECTRIC COMPANY, North Adams, Mass.
(Formerly Sprague Specialties Co.)

SPRAGUE

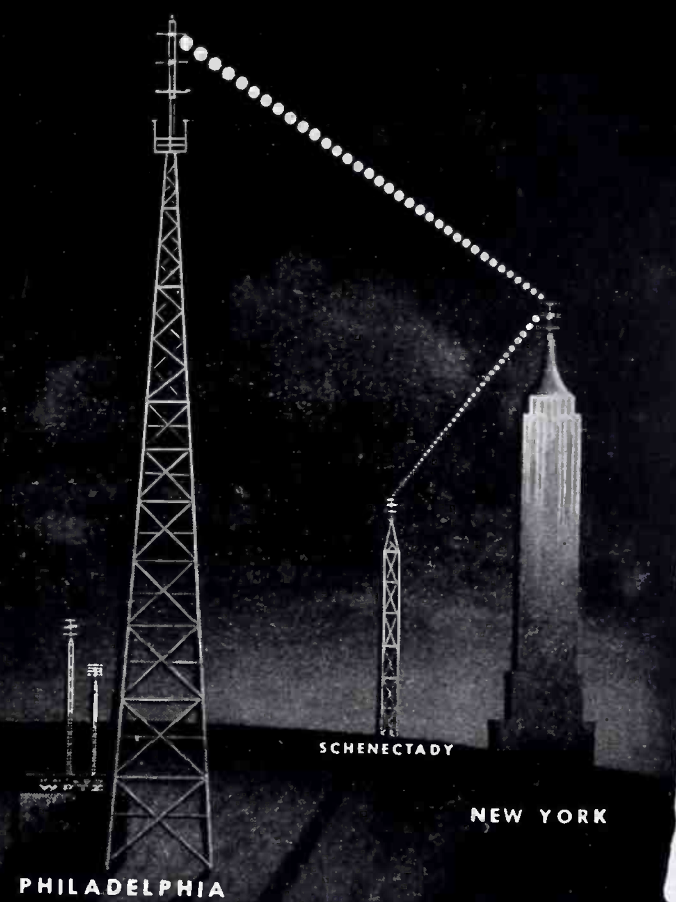
ARMY E NAVY

CAPACITORS · KOOLOHM RESISTORS

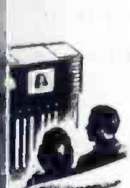
The First Network!

ANOTHER MILESTONE IN THE PROGRESS OF

TELEVISION



CHAIN television is here! With the recent dedication of the new Philco Relay Transmitter at Mt. Rose, N. J., the first Television Network, linking Philadelphia, New York and Schenectady, is in actual operation today. Now Philadelphians enjoy clear reception of programs from New York through their local Philco television station. Thus the first step has been taken through which millions will eventually witness events that take place thousands of miles away . . . *by television.*



HOW PHILCO RESEARCH SPEEDS THE ADVANCE OF TELEVISION

This first television network is an example of how Philco research is working to establish transmission principles which can extend chain television broadcasting from coast to coast. At the same time, Philco research is improving the clarity, sharpness and detail of the television picture . . . so that future television sets will have the greatest possible sales appeal. Thus in two ways . . . by helping to broaden the market for television, and by designing a more saleable product for that market . . . Philco leads toward the goal of television as tomorrow's "billion dollar industry."

Radio Hall of Fame Orchestra and Chorus. Tune in Sundays, 6 P. M., E. W. T., Blue Network.

★

BACK THE ATTACK—BUY WAR BONDS

WITH PROGRAMS LIKE THESE, PHILCO TELEVISION STATION WPTZ HAS PIONEERED IN TELEVISION BROADCASTING

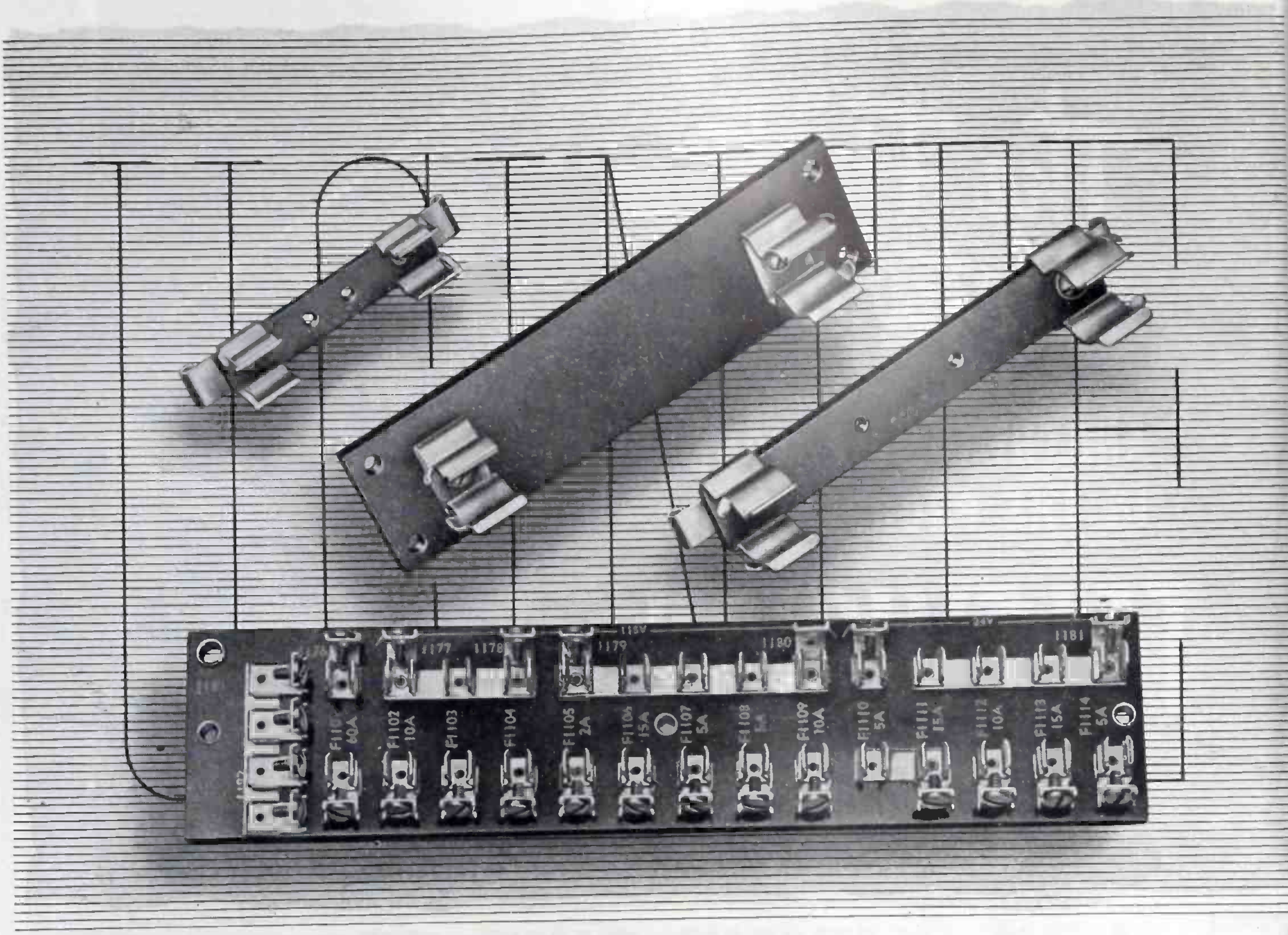
Since 1932, Philco has owned and operated its own television station, a rich laboratory of research and experience for television progress.

The Philco station has televised football, boxing, wrestling and other sports as well as news events direct from the scene of action.

Movies, variety acts, dramatic sketches, illustrated news talks and civic programs have been televised from the Philco studios.

PHILCO

THE OVERWHELMING LEADER IN RADIO FOR 12 STRAIGHT YEARS



Right...the First Time

Fuse panels like these are in line with our most specialized kind of work . . . the combining of metal parts in bakelite assemblies. These are not standard parts, however. They were all made to the particular specifications of a new customer. From a small first order these panels have since developed into numerous and larger orders from the same source.

Many, perhaps *most,* of our new jobs at Ucinite come from companies which have production bottlenecks to break and not too much time to make sure that it is done. We get a great kick out of being able to turn emergency customers into regular customers . . . by getting things right the first time.

The UCINITE CO.

Newtonville 60, Mass.

Division of United-Carr Fastener Corp.

***Specialists in* RADIO & ELECTRONICS**

LAMINATED BAKELITE ASSEMBLIES

CERAMIC SOCKETS · BANANA PINS &

JACKS · PLUGS · CONNECTORS · ETC.

THERE'S GOLD HERE!
another new letter contest

$200.00 in prizes every month

$100.00 first prize, $50.00 second prize, $25.00 third prize, $15.00 fourth prize, $10.00 fifth prize, plus $1.00 for every letter received.

Here we go again. Another great Hallicrafters letter contest or service men. Wherever you are, whenever you see this nnouncement, drop us a line. Write and tell us your first iand experience with *all* types of radio communications built y Hallicrafters, including the famous SCR-299.

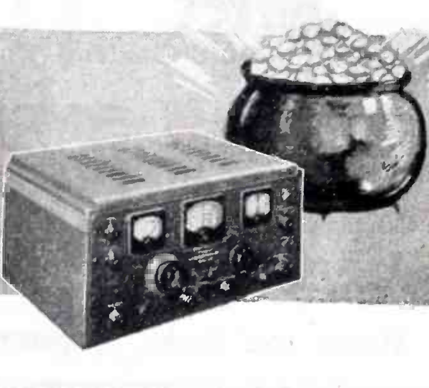
There is gold here! Write today to get your share. Tell us our story in your own way. You can't lose and you *can* win s high as $100.00.

Rules for the Contest

Hallicrafters will give $200.00 for the best letters received during each of the six months of September, October, November, December, 1944, January, and February, 1945. (Deadline: Your letter must be received by midnight, the last day of each month.)

For every serious letter received, Hallicrafters will send $1.00 so even if you do not win a big prize your time will not be in vain. Your letter will become the property of Hallicrafters and they will have the right to reproduce it in a Hallicrafters advertisement. Write as many letters as you wish. V-mail letters will do.

Open to servicemen around the world. Wherever you are, whenever you see this ad, drop us a line. Monthly winners will be notified immediately upon judging.



There's gold here at the end of the rainbow in Hallicrafters great letter contest—and there's a great and exciting future ahead for short wave enthusiasts. In peace time Hallicrafters will continue to build "the radio man's radio" and that means the best that can be made. There will be a set for you in our postwar line.

BUY A WAR BOND TODAY!

hallicrafters RADIO

HE HALLICRAFTERS COMPANY, MANUFACTURERS OF RADIO AND ELECTRONIC EQUIPMENT, CHICAGO 16, U.S.A.

PERFECTION
assured by quality control

You can be sure your wiring harnesses are okay--if Whitaker produces them

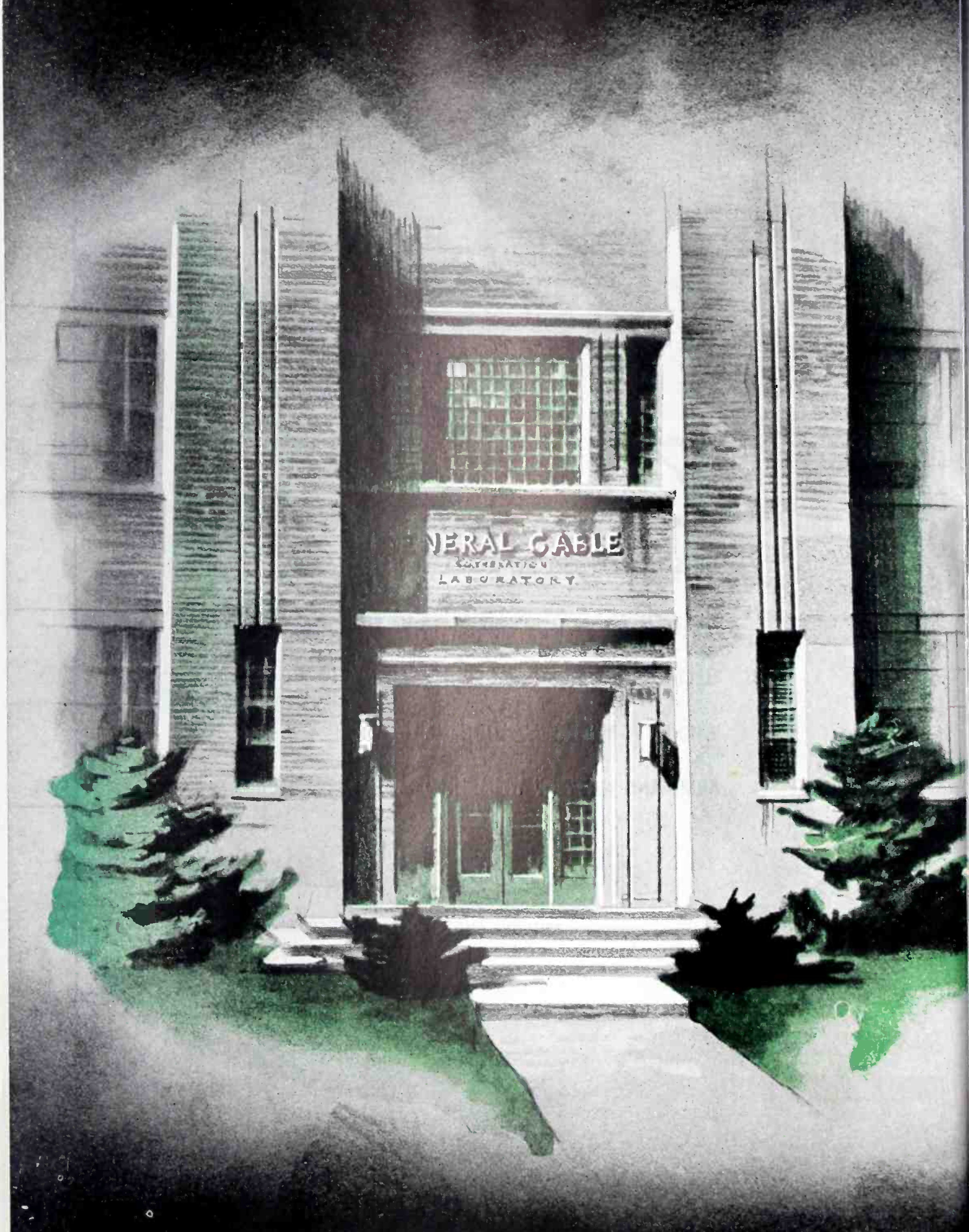
Skilled technicians, utilizing specially designed testing equipment, check every assembly produced by Whitaker. Hundreds of individual tests are made on some assemblies — and when passed by our experts, you can be sure the job is okay.

If your production needs include wiring harnessess, bonding jumpers, or cable assemblies — it will pay you to get in touch with us...Whitaker Cable Corporation, 1307 Burlington Ave., Kansas City 16, Mo. . . St. Joseph, Mo. . . Philadelphia . . Oakland.

WHITAKER

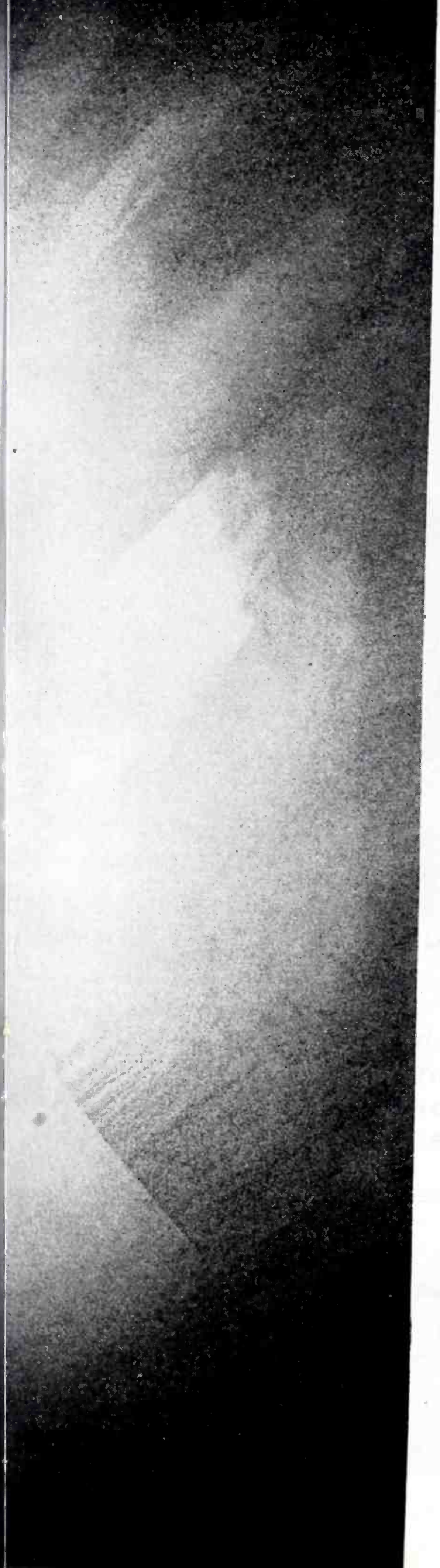
Cables, Wiring Harnesses and Assemblies for Automotive, Aircraft, Marine and Radio Equipment

RESEARCH...SPEARHEAD



The 80 practical specialists who work in this magnificent building at Bayonne, N. J., have every facility—chemical, physical, metallurgical—to aid them in bringing nearer their goal—extending to the utmost the effective means of electrical transmission and distribution. Built in 1941, the structure has already grown to 60,000 sq. ft. of floor space—is planned for further expansion as needed.

OF ALL PROGRESS...

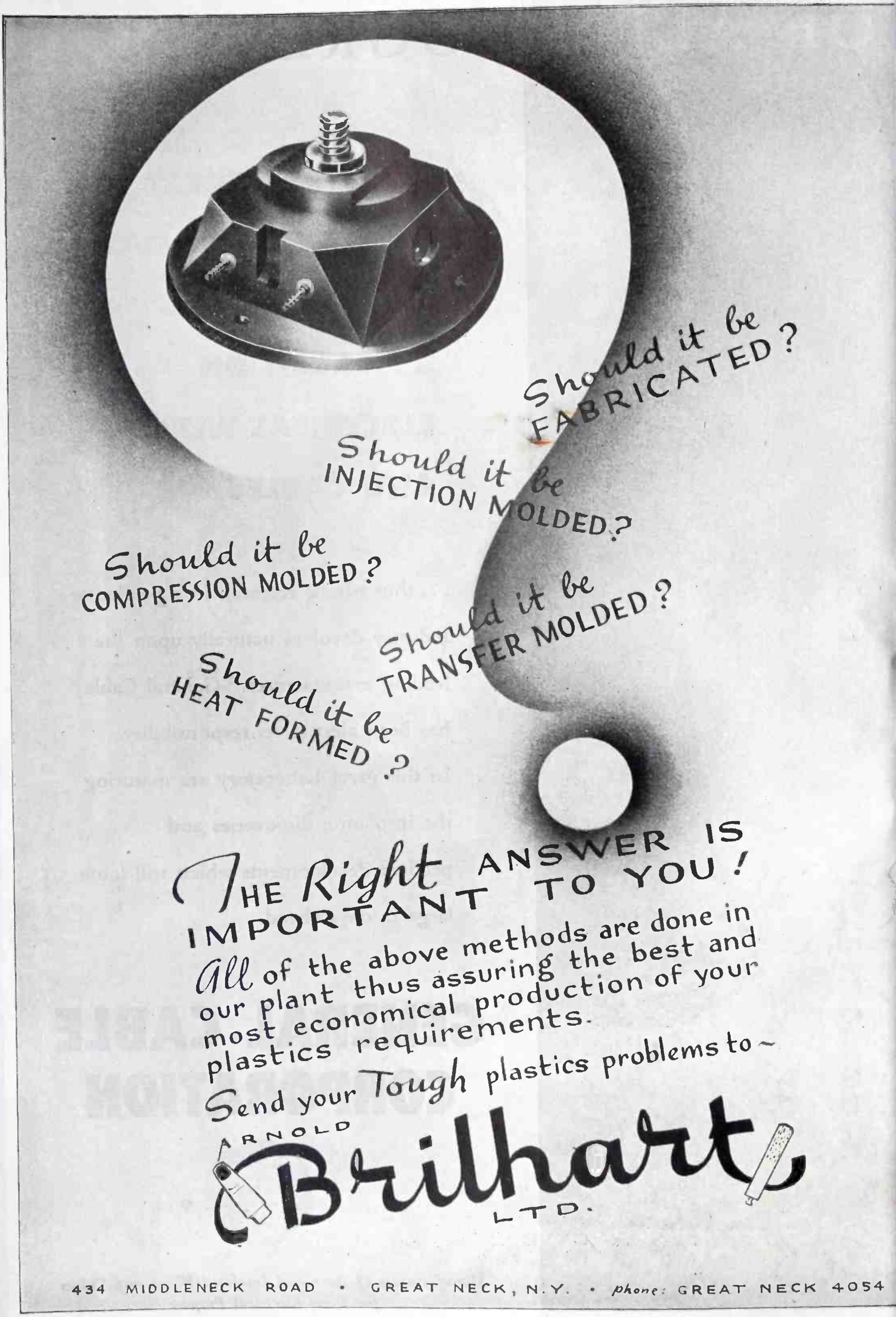


THE FIRST GREAT LABORATORY DEVOTED EXCLUSIVELY TO RESEARCH ON ELECTRICAL WIRES AND CABLES

... thus "basic research in a particular industry devolves naturally upon the leading manufacturer." General Cable has been alert to its responsibility. In this great Laboratory are maturing the insulation discoveries and product developments which will loom large in days ahead.

GENERAL CABLE CORPORATION

Manufacturers of Bare and Insulated Wires and Cables for Every Electrical Purpose


Should it be FABRICATED?
Should it be INJECTION MOLDED?
Should it be COMPRESSION MOLDED?
Should it be TRANSFER MOLDED?
Should it be HEAT FORMED?
THE Right ANSWER IS IMPORTANT TO YOU!
All of the above methods are done in our plant thus assuring the best and most economical production of your plastics requirements.
Send your Tough plastics problems to~
ARNOLD Brilhart LTD.
434 MIDDLENECK ROAD • GREAT NECK, N.Y. • phone: GREAT NECK 4054

WE HAVE AN OBJECTIVE, TOO!

onversion from the frantic pace of wartime production to e tranquil ways of a world at peace will be another gi-antic job. But it's one that must be done and done quickly hen the time comes. For we must be ready for peace.. e must have jobs waiting for those boys who have been ut there doing the biggest job of all for us!

That's one of the reasons why the WPB recently en-couraged such planning and released materials for the development of new products.

This future-minded organization . . is still 100% engaged in war work. But it is already planning and perfecting Electronic control devices which may readily play an important part in your conversion plans.

Electronics will add to the comforts and conveniences of the home of the future, in the country as well as the city. Keep your eye on the Magic Eye. It's going places.

★ BUY MORE THAN BEFORE . . . BONDS

E-MARK REG. U.S. PAT. OFF.

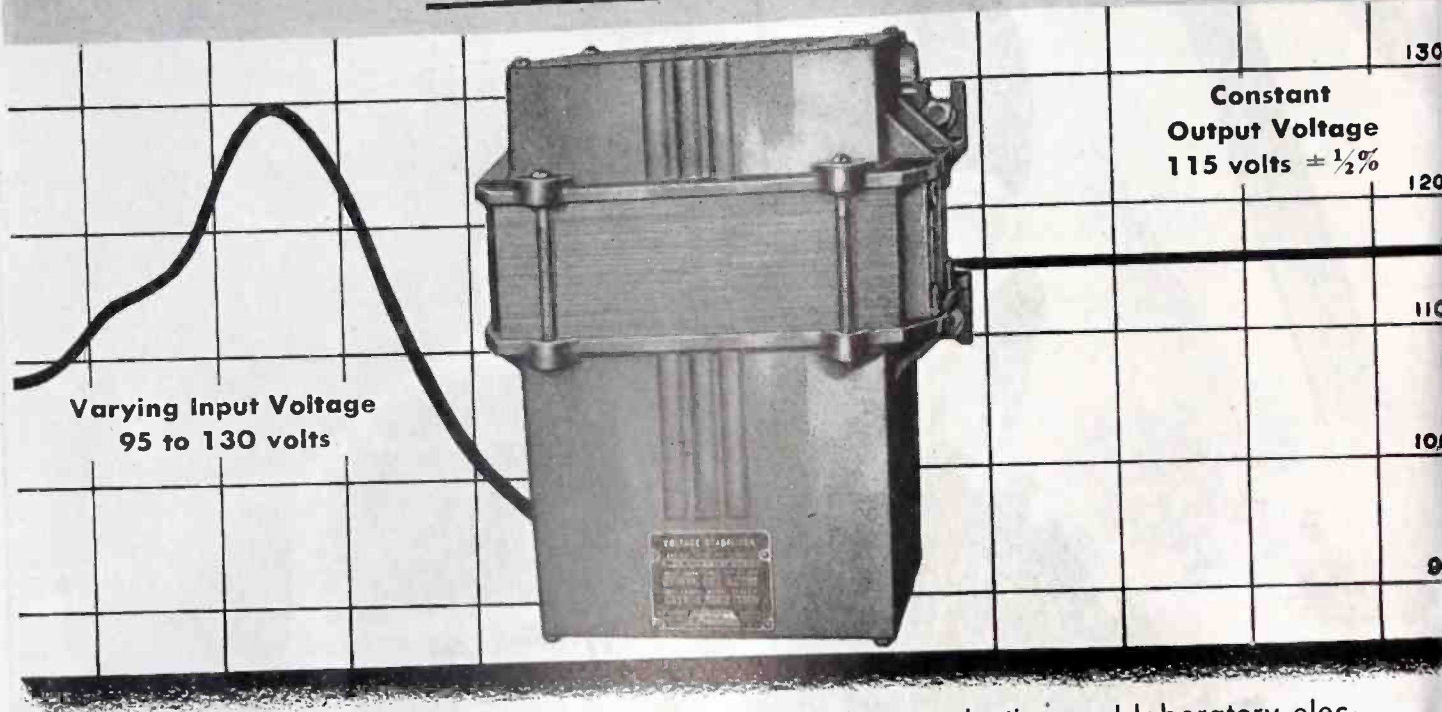
MAGUIRE INDUSTRIES, INC.

ELECTRONICS *division*

AGUIRE INDUSTRIES, INC., GREENWICH • STAMFORD • BRIDGEPORT • NEW MILFORD • NEW YORK

RAYTHEON VOLTAGE STABILIZERS

Regulate Varying Input Voltage to Constant Output Voltage



Precision operation of a wide variety of factory testing, production and laboratory electrical equipment requires uniform, stabilized AC input voltage. A Raytheon Voltage Stabilizer, incorporated in the product, permanently eliminates fluctuating voltages by assuring constant output voltage of 115 volts ± ½%. They are available in three designs to meet practically every installation requirement. Bulletin DL48-537 gives the complete story. Write for your copy.

NOTE THESE PERFORMANCE FEATURES

CONSTANT AC OUTPUT VOLTAGE

Raytheon Voltage Stabilizers control fluctuating input voltages and hold constant output voltage to ± ½%.

WIDE AC INPUT VOLTAGE LIMITS

Raytheon Voltage Stabilizers will stabilize input voltages varying from 95 to 130 volts.

QUICK RESPONSE

Raytheon Voltage Stabilizers stabilize the varying input voltage *within* 2 *cycles*. Variations cannot be observed on an ordinary volt meter.

ENTIRELY AUTOMATIC

Raytheon Voltage Stabilizers are entirely automatic in operation. They require no adjustments or maintenance. Simply connect the stabilizer to the AC input and the output to the electrical device and the unit will take care of itself, stabilizing the varying voltage to ± ½%.

NO MOVING PARTS

Raytheon Voltage Stabilizers have no moving parts . . . Nothing to wear out thus assuring long life.

PARALLEL OPERATION

Standard Raytheon Stabilizers of identical rating can be connected in parallel for higher output rating.

THREE DESIGNS

Standard Raytheon Voltage Stabilizers are available in three designs . . . cased, uncased and endbell . . . to meet practically every installation requirement.

RAYTHEON

MANUFACTURING COMPANY

190 WILLOW STREET, 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 15,000 men and women are producing for VICTORY.

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

Qualities OF A PERFECT RECORDING BLANK

PURITY OF COATING: There must be no surface or concealed dirt, grit, mottling, lint, streaks, whorls, "orange peel" scratches, oiliness, ripples, wrinkles or unpleasant odor. **PROPERTIES OF COATING:** It should be absolutely smooth, of uniform density and thickness, without pits which pop and click; soft enough to cut; hard enough to retain good tonal values; and it ~~must not~~ deteriorate with age. **GROOVES** should be glossy, which means playbacks without surface noise. **THREAD** must curl in one piece and be static free. **PLAYBACK,** whether at once, next month, or next year, must be 100%. **PROCESSING** must give fine results whether silvered or sputtered.

THESE ARE THE QUALITIES CRITICAL USERS FIND IN

audiodiscs

they speak for themselves

JOIN METALS FASTER, BETTER

See the Lepel Unit in Operation
Booth H-610
National Metal Congress and War Conference Display
Public Hall, Cleveland
October 16-20

with High Frequency Induction Heating

Many production metal-joining operations now performed by welding or brazing can be done with remarkable savings of time and cost by modern Lepel High Frequency Induction Heating. The most intricate jobs can be so simplified that they can be accomplished in a matter of seconds by

1. Assembling pre-fluxed parts (in jigs if necessary) with the brazing alloy pre-formed in the form of rings, strips or irregular shapes.
2. Heating the joint or seam by means of a "load coil" for the exact time necessary to insure thorough penetration by the molten alloy.

Brazing alloys of any melting point from the lowest to the highest can be used.

An entire joint of any shape—or several joints—can be heated at one time. Heating frequently can be performed on a moving belt in conjunction with other operations to provide continuous-flow production.

As the heat is generated within the metal itself, the brazing alloy penetrates throughout the joint, producing maximum strength and soundness. At the same time, accurate manual or automatic control of time and temperature cycles prevents excessive heating, minimizing discoloration and practically eliminating scale. Thus little, if any, cleaning up or refinishing is necessary.

A Lepel field service engineer will be pleased to call to give you further information and aid in working out details of the applications of this modern method to your joining operations.

Lepel *High Frequency* INDUCTION HEATING UNITS

LEPEL HIGH FREQUENCY LABORATORIES, INC.
PIONEERS IN INDUCTION HEATING
39 W. 60th STREET NEW YORK 23, N.Y.


The Symbol of
Capacitor Experience

FASTER WINDING

Fewer Rejects

. . . WHEN YOU USE FORMEX MAGNET WIRE

TOUGHNESS . . . in terms of abrasion resistance

Type of wire	Number of scrapes per mil of insulation before failure
Conventional heavy-enameled wire	0.9
Synthetic A	10.0
Synthetic B	9.0
Formex wire	28.0

Abrasion or wear resistance, as determined by the repeated-scrape tester, provides the best single measure of film toughness.

FLEXIBILITY . . . measured by tapered-mandrel test

Formex wire (bottom) compared with enameled wire (top). The outer surfaces of the films have been elongated by stretching around a tapered mandrel and heating the samples to 150 C. Note the cracks on the enameled wire.

Its tough, flexible insulation enables you to produce tighter coils in less time

● When you're using Formex* magnet wire, you can literally "go the limit" in speed of coil winding and in tension. Its insulation film is so flexible that it can be wound around its own diameter without cracking.

It is so tough that it has thirty times the abrasion resistance of conventional enameled wire; so tough that, even in the ultrafine sizes, the tension limit is determined by the strength of the copper conductor, not by the insulation.

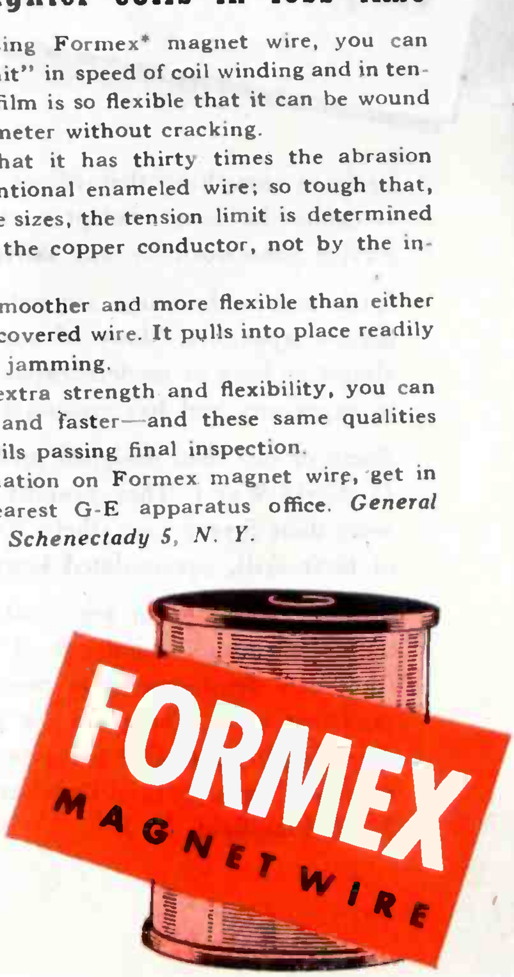
Formex wire is smoother and more flexible than either enameled or fabric-covered wire. It pulls into place readily without forcing or jamming.

Because of this extra strength and flexibility, you can wind coils tighter and faster—and these same qualities will insure more coils passing final inspection.

For more information on Formex magnet wire, get in touch with the nearest G-E apparatus office. *General Electric Company, Schenectady 5, N. Y.*

*Reg. U.S. Pat. Off.

BUY WAR BONDS



GENERAL ELECTRIC

508-18-1200

STOP CORROSION

WITH LEXEL INSULATED WIRE

If you are worried about copper wire corrosion, there's good news in recent tests made by a well-known laboratory. They placed cellulose acetate butyrate film in contact with copper wires in electrical use, under maximum water absorption conditions. *No evidence of corrosion was found on either the wire or the film.* (Copy of report on request.)

Lexel insulating tape is cellulose acetate butyrate. These tests confirm our own laboratory findings and the long experience of Lexel users. They prove not only its noncorrosive qualities, but also its low moisture absorption characteristics.

Lexel has other advantages, too. Small bulk and weight save space in tight places. The conductor is always center-sealed by heat in a continuous helical tube. Lexel has high dielectric strength and insulation resistance.

Test Lexel insulation tape for instruments, controls, lead-in and hook-up wires and other low-tension applications. We'll send you samples and names of manufacturers that can 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.

*Made by the makers of DOBAR Insulation

THE **DOBECKMUN** COMPANY

INDUSTRIAL PRODUCTS DIVISION • CLEVELAND 13, OHIO

WESTERN SALES HEADQUARTERS • SAN FRANCISCO 4, CALIF.

The performance of a high power transmitting tube depends largely on the purity of the component metals used. That's why Taylor "Custom-Built" heavy duty tubes rely on Callite for thoriated tungsten filament wire, tungsten filament springs and tungsten welds.

Callite Thoriated Tungsten Filaments contain the right proportions of tungsten and thorium to give the required electronic emission plus the strength to withstand rough handling and higher overloads. Callite's careful processing of tube components is backed by long experience in tungsten metallurgy. You, too, can rely on us as a dependable source of supply. Callite Tungsten Corporation, 544—39th St., Union Cit
N. J. Branch Offices: Chicago, Clevelan

Taylor Tube Type B 838, manufactur by Taylor Tubes, Inc. of Chicago, wi Callite components.

R_x FOR R-DAY (Reconversion)

Discuss your post-war plans with our engineers. Our accumulated knowledge and experience is worth having —Now. We can help you on the design and selection of materials.

Callite tube components

CALLITE TUNGSTEN CORPORATION

HARD GLASS LEADS, TUNGSTEN AND MOLYBDENUM WIRE, ROD AND SHEET, FORMED PAR

E-E Electronic Tubes!

New principles, new methods, startling results! Voices and images hurled across the miles! Pin point navigation, electron-optics, electronic heating and control—all these and more, speeding and bettering production and communications! The vacuum tube is a super-bazooka blasting and clearing the path of civilization.

E-E power Rectifiers and Amplifiers are leaders in the vanguard of this advance. Included in this diversified line are High Vacuum, Mercury Vapor and Grid Control Rectifiers, Oscillators, Modulators and Amplifiers—all ruggedly designed for heavy duty applications, and rigidly controlled throughout production.

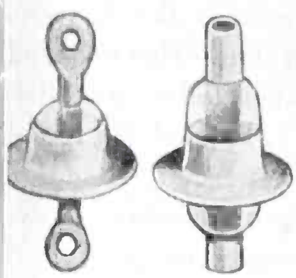
Complete technical information is contained in the descriptive E-E Data Book—why not write today for your copy.

ELECTRONIC ENTERPRISES, INC.

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

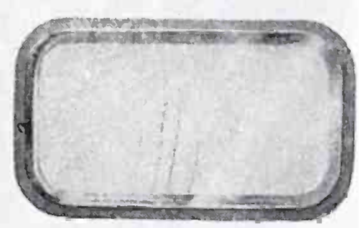
Hermetic Seals
(METAL-GLASS)
by STUPAKOFF





for sealing
ELECTRONIC TUBES
TRANSFORMERS
RESISTORS
CAPACITORS
CONDENSERS
VIBRATORS
SWITCHES
RELAYS
INSTRUMENTS
GAUGES
METERS
RECEIVERS
TRANSMITTERS





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

The metal, KOVAR,* a cobalt, nickel, iron alloy, has made possible a hermetically sealed terminal without the use of cements or gaskets. The seal between Kovar and glass is a chemical bond in which the oxide of Kovar is dissolved into the glass during a heating process. The result—a permanently vacuum and pressure tight seal—effective under the most extreme climatic conditions.

Stupakoff also supplies Kovar as rod, sheet, wire, tubing, eyelets, cups and other forms for those equipped to do their own glass working.

Kovar-glass seals answer most hermetic sealing problems. Write today for technical data Bulletin KA-12 listing currently available Kovar-glass terminals and Bulletin KA-11A for standard Kovar shapes and sizes.

ARMY E NAVY "FOR GREAT ACHIEVEMENT"

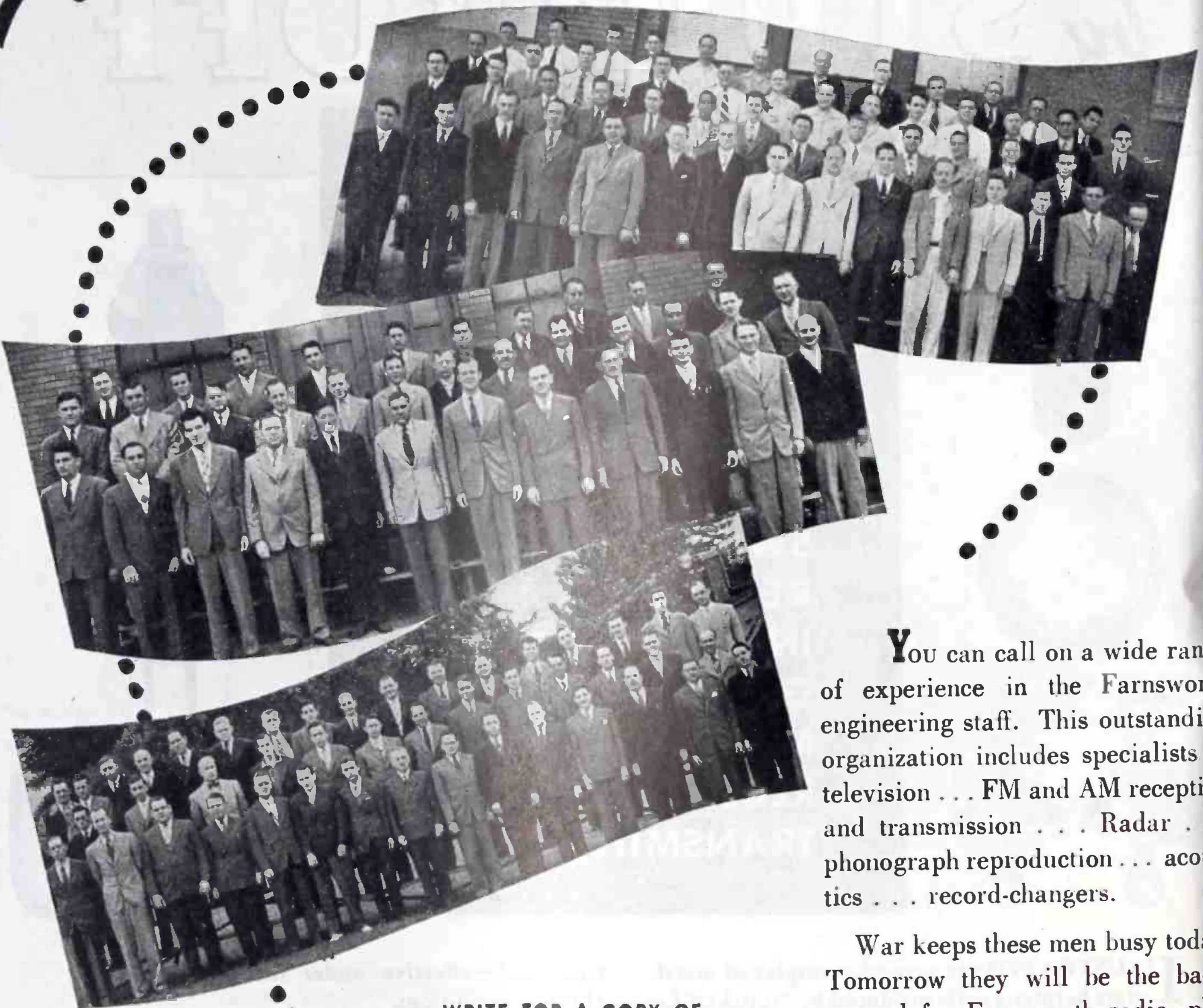
DO MORE THAN BEFORE—BUY EXTRA WAR BONDS

*TRADE MARK 337962 REGISTERED IN U.S. PATENT OFFICE

STUPAKOFF CERAMIC AND MANUFACTURING CO., LATROBE, PA.

Farnsworth engineers...

AT YOUR SERVICE



You can call on a wide rang of experience in the Farnswort engineering staff. This outstandin organization includes specialists i television . . . FM and AM receptio and transmission . . . Radar . . phonograph reproduction . . . acou tics . . . record-changers.

War keeps these men busy toda Tomorrow they will be the bac ground for Farnsworth radio, ph nograph and television equipme . . drawing upon a rich experienc of more than 19 years in electroni research and development . . guarantee of leadership.

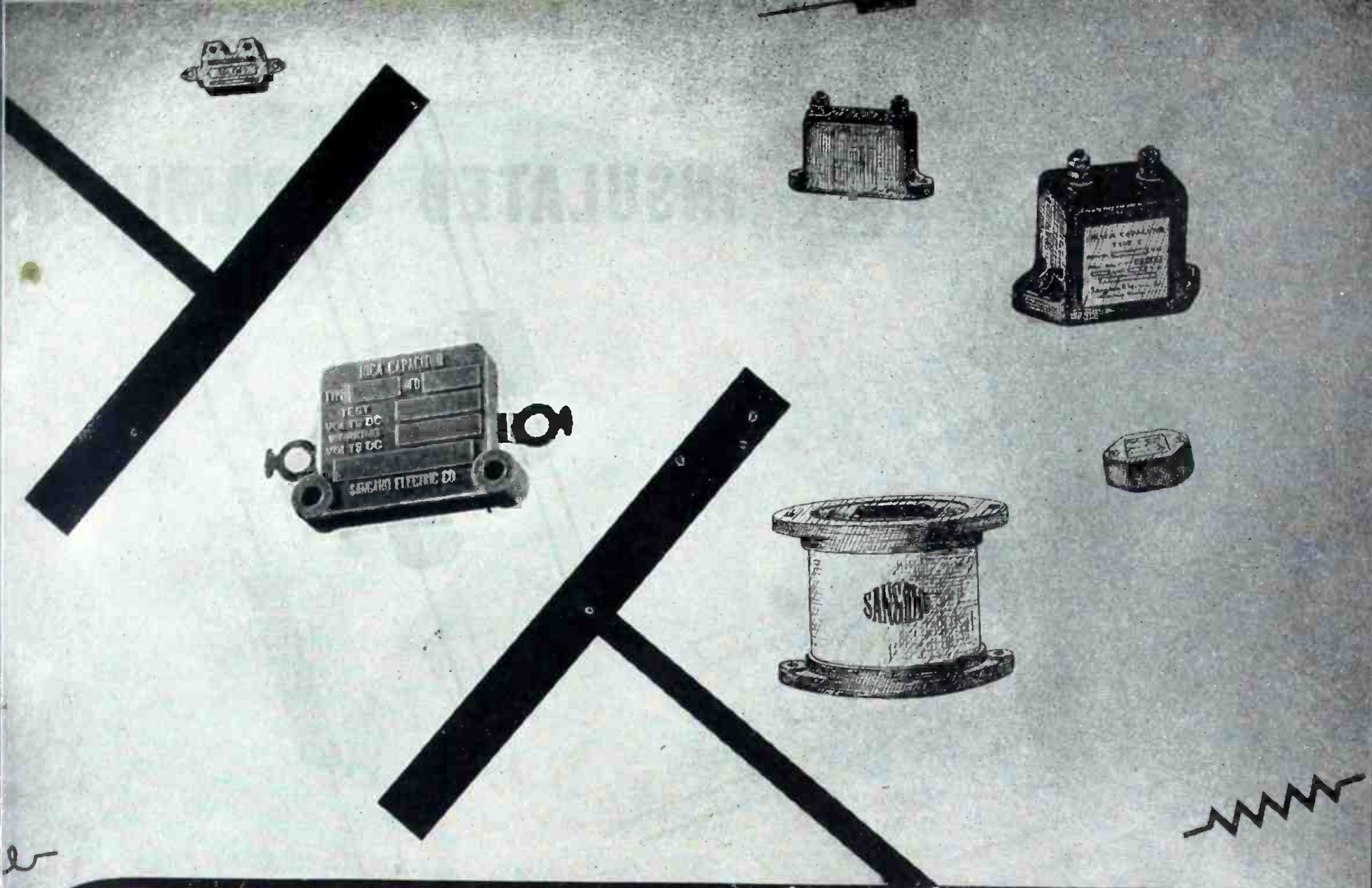
. . . And they will welcome yo questions regarding all phases of r dio and television transmission a reception. You'll find Farnswor engineers leading in more and mo fields . . . Farnsworth experien and Farnsworth equipment belo in your plans for the future.

• **WRITE FOR A COPY OF** *"The Story of Electronic Television"* — a new brochure for which you'll have many uses.

FARNSWORTH

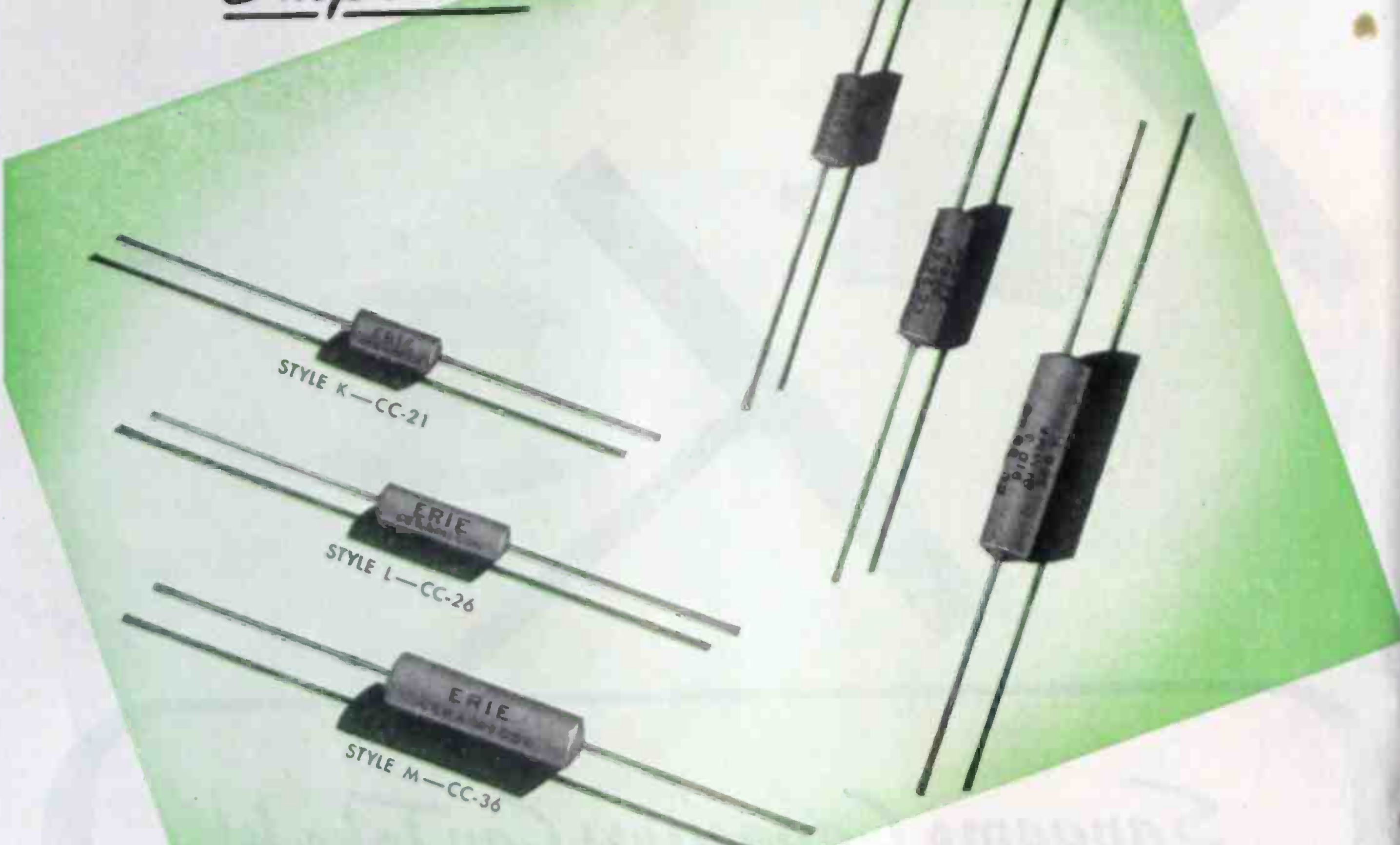
Television · Radio · Phonographs

Farnsworth Television & Radio Corporation, Fort Wayne 1, Ind. Farnsworth Radio and Television Transmitters and Receivers; Aircraft Radio Equipment; Farnsworth Television Tubes; the Farnsworth Phonograph-Radio; the Capehart; the Capehart-Panamuse.


MICA CAPACITOR
SANGAMO ELECTRIC CO

Improved INSULATED CERAMICONS

REG. U. S. PAT. OFF.



. . . now made with Molded Insulation by ERIE RESISTOR

RETAINING all of the inherent advantages of the ceramic case Erie Insulated Ceramicons, this new improved type, with a one piece molded phenolic case offers even better protection against humidity. It also insures more intimate contact between the silver electrode and the molded dielectric, eliminating the possibility of air gaps.

In all other respects the molded type Erie Ceramicons are the same as Ceramicons with ceramic insulation. Overall dimensions are unchanged. They cover the same standard range of temperature coefficients, from +100 P/M/°C to −750 P/M/°C.

At present both types are available, but all production will be standardized on the molded type in the near future.

Samples have been submitted to the Army-Navy Electronics Standard Agency at Redbank, N. J., for approval against JAN-C-20. Orders are now being accepted for both the molded insulated and ceramic insulated styles against JAN-C-20. Write for cross reference sheet showing styles of Erie Ceramicons and corresponding JAN-C-20 designations.

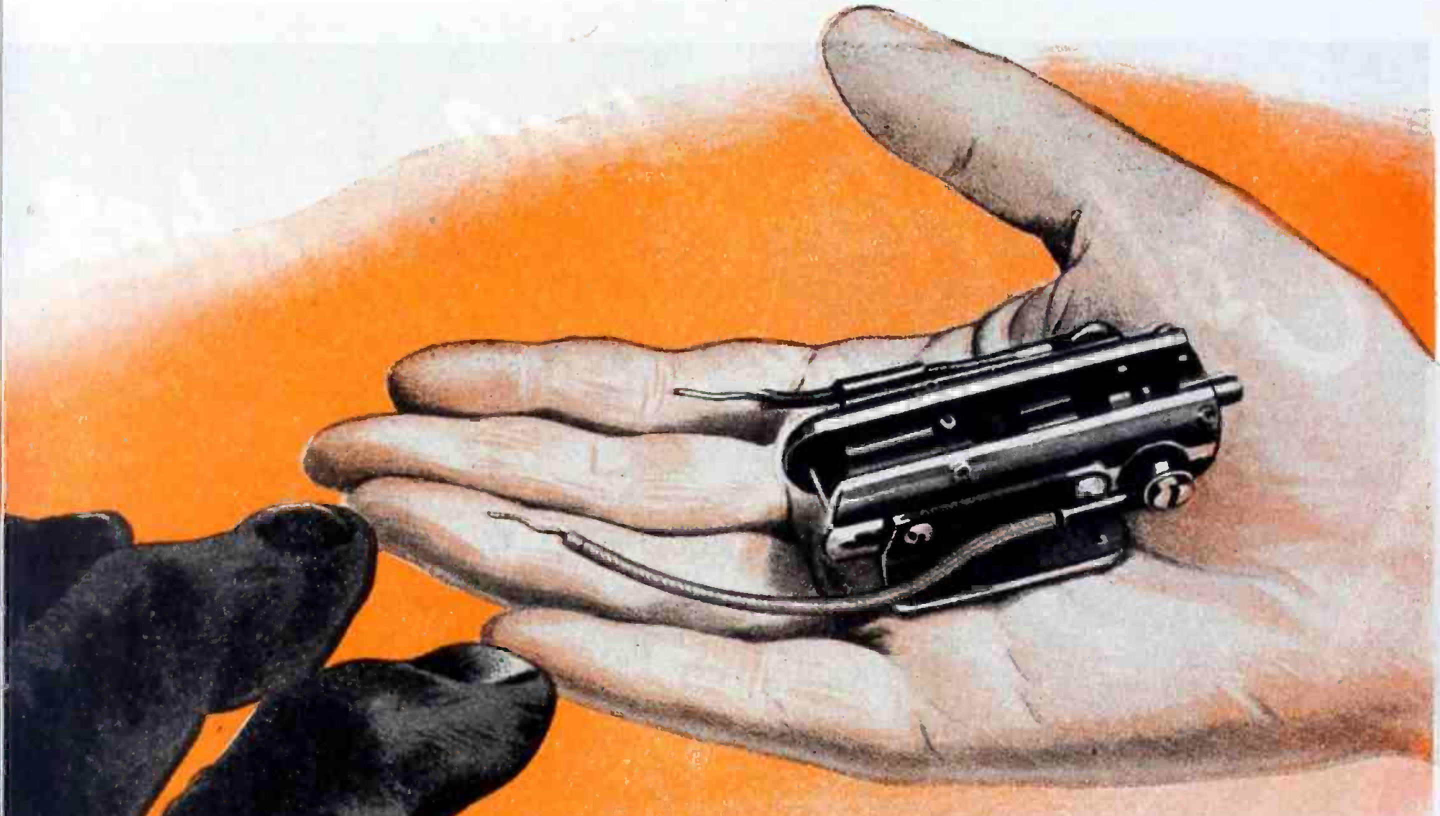
Do More Than Before — Buy EXTRA War Bonds

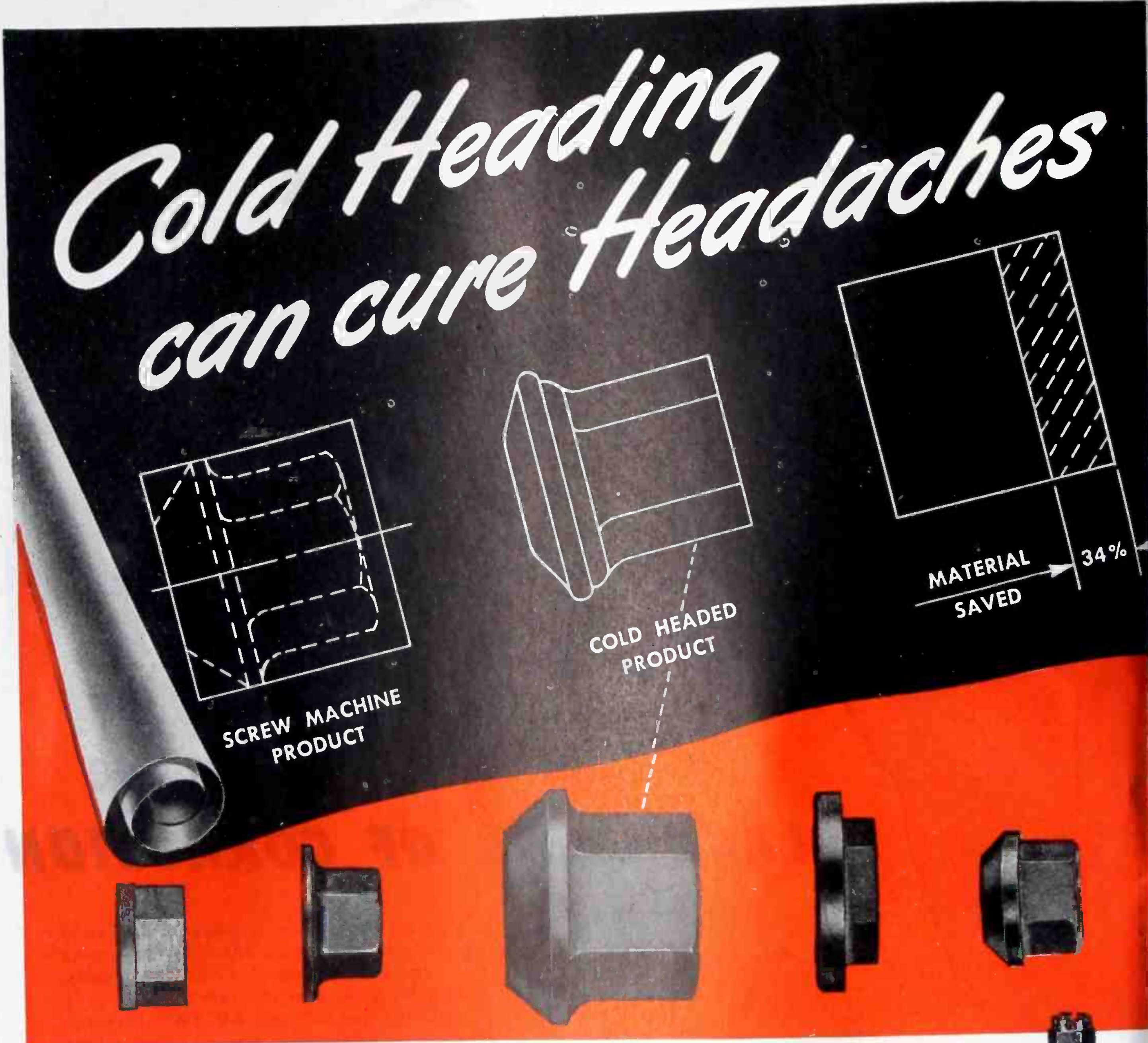
FOR HIGH ACHIEVEMENT IN WAR PRODUCTION

Electronics Division

ERIE RESISTOR CORP., ERIE, PA.

LONDON, ENGLAND • • TORONTO, CANADA

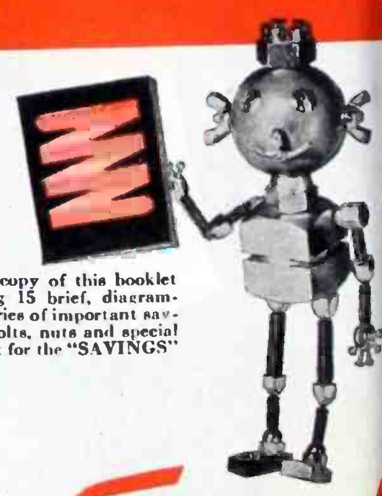




These are special nuts, critical items of war production. They were made originally by milling from round bar stock. Production could not come near to meeting the demand. "National" developed the cold header method, upsetting the collar from a hex bar of smaller diameter. This obviates the necessity of milling the hex from the round bar.

On one of these items alone, our process released 500 milling machines and effected a saving in material of about one-third. A serious production bottleneck was broken.

Have you seen our booklet "Saving Critical Man Power, Material. Machines"? It may suggest how you can have a production headache relieved. Write for it today.



Send for copy of this booklet containing 15 brief, diagrammatic stories of important savings on bolts, nuts and special parts. Ask for the "SAVINGS" booklet.

National
HEADED AND THREADED
PRODUCTS

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


AAC PRECISION
* The Pan American World Airwa
routes shown below are those in ex
tence on December 7th, 1941. Prese
routes cannot be shown.
AAC
Products
AIRCRAFT
PRECISION RADIO
Kansas City, Kans.

RADIO PRODUCTS

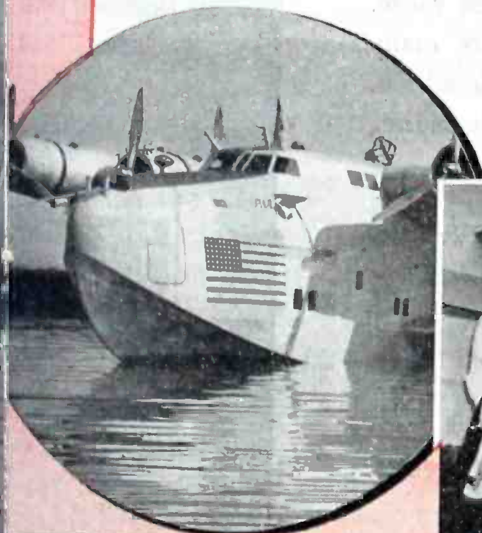
Serve PAA

PAN AMERICAN WORLD AIRWAYS continues to perform a vital wartime service by speeding men and materials to every U. S. front and outpost . . . and AAC Precision Radio Products play an important part in this service.

As the giant *Clippers* spread their wings across the world, AAC Products help to maintain communications along the lifelines of this vast system which flies to every continent on the globe. These products are in use at operations bases, both here and overseas.

This is just one example of how the engineering and production skill of Aircraft Accessories Corporation serves the world's great airlines—as well as various branches of the armed forces. As one of America's largest producers of transmitters and other precision radio equipment, AAC offers the services of its Engineering Department in designing special equipment for you, without obligation.

ELECTRONICS DIVISION
KANSAS CITY, KANSAS



In war as in peace the PAA Clippers serve humanity. Here 1810 pounds of medical supplies go aboard at LaGuardia Field.

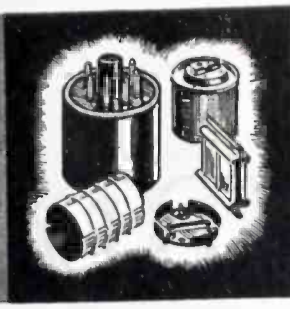
(E-54)

ACCESSORIES CORPORATION

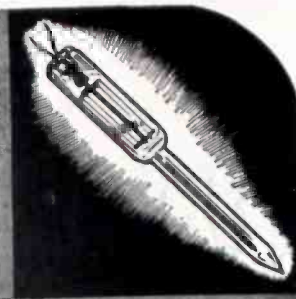
nd ELECTRONICS • ENGINEERED POWER CONTROLS

New York, N. Y. Burbank, Calif. Cable Address: AACPRO

THERMOCOUPLE
◀ TUBES



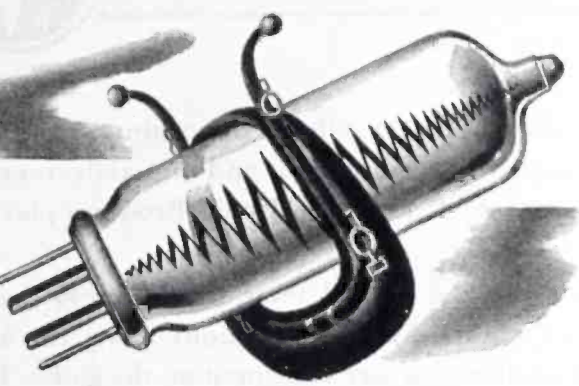
RADIO
TUBE
◀ PARTS

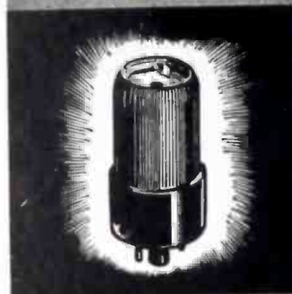


▲ PIRANI
TUBES

STROBOTRONS ▼

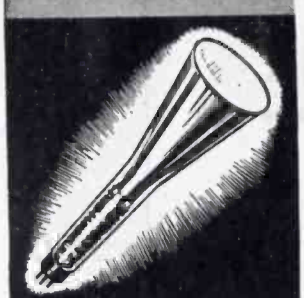
GLASS HARNESS FOR SALE





▲ FACSIMILE
RECORDING
TUBES

CATHODE RAY
TUBES ▼



THE purpose of the electron tube is simply to harness electrons to useful work. What shape the electron tube takes in glass depends upon the type of work to be done. As the result of fulfilling many important wartime electronic assignments, Sylvania now makes a wide variety of electron tubes and now has the experience to design even more. A few of them are shown here. There are many more, some of which are still on the restricted list. For information, write Sylvania Electric Products Inc., 500 Fifth Avenue, New York 18, N. Y.

one standard—the highest anywhere known

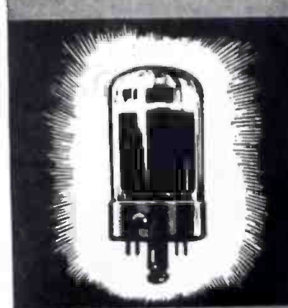
SYLVANIA

ELECTRIC PRODUCTS INC.

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

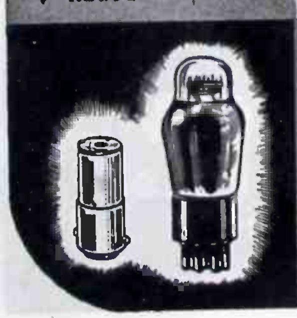
▲ TRANSMITTING
TUBES

STANDARD TYPE
RECEIVING TUBES ▼



MINIATURE SIZE
GAS VOLTAGE
▼ REGULATOR TUBES

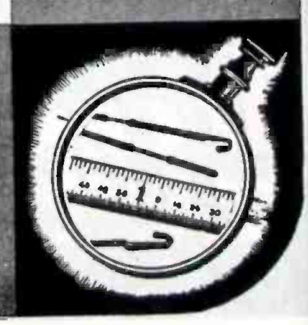
▲ SYLVANIA
"LOCK-IN" TYPE
RECEIVING TUBES



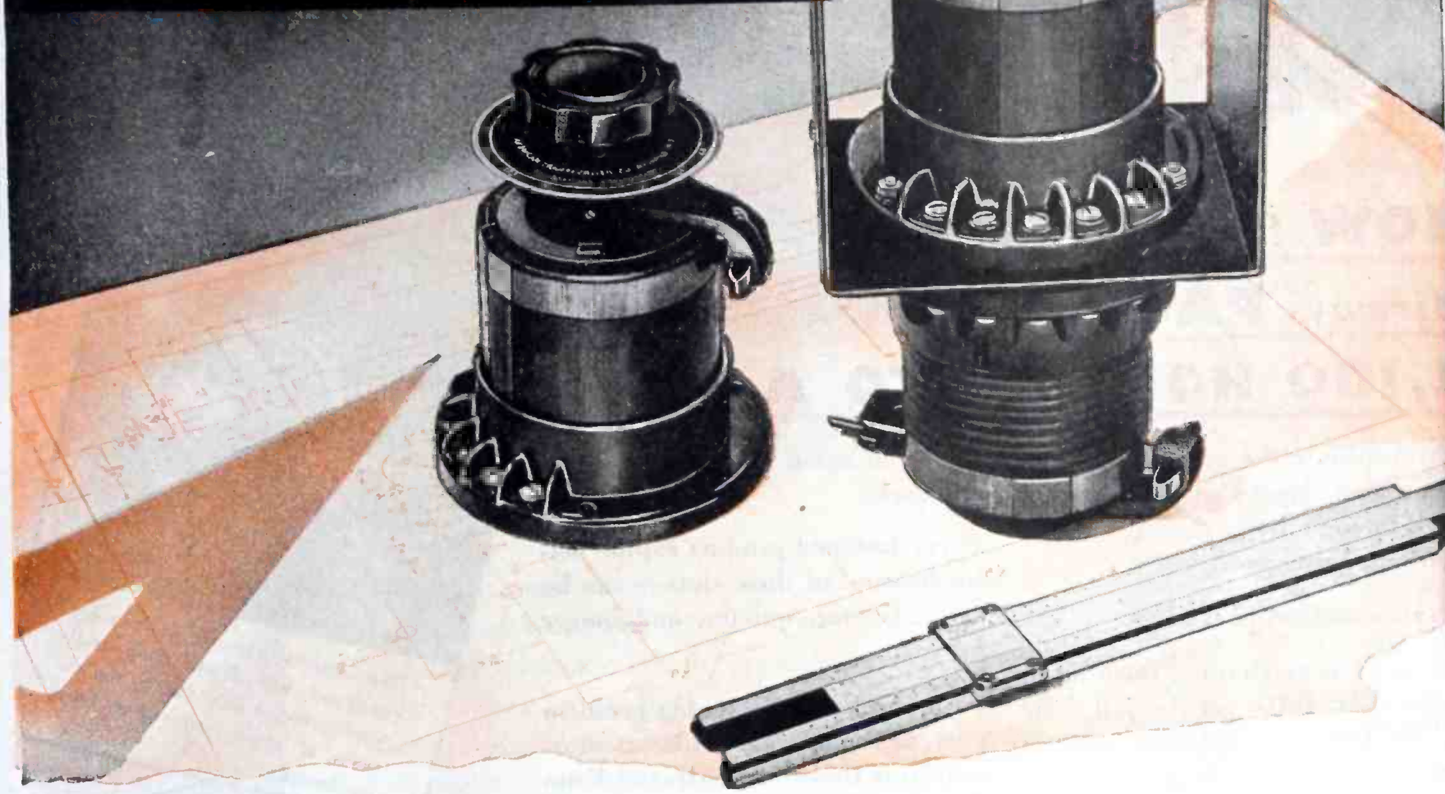
STANDARD SIZE
◀ GAS VOLTAGE
REGULATOR TUBES

MINIATURE RADIO
◀ RECEIVING TUBES

WELDS AND
LEADS ▶



This *NEW* Sturdy, Smaller Transtat AC Voltage Regulator OFFERS INCREASED DESIGN POSSIBILITIES!



The new TH 2½A Transtat A. C. Voltage Regulator is half the size and less than half the weight of the smallest previous TH Transtat. When used as a dual unit, a further space saving is made possible by base-to-base mounting. In attaining this extreme compactness, AmerTran also introduced several mechanical innovations: the unique die cast brush arm with its generous heat dissipating surface; smooth commutator with solid insulation between segments; the operating shaft that can be quickly changed for table, panel or gang mounting; the Phenolic Thermosetting Plastic Base with its terminal barriers and other features.

Yet the TH-2½A Transtat's conservative rating is a working rating—output voltages are full load voltages. Exciting current is only 0.06 amperes. Control throughout working range never exceeds 0.4 volt increments. And like its larger brothers, it cannot disturb power factor, distort wave form or interfere with radio reception. Investigate its possibilities in your apparatus today.

Write for Bulletin 171-01

TYPE TH-2½A TRANSTAT FOR SINGLE PHASE OPERATION					
	VA	Frequency	Input Volts	Output Volts	Output Amperes
		50° Centigrade Rise			
Nominal	300	50/60	115	0-115	2.6
Maximum	340	50/60	115	0-130	2.6
TYPE TH-2X-2½A TRANSTAT DUAL UNIT. OPEN DELTA CONNECTED FOR THREE PHASE REGULATION					
		50° Centigrade Rise			
Nominal	520	50/60	115	0-115	2.6
Maximum	590	50/60	115	0-130	2.6

AMERICAN TRANSFORMER COMPANY, 178 Emmet St., Newark 5, N. J.

AMER TRAN

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

AMERTRAN

MANUFACTURING SINCE 1901 AT NEWARK, N. J.

WARNING TO FIRST-TIME USERS - - - -

DON'T LOOK FOR A JACK-OF-ALL-TRADES IN ELECTRONIC HEATING MACHINES

ELECTRONIC HEATING is rapidly outmoding many ndustrial heating processes because of its numerous ıdvantages, recognized and acknowledged by all lead-ng industries.

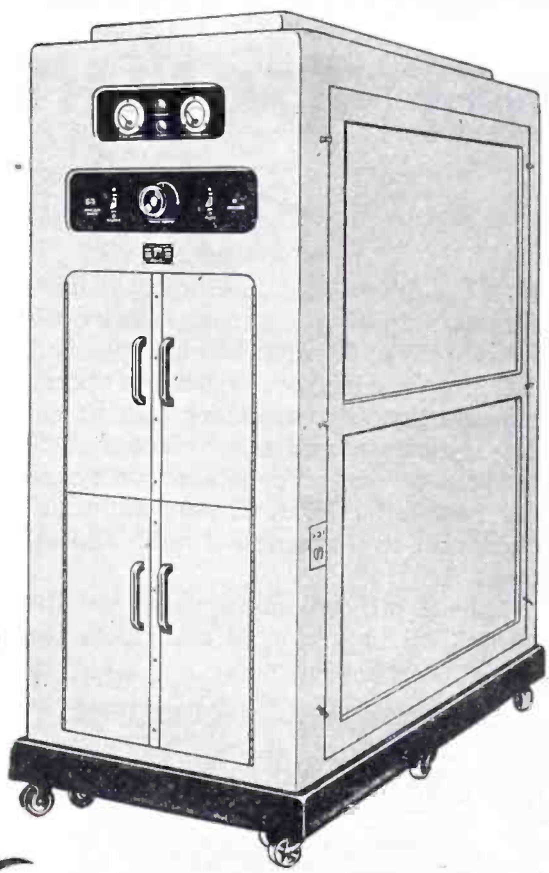
It is, however, important to realize that the maximum time-ınd-money-saving advantages of the process can only be ealized by *using it correctly in every application.* Each heat-ng process requires a definite FREQUENCY and POWER :ombination.

To use any combination of frequency and power other than he one ideally adjusted to the process implies a waste of power ınd the use of a "misfit" size machine.

No electronic heater has ever been built that can provide a arge enough variety of frequency and power combinations o permit economical application to more than one type of ıeating operation.

For 23 years we have pioneered and specialized in electronic ıeating. As recognized experts we urge all first-time users to onsult our engineers and to investigate the many advantages of our complete variety of units before buying. Write to us or detailed information.

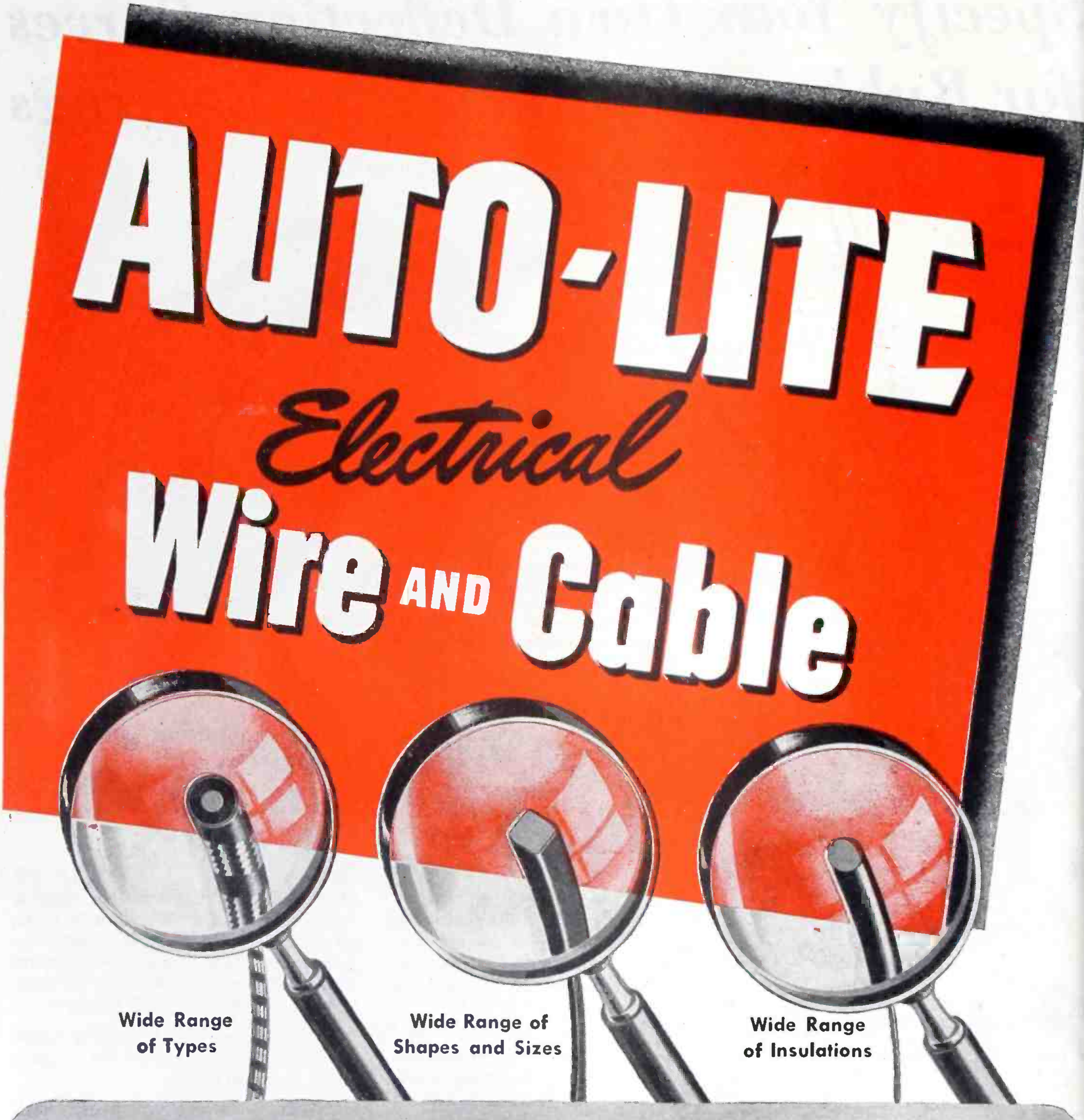
ur equipment offers you a selection of frequencies up to 300 megacycles—nd the following power range, with stepless control from zero to full load: , 5, 7½, 10, 12½, 15, 18, 25, 40 and 100 Kw.



Scientific Electric

DIVISION OF "S" CORRUGATED QUENCHED GAP COMPANY
119 MONROE STREET GARFIELD, NEW JERSEY

Manufacturers of Vacuum Tube and Spark Gap Converters
Since 1921



Precision-Made to fit your wiring job

The question faced by every user of electrical wire and cable is: What is the specific job, what are the special qualities needed? The answer can be readily found at Auto-Lite.

Auto-Lite engineers will be glad to help you determine just what size, type and shape of wire you need, what material to use and what insulation.

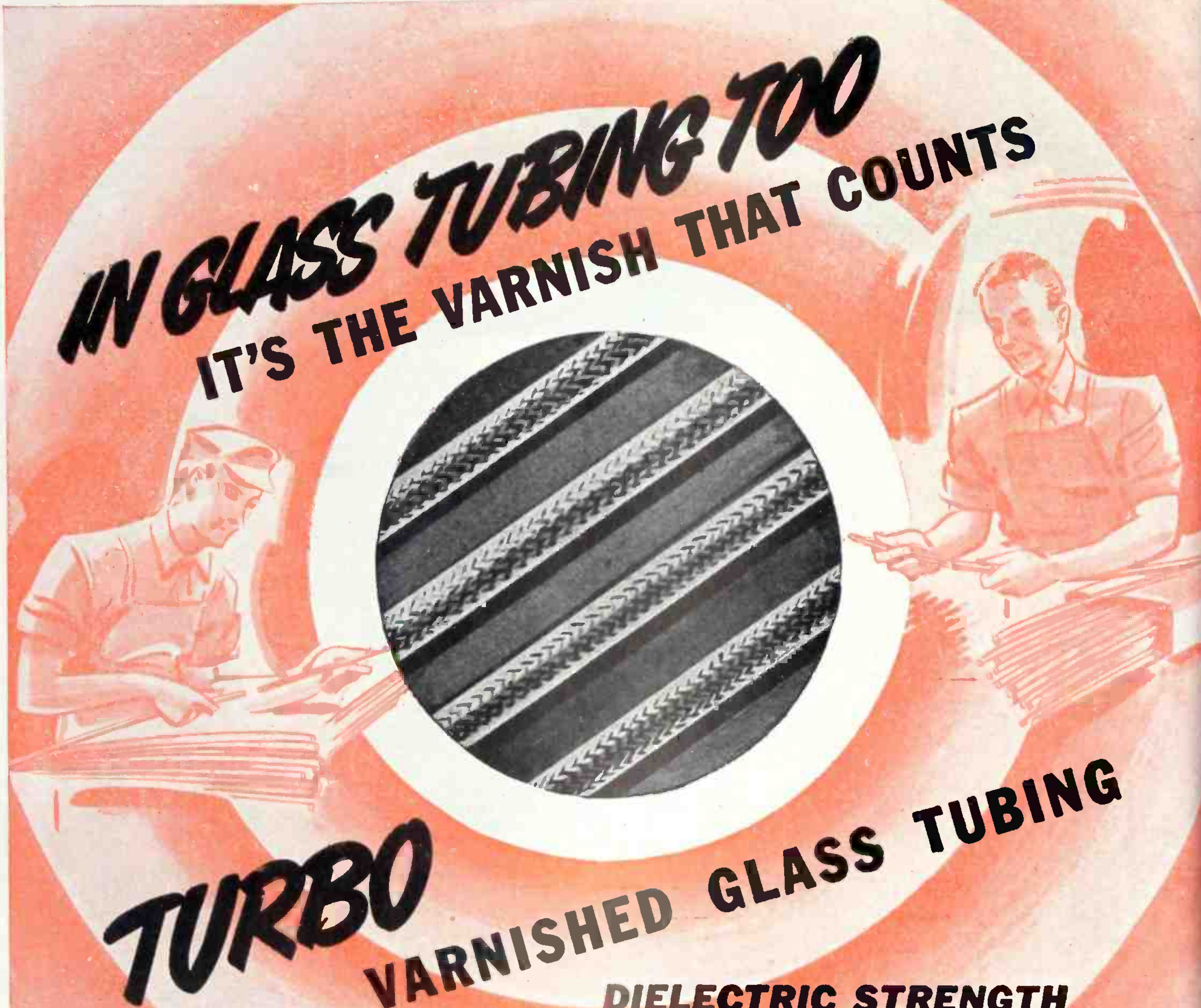
Auto-Lite research has anticipated the problem, has engineered the solution. The manufacturing facilities in the big Auto-Lite plant are diverse enough to furnish the kind and quantity of electrical wire and cable you need. Address your inquiries to

THE ELECTRIC AUTO-LITE COMPANY

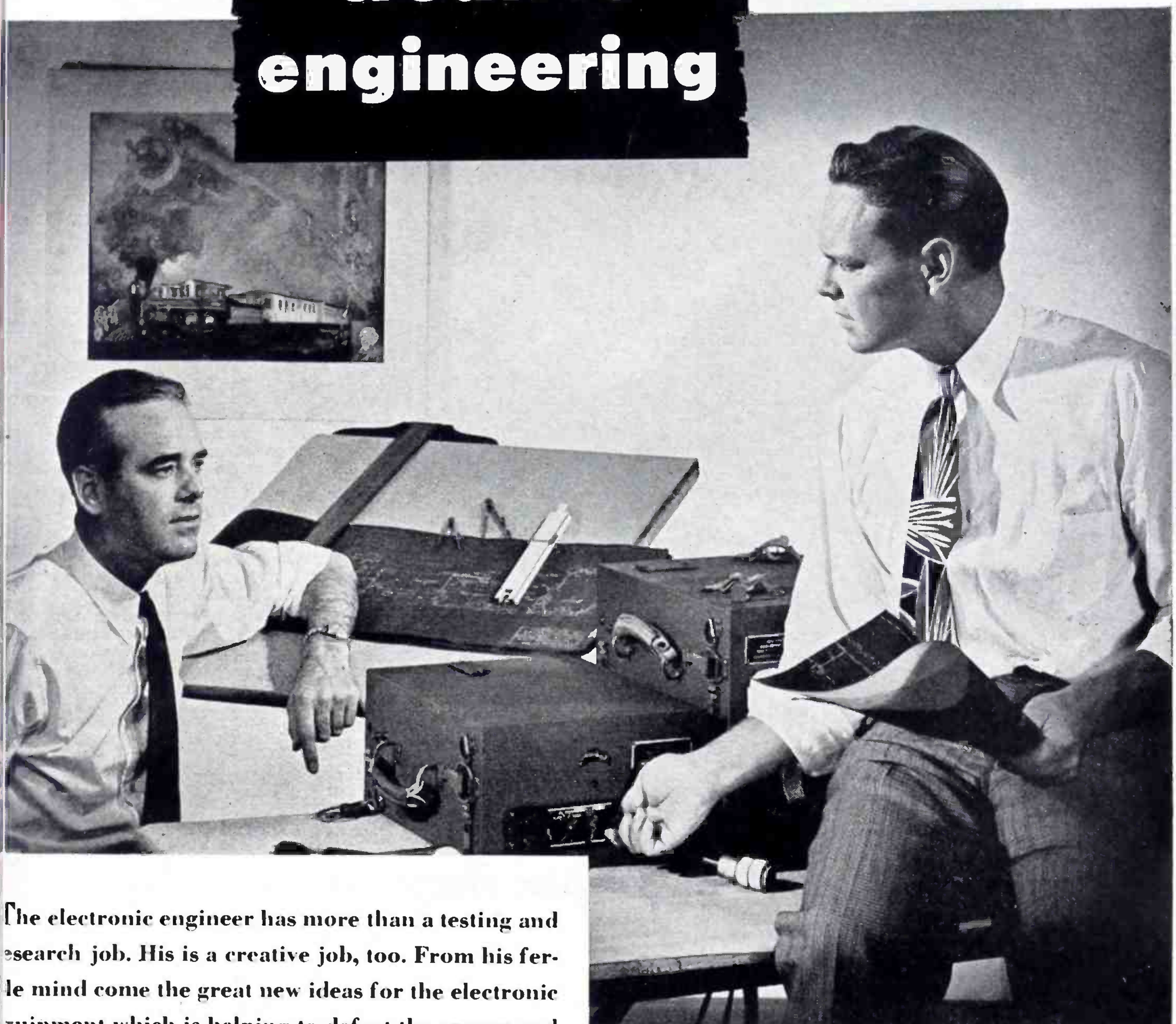
SARNIA, ONT. — *Wire Division* — PORT HURON, MICH.

BUY WAR BONDS

TUNE IN "EVERYTHING FOR THE BOYS" STARRING DICK HAYMES—EVERY TUESDAY NIGHT—NBC NETWORK


IN GLASS TUBING TOO
IT'S THE VARNISH THAT COUNTS
TURBO
VARNISHED GLASS TUBING

creative engineering



[he electronic engineer has more than a testing and esearch job. His is a creative job, too. From his fer- le mind come the great new ideas for the electronic quipment which is helping to defeat the enemy and hich will mean a glorious peacetime era when peace assured. Most all industries will benefit from the ighly specialized technical and scientific knowledge f the electronic engineer and the discoveries he has ade.

Raytheon is proud of its part in the immeasurably nportant role that advanced electronic equipment is playing in winning the war. When peace comes, Raytheon's research and wartime production knowledge will be used to doubly protect the electronic equipment requirements of post-war radio and industrial products manufacturers, and to assure Raytheon's continued leadership in the electronic era.

ARMY-NAVY "E" WITH STARS
Awarded All Four Divisions of Raytheon
for Continued Excellence in Production

RAYTHEON

Raytheon Manufacturing Company
ELECTRICAL EQUIPMENT DIVISION
Waltham and Newton, Massachusetts

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

CONTENTS OF MANUAL

The Cathode-Ray Oscillograph: introduction, general description, high-voltage power supply, amplifiers, linear time-base generator, intensity modulation, low-voltage power supply, mechanical considerations, conclusion.

• • •

Oscillograph Design Considerations: power supplies, amplifier design, time-bases or sweep generators.

• • •

DuMont Cathode-Ray Equipment: description, specifications, accessories, oscillograph type comparison list, specialty products.

• • •

DuMont Cathode-Ray Tube: general information, installation notes, type specification sheets, tube type comparison list.

• • •

Sales and Service Information: how to order, patent notice, price list, etc.

• • •

Instrument and Tube Application Notes: frequency and phase determination, photographic measurements, observation of relay rebounce, etc.

Cathode-Ray Tubes

. . . and how they are applied

For a dozen years past the Allen B. DuMont Laboratories have specialized in the development, production and application of cathode-ray tubes.

DuMont was the first to introduce the *commercialized* cathode-ray tube as a practical tool for research worker, production engineer and technician. Not only have DuMont tubes and oscillographs resulted in savings in time required to investigate the many problems to which they are applicable, but they have also revealed truths in man's laws of the working forces of nature.

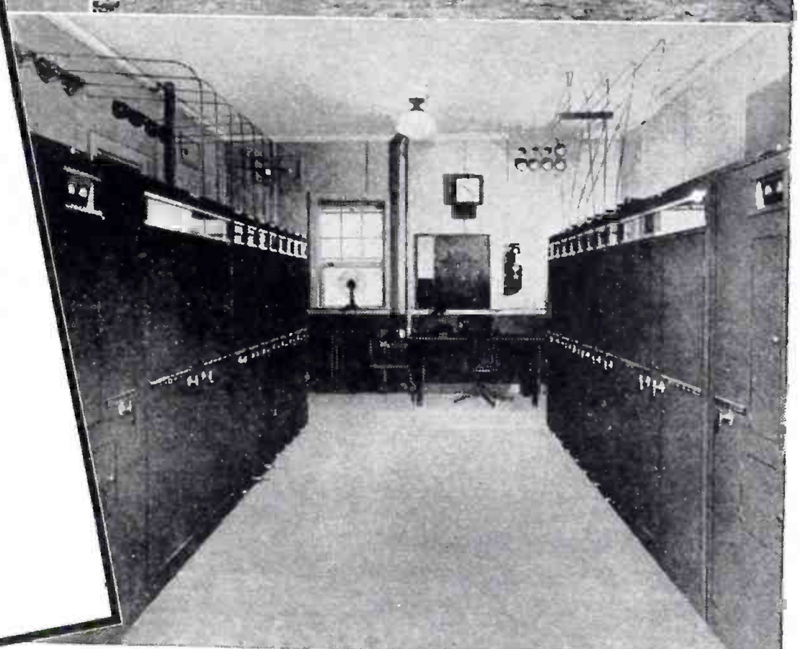
And now, as a further service, DuMont engineers have compiled a manual of pertinent data, together with detailed descriptions of DuMont tubes and associated equipment. This data is in loose-leaf form. The binder permits constant revision to keep pace with the fast-moving cathode-ray technique. Each manual bears a serial number so that the name and address of its recipient may be duly registered. Additional pages are mailed from time to time.

• • •

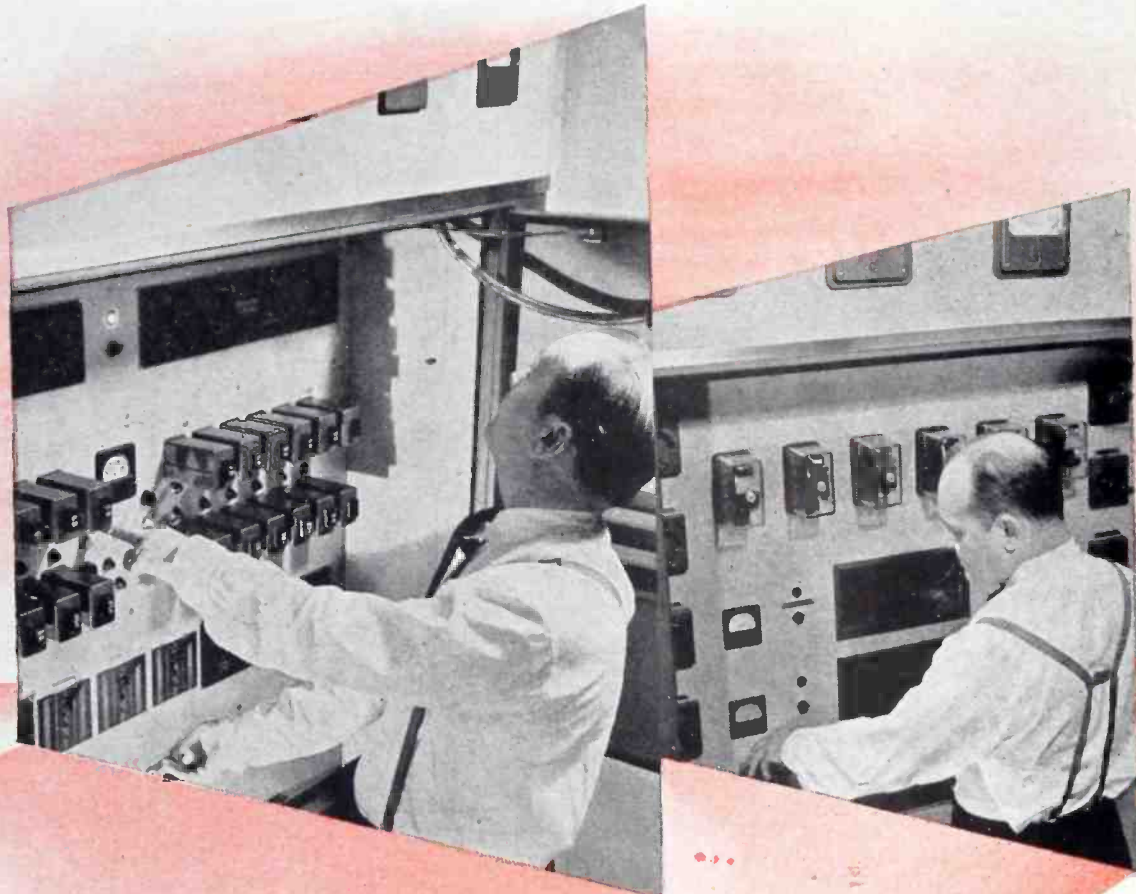
Write on your business stationery for your copy. Our Engineering Department is interested in aiding you with your cathode-ray application problems.

DUMONT *Precision Electronics & Television*

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



Official United States Army Photographs



CONSIDER *Simplicity of Control*

WHEN YOU SELECT A NEW TRANSMITTER

Easy to put on the air, easy to keep on the air . . . that's what you want in a transmitter, and that's what Westinghouse equipment assures.

Specifically, here are some of the features that make for operating simplicity in Westinghouse Transmitters:

1. One Master Control puts the transmitter on the air and cuts the power off at the end of the broadcast period. It is impossible for power to be applied in the wrong sequence.
2. Individual Tuning and Adjustment Controls are mounted on the front panel, easily accessible.
3. Indicator Lights Flash Circuit Conditions to Operator, indicating instantly which circuit requires attention.
4. Simplified Circuits—require a minimum of tubes . . . no tricky wiring.
5. "De-ion" Breakers Show Outage Location, providing fuseless protection for the low-voltage power circuits.

Simplicity of Control is only one feature of Westinghouse Transmitters. Others equally important are: ***Low Operating Cost, Continuity of Operation, High Fidelity Signals, Ease of Maintenance.***

PLACE YOUR ORDER NOW
FOR YOUR POSTWAR TRANSMITTER

By placing your order today for a Westinghouse transmitter, you assure yourself of the fastest possible delivery following the lifting of wartime manufacturing restrictions. We are scheduling deliveries in the sequence in which orders are received. For details, write Westinghouse Electric & Mfg. Company, Dept. 1NB, P. O. Box 868, Pittsburgh 30, Pa.

J-0808

Westinghouse RADIO DIVISION

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

A M • E L E C T R O N I C S • F M

PURE, READY-TO-USE ZIRCONIUM METAL POWDER EXPEDITES TUBE PRODUCTION

Of the many advantages of "G" grade Foote Zirconium Metal Powder, one of timely interest to tube manufacturers is its purity.

"G" grade is specially prepared for power and transmitting tubes. It is extremely pure, a typical analysis revealing only .028% acid soluble calcium, .005% iron, and .04% aluminum. Furthermore, "G" grade is not a compound and contains no gases which must be driven off before using. "G" grade may be used just as received with the addition of the usual proper binders.

If you are not familiar with the other advantages of Foote "G" grade, this brief review may be helpful to you:

a. A surface sprayed with "G" grade Zirconium Metal Powder approaches a perfect black body in heat radiation.

b. "G" grade has little or no tendency to mirror the tube wall or insulating parts, therefore it eliminates inter-element leakage and losses, raises the maximum load limit of the tube, decreases shrinkage and increases tube life.

c. It does not easily alloy with the molybdenum plate and thus decrease its efficiency as a getter.

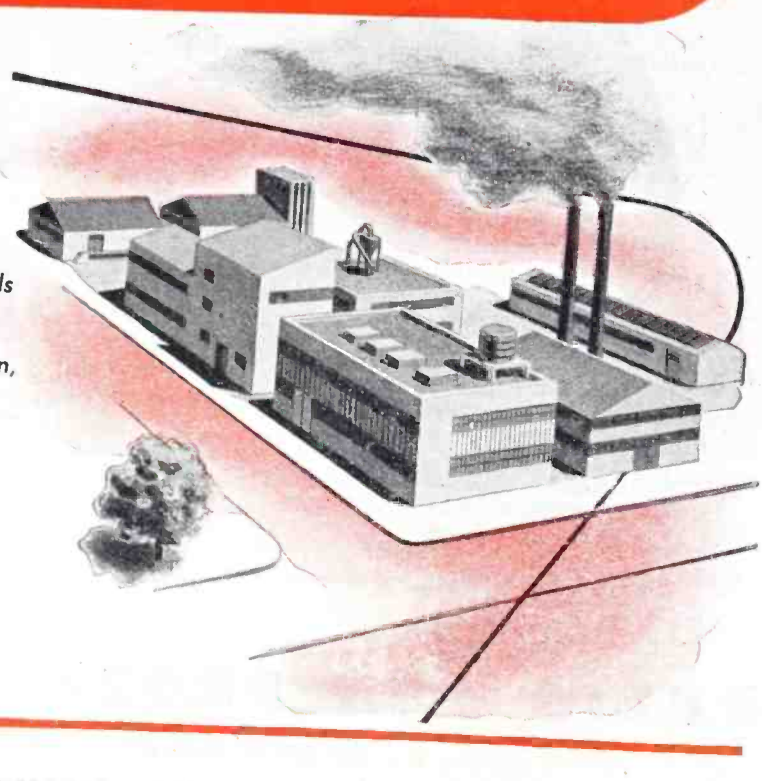
d. With "G" grade the pumping time for certain tubes with carbon or graphite anodes is reduced over 50%.

e. "G" grade is a continuous getter at temperatures less than 400°C. but is most active over 600°C.

For additional information about Foote Zirconium Metal Powder you are urged to write us.

"HOUSE OF TOMORROW"

From our "house of tomorrow"—that is, the various Foote ants and laboratories, pour products used by hundreds of industries, and by our Armed Forces and those of our Allies on far flung battle fronts. Ores and minerals, chemicals and alloys, wrested from the earth, and new processes developed in our laboratories and plants, await your consideration, cooperation or application. Let Foote research and products help you today—for tomorrow.



Foote MINERAL COMPANY

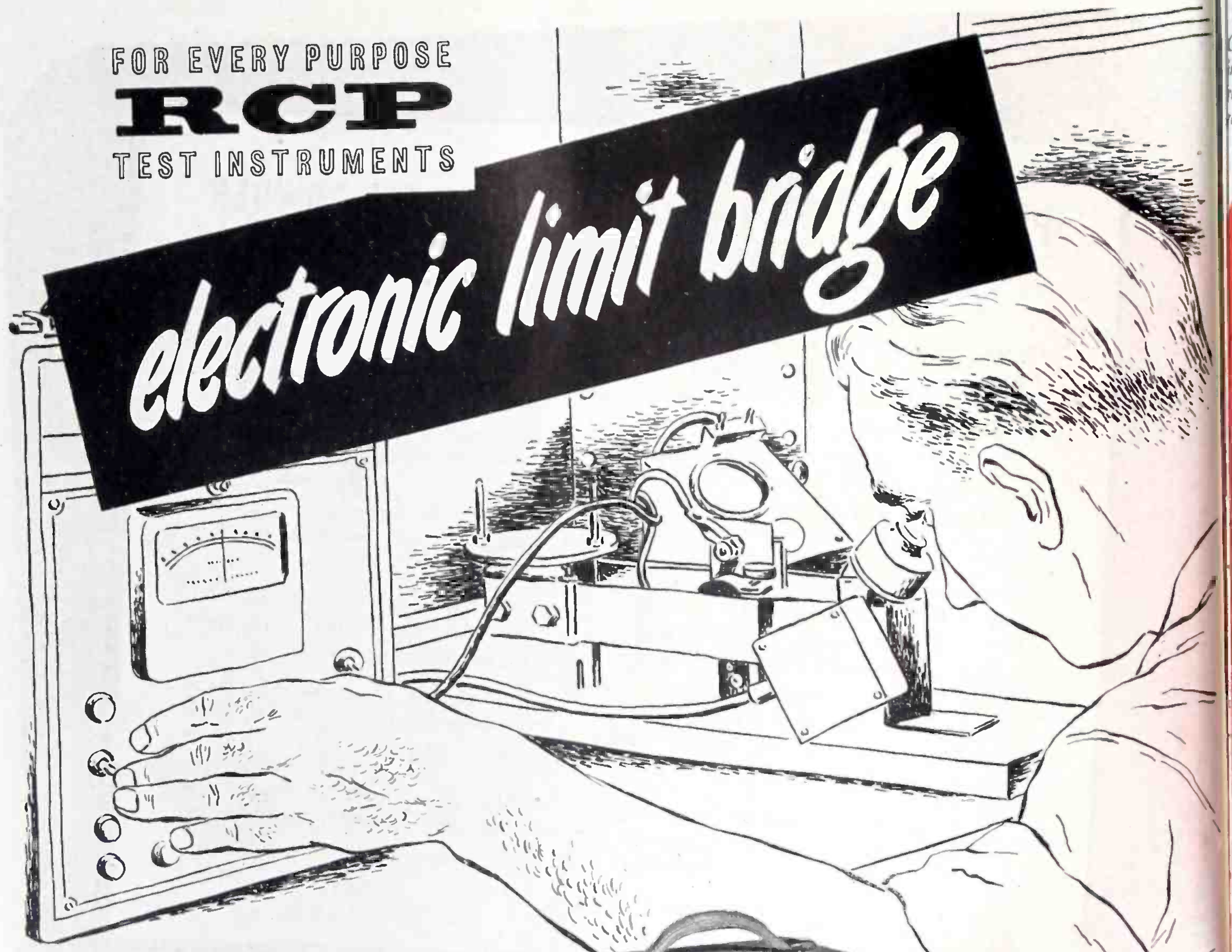
A Step Ahead in Industrial Ores and Chemicals

PHILADELPHIA • ASBESTOS • EXTON, PENNSYLVANIA
Home Office: 1617 SUMMER STREET, PHILADELPHIA, PA.
West Coast Repr.: Griffin Chemical Co., San Francisco, Calif. • English Repr.: Ernst B. Westman, Ltd., London, Engl

FOR EVERY PURPOSE

RCP

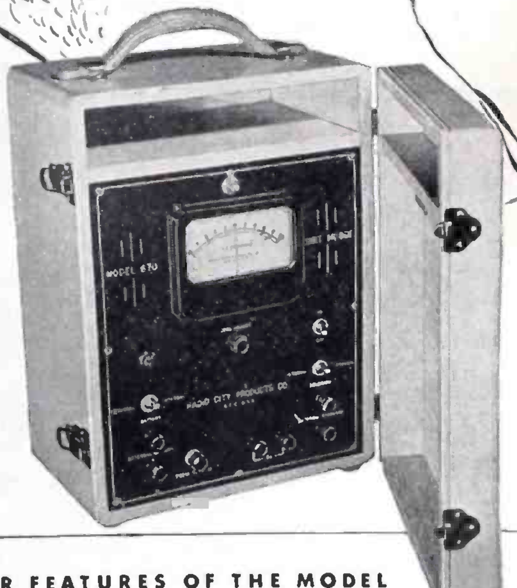
TEST INSTRUMENTS



Precision apparatus performs with maximum efficiency when serviced by precision test equipment. The quality testers manufactured by RCP meet industries' needs for superior equipment because of their consistently reliable performance.

Typical of RCP's advanced design is the Electronic Limit Bridge Model 670 for precision resistance testing.

The scale is uniformly calibrated from 0 to 10% deviation on either side of center; each division represents 0.5%. Simplified direct readings are in terms of plus/minus deviation from a built-in standard of predetermined resistance. The built-in standard can be any value specified from 8 ohms to 10 megohms. Provision is made for the use of external standards of specified values as well as external and internal standards in combination.



Other RCP electronic and electrical instruments are described in catalog 128. If you have an unusual test problem—for production or laboratory work — our engineers will cooperate in helping you find the most efficient solution.

OTHER FEATURES OF THE MODEL 670 ARE:

Component resistors are 0.1% accurate • 4½" Galvanometer has a sensitivity of 25 microamperes in either direction • Battery operated • Automatic cutout switch disconnects batteries when instrument is not in use • Engraved bakelite case is heavily shielded • Complete with self-contained battery supply, ready to operate **$150.00**

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

Casting the International Meter Rods in Paris 1874. The degree of accuracy attained 1/10,000,000 of a quadrant of a terrestrial meridian.

WHO SETS THE *Quality Standard* FOR TRANSMITTING TUBES

UNITED

TRANSMITTING TUBES

IN every art or craft, the work of some acknowledged master sets the standard.

Since 1934 UNITED has won recognition by specializing exclusively in the engineering, design and building of transmitting tubes which are unchallenged for excellence. UNITED tubes excel in every electronic application . . . including radio communication, physiotherapy, industrial control and electronic heating. In these and other applications, tubes by UNITED continue to win top honors for uniformly dependable performance.

In communication equipment for airlines, commercial broadcasting, police radio stations and other vital civilian services, UNITED transmitting tubes set the standard. Accept nothing less than UNITED quality tubes for your requirements.

Order direct or from your electronic parts jobber.

UNITED ELECTRONICS COMPANY
NEWARK, 2 New Jersey

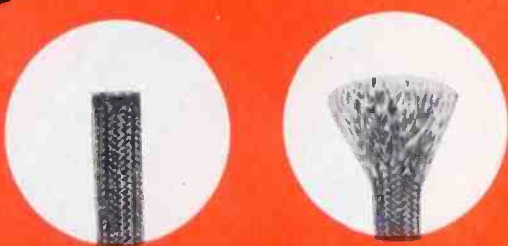
Transmitting Tubes EXCLUSIVELY Since 1934

NO FRAYED ENDS
NO FRAYED NERVES

WHEN YOU USE BH FIBERGLAS SLEEVING!

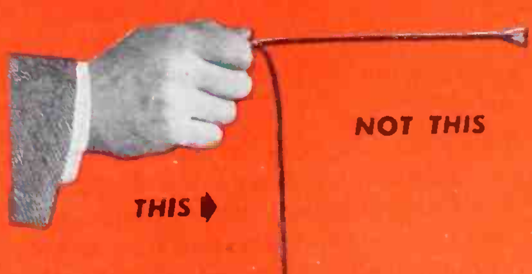
BH EXTRA FLEXIBLE FIBERGLAS SLEEVING

2 WAYS BETTER



THIS NOT THIS

NON-FRAYING



NOT THIS

THIS

NON-STIFFENING

Here's an Insulation that Handles Easier, Cuts Cleaner and Saves Time

IF you're exasperated by ordinary sleeving that frays on the ends, works stiffly and doesn't hold up in use . . . then you'll certainly want the low-down on BH *Extra Flexible* Fiberglas Sleeving! For this is a really *flexible* and definitely *non-fraying* sleeving—built around the excellent insulating qualities of Fiberglas by an *exclusive* BH process.

Fiberglas, you know, is moisture-resistant, high in dielectric and tensile strength and is shunned by fungus growths and unharmed by most chemicals. "Punishment" tests prove that BH *Extra Flexible* Fiberglas Sleeving has even more advantages. It is *permanently* non-fraying and non-stiffening. It won't burn because both yarns *and* impregnation are non-inflammable. And it lasts indefinitely without cracking or rotting.

Assembly and repair men say BH *Extra Flexible* Fiberglas Sleeving is a pleasure to handle and a sure bet for long life in the most severe service. So why tolerate a less efficient sleeving any longer? BH is available in all standard colors and all sizes from No. 20 to ⅝″, inclusive. Write for samples today and make your own comparison!

BH PRODUCTS

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

BENTLEY, HARRIS MANUFACTURING CO.

Dept. E Conshohocken, Penna.

The *Stake* of the United States in Expanding World Trade

WITH the war in Europe racing to a climax, and with a sure pattern for the defeat of Japan already outlined, American business is confronted with the need for an immediate decision on long-term economic policy.

What is this country's foreign trade program to be after the war?

No intelligent appraisal of all the factors any longer can allow us to postpone considering the issue merely because, in the past, foreign trade absorbed barely eight per cent of our production.

Actually, a whole new set of conditions was injected into the picture by the first World War; but we persisted in ignoring these new factors.

Almost overnight, the United States was transformed from the largest debtor nation in the world to the second largest creditor nation. At the same time, we made faster technological progress than any other nation. Thus we created the need for more dollar exchange on the part of the rest of the world and simultaneously made it harder for other nations to earn dollars.

Today, as another, far vaster war is approaching its end, those changed circumstances are magnified. America has new responsibilities—to itself, and to the world.

Our war-inflated industrial capacity cannot be allowed to drop back to prewar levels without causing a domestic crisis which we dare not permit.

And, because so much of the world is geared to the American industrial machine, we can no longer contemplate calmly the repercussions of a largely self-sufficient trade program or of an unplanned foreign trade program. Either would inevitably set the stage for the next world war.

☆ ☆ ☆

If we are going to prepare ourselves intelligently to cope with this new problem, we must acknowledge certain basic principles.

World trade cannot be rebuilt simply by attempting to restore *prewar* flows of goods. The war has so completely changed the economic fiber of many countries that it is necessary to develop *new* trade relationships. The East Indies, for example, may find the demand for their rubber considerably reduced; the United States may, to a large extent, have to cease exporting cotton; Japan will need to find new substitutes for much of its exports of silk; the British will need new markets to replace the income which they formerly derived from their large overseas investments.

We cannot expand markets for our goods, at home or abroad, unless we find ways of buying more supplies from more people at home or abroad, so that they will have more dollars to spend.

And we probably cannot create increasing buying power abroad without first exporting more of our technical skills—our engineers, our production and management men—to build new markets for our own specialties.

☆ ☆ ☆

What is needed to rebuild the world's economic system?

1. Most basic of all, of course, are stable governments which command popular support. In the absence of strong governments, currency stability cannot be achieved.
2. Most war-stricken countries, for a year or two, will need rehabilitation loans, because they will require far more raw materials, equipment, and live stock than they can pay for out of current production.
3. Loans, however, are only a stop-gap, though often a necessary one. Far more important than rehabilitation loans will be the creation of better opportunities for war-stricken countries to sell to the rest of the world, particularly to the United States, South America, South Africa, and India. The ravages of war do not completely destroy the ability of a country to sell. Indeed, it is surprising what large supplies of certain commodities war-torn countries have on hand even before devastated industries have been restored. The invading troops in Normandy found shoes almost non-existent, but they found food more plentiful than in Britain.

   Better opportunities for war-stricken countries to se[ll] would create opportunities for them to buy the thing[s] they will require to restore scattered industries and de[-] pleted farms, and would help those countries to get ri[d] of the exchange controls which are now universal. S[o] long as a country is able to expand its exports only slow[ly] and painfully, and is dependent upon foreign loans [to] prevent the depreciation of its currency, so long will [it] carefully preserve exchange controls and other restri[c-] tions in imports. That is why large advances, eit[her] through an International Monetary Fund or an Inter[na-] tional Investment Bank, can make only limited cont[ri-] bution to the removal of trade restrictions.
4. Permanent monetary and credit arrangements are nee[ded] to protect nations against temporary pressure upon th[eir] currencies, to permit necessary changes in exchange r[ates] to be made in an orderly manner, and to assure that g[ov-] ernments never again will repeat the "beggar-my-nei[gh-] bor" policies of 1931 and 1932.
5. Finally, the world needs a reversal of the trend to[ward] economic self-sufficiency, which received a strong [im-] petus from the first World War and an even stronge[r] from the great depression of the Thirties. This doe[s] mean that the efforts of many raw-material prod[ucing] countries to diversify their industries should be opp[osed]. During the late Nineteenth Century and the first p[art]

this century, the international specialization of production was carried too far, with the result that many countries became dependent for a large part of their standard of living upon the export of one or two raw materials—coffee, sugar, rubber, silk, wheat, wool, and meat. Between the two World Wars, however, the pendulum swung much too far in the direction of self-sufficiency. Some densely populated industrial countries of Europe (Italy, France, and Germany) even attempted to become self-sufficient in wheat, fats, and sugar. So limited are the natural resources and technical skills of most countries that each one finds many things which it can produce only at prohibitive costs. Between the extreme specialization of the late Nineteenth Century and the more recent trend toward extreme self-sufficiency, a happy medium should be sought.

☆ ☆ ☆

What role should the United States play in reconstructing the world's international economic system?

There are those who suggest that the United States be a more or less permanent Santa Claus. They believe that an excess of exports could be financed only by "loans"—loans that would eventually turn into gifts, after producing bitter controversy over why the "debtor" country did not meet its obligations. The persons who assert that full employment can be provided only by an excess of exports are in effect saying that our economy cannot become self-supporting. That is a confession of economic defeatism which a young and vigorous nation should not be willing to make.

The most immediate contribution which the United States can make to world reconstruction is to make itself prosperous.

Prosperity here means a large demand by our industries for imports. The more we import, the easier will it be for foreign countries to meet their large and urgent needs for goods. In 1939, with a gross national product of $100 billion, our imports were $3 billion. After the war, with 55 million people employed and a gross national product of $155 billion, our imports would be about $7 billion or $8 billion.

Not only should the United States make itself prosperous, but it should *keep* itself prosperous. *So important is the United States in the world economy that a depression here is bound to produce a disastrous drop in the price of raw materials throughout the world and to throw most countries into an economic tailspin.*

The United States should support the principle of a large fund to protect the exchanges of the world from temporary pressure. We should not permit differences over the details to prevent its establishment in ample time to be available during the critical period when war-stricken countries will need goods far in excess of their immediate ability to pay for them. *Some* arrangement, even though imperfect in details, will be infinitely superior to no arrangement.

Finally, the United States should take the lead in breaking down barriers to trade. We are the logical country to do this, partly because of our immense domestic market, and partly because for most of the last twenty-five years this country has been able to sell other countries more goods than they have been able to sell to us. One of the greatest contributions which the United States could make to a sound and expanding world economy would be to bring our imports, as far as practicable, up to our exports. *In other words, the United States, in the long run, should be hard to borrow from but easy to sell to.* The United States should implement this policy (1) by continuing the negotiation of reciprocal reductions in duty, and (2) by accepting exchange rates which make foreign currencies cheaper in dollars than they were in 1939. So great will be the world's need for goods that we can be sure that any dollar exchange earned by sales to us will be converted into American-made goods and will lead to larger exports.

Time was when the United States obtained about eight per cent of its standard of living by sending goods abroad and bringing back other goods. Before the war, however, we were getting less than five per cent of our living by international trade. If, after the war, we were gradually to raise the proportion of our standard of living obtained by trading with other countries to ten per cent of domestic production, our imports would be about $15 billion or $16 billion a year. Our people would be able to buy many things which they now cannot afford, and scores of countries which export raw materials and luxury products would feel the stimulus of rapidly expanding markets. Their expanded demand for road building machinery, mining machinery, machine tools, agricultural implements, locomotives, railroad cars, electrical equipment, trucks, automobiles, and a multitude of products of our factories would create a million or more additional jobs in our factories.

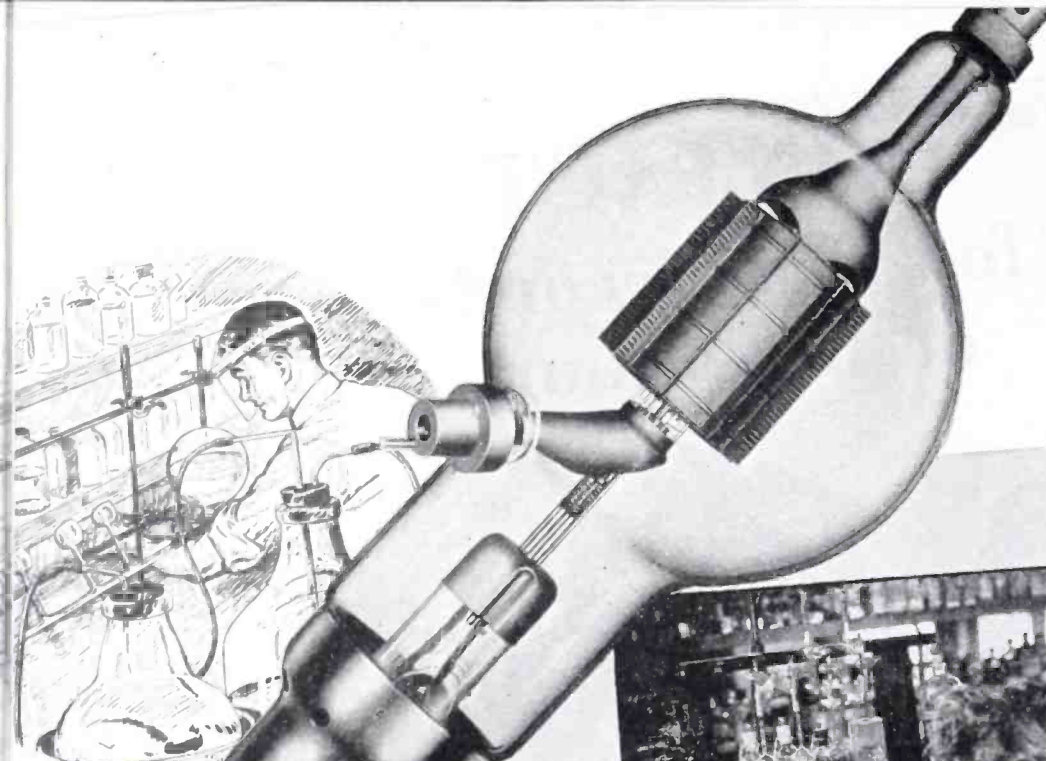
Although the United States would raise its standard of living by increasing its imports and its exports, it should honestly face the fact that the resulting shifts in production and employment would temporarily be painful for some people. The increase in imports would be in commodities which other countries can produce for less than the cost at which much of our output is produced—such as sugar, wool, copper, some fats and oils, wines, winter vegetables and fruits. The increase in our exports would come from those industries in which our superiority is greatest—particularly the manufacturing industries. Finally it would be advantageous, to the country as a whole, to shift a million or two workers from agriculture, where they earn about 60 cents an hour at best, to manufacturing, where they earn better than 80 cents an hour.

☆ ☆ ☆

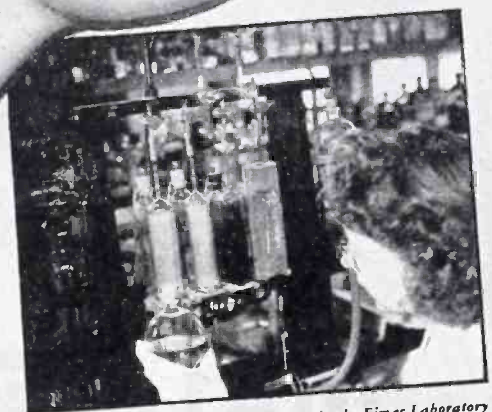
The very fact that in economic matters the rest of the world is dependent upon the United States, exposes our country to great demands and to envy and misunderstanding. The United States must be willing to help the rest of the world, but its help should take the form of assisting other countries to help themselves. Never in all history has one country had such an opportunity to give the world a rising standard of living, to foster conditions under which peace flourishes. What greater tragedy could there be than to make the sacrifices which we are now making and fail to seize this chance to create a world of hope and opportunity in which the spirit of goodwill among nations is able to flourish.

James H. McGraw, Jr.

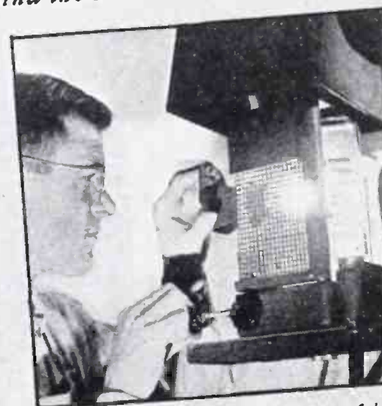
President McGraw-Hill Publishing Company, Inc.



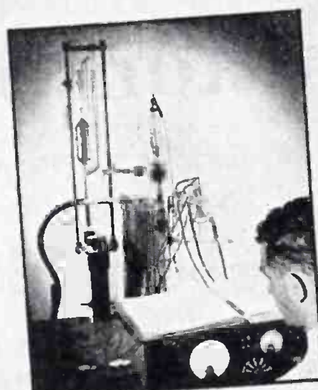
A few of the branches of the Science behind the Science of Electronics



CHEMISTRY—*Making Gas Analysis in the Eimac Laboratory*



METALLURGY—*Spectrographic Analysis of the Metals Used in Vacuum Tubes*



VACUUM TECHNOLOGY—*Constant Research to Develop Better Vacuum Techniques*

PHYSICS—*Actually Viewing Emission of Electrons with Electron Microscope*

ELECTRONICS—*Determ... about and Recording ... Vacuum Tube Capa...*

OPTICS—*Studying the Effect Processing has on the Structure of Materials Through Photomicrography*

GLASS TECHNOLOGY—*Special Technique to Produce Complicated G...*

the *Science* behind the science of electronics

The pattern of progress in the science of electronics is determined by the achievements in creating and developing new and more efficient electron vacuum tubes. Therefore, the whole complex task of vacuum tube development – involving the intelligent application of many sciences – comprises the real science behind the science of electronics.

To create and produce the modern vacuum tube requires experience and skill of the highest order in these many sciences in addition to complete facilities for their application. The list includes everything from chemistry and metallurgy – the technology of glass fabrication and vacuum pumping – to physics, optics, thermo-dynamics and most important of all – Electronics.

The resources and resourcefulness of Eimac laboratories have accounted for many outstanding contributions to the science of Electronics. A fact which is attested to by the leadership which Eimac tubes enjoy throughout the world. These comprehensive facilities are continuously being utilized to achieve better and better results for the users of Eimac tubes.

Eimac Engineering is devoted solely to the development and production of electron vacuum tubes. However, since the electron vacuum tube is the heart of all electronic devices it is advisable for users and prospective users of electronics to look first to the vacuum tubes required. A note outlining your problem will bring advice and assistance without cost or obligation.

• • •

Write for your copy of Electronic Telesis – a 64 page booklet fully illustrated – covering fundamentals of Electronics and many of its important applications. Written in layman's language.

Follow the leaders to

Eimac REG. U. S. PAT. OFF. **TUBES**

EITEL-McCULLOUGH, INC., 869 San Mateo Ave., SAN BR...

Plants located at: San Bruno, California and Salt ...

Export Agents: FRAZAR & HANSEN, 301 Clay Street, San Francisco, Ca...

CONTACT for Five Seconds or Five Hours

MALLORY Push Button Switches

Mallory Circuit Selector Switches — Single gang and multi-gang types. Low capacity, low resistance, silver-to-silver contacts, extreme flexibility in circuit and coil combinations.

Mallory Jacks — Long frame, junior, midget, Signal Corps and extension types. Spring combinations for practically any application.

Mallory Plugs — Two and three conductor types in bakelite or shielded nickel shell. Tips insulated from sleeves to prevent shorting.

Mallory Dial Lights — In screw base and bayonet base types.

Many products on today's drawing boards call for manual make and break of the electrical circuit—either momentary or locked for an indefinite period. The answer to that need is provided by Mallory in this versatile, dependable Push Button Switch.

The switch is available in two different types: a non-locking model which operates only when the button is pushed in and releases on removal of pressure . . . and a locking switch which maintains its position when the button is pushed in, and is released only when the button is pulled out. In either case, eight circuit combinations are provided, and the switches can be mounted on panels up to ¼ inch thick with a single hole 7/16 inch in diameter.

For other precision electronic parts geared to today's specifications and backed by Mallory's wide application knowledge, send for the Mallory Catalog or see your Mallory distributor. A few typical Mallory products are mentioned at the left.

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

Serving the Aviation, Electrical, Electronics and Industrial Fields

P. R. MALLORY & CO. Inc.
MALLORY

ARMY E NAVY

There are Bonds That Tie You to Your Fighting Man —Government War Bonds!

Approved Precision Products

CROSS TALK

"An alert Navy must have appropriations from Congress for extensive research in time of peace. Research before a war is the only research which will do us any good on the day the enemy strikes."

James Forrestal, Secretary of the Navy, *Saturday Evening Post*, June 24, 1944.

► **RESEARCH** . . . It is an unfortunate fact that a very great deal of the research which is now bearing us such good fruit in the war was started almost too late. In some branches of the armed services, forward-looking research had practically ceased, either due to lack of foresight or imagination, or due to the fact that Congress would not provide the funds for it. After every war, the people lull themselves to sleep with the happy hopes that no further war-like expenditures will be necessary, and, therefore, no more taxes need be collected for preparation for future conflicts.

Admiral Mahan, in his well known treatises on naval history, cites chapter and verse to show that after every war in which this country is engaged there arises a clamor to stop all warlike activities, to get back to "normal" and to stop spending money so that the people can make more of it.

As soon as peace seems close, watch for an outcry to lower taxes, to stop the expense of further research. Watch for all of the age-old arguments which a people, tired of war, eternally advance for going back to sleep. Remember that savings made by stopping research are only illusory; that money saved before a war is spent many fold after a war starts; that abundant research prior to a war may prevent it entirely.

► **STANDARDIZATION** . . . Some people make fetish of the business of standardization. Certainl the subject can be worked so hard that the potenti benefits are not secured. Yet the recent happy co clusion of the conflict in the symbols used for ele tronic components leads one to hope that addition benefits could be secured by some standardization the components themselves.

The vast number of different types of electro components is a great waste of manufacturing eff a waste of storage space, a great burden on ra service agencies and a great trouble to manufactu and users of radio sets.

Most of the different types of components vary f each other in minor degree only; a very great n of them could be eliminated. It is true that the signer who uses the components would have f types to choose from—but it is a fair assumption he, too, would find his problems simplified, not m fied, by standardization of this kind.

British Columbia's

By N. R. OLDING

Regional Engineer
Canadian Broadcasting Corp.
Vancouver, B. C.

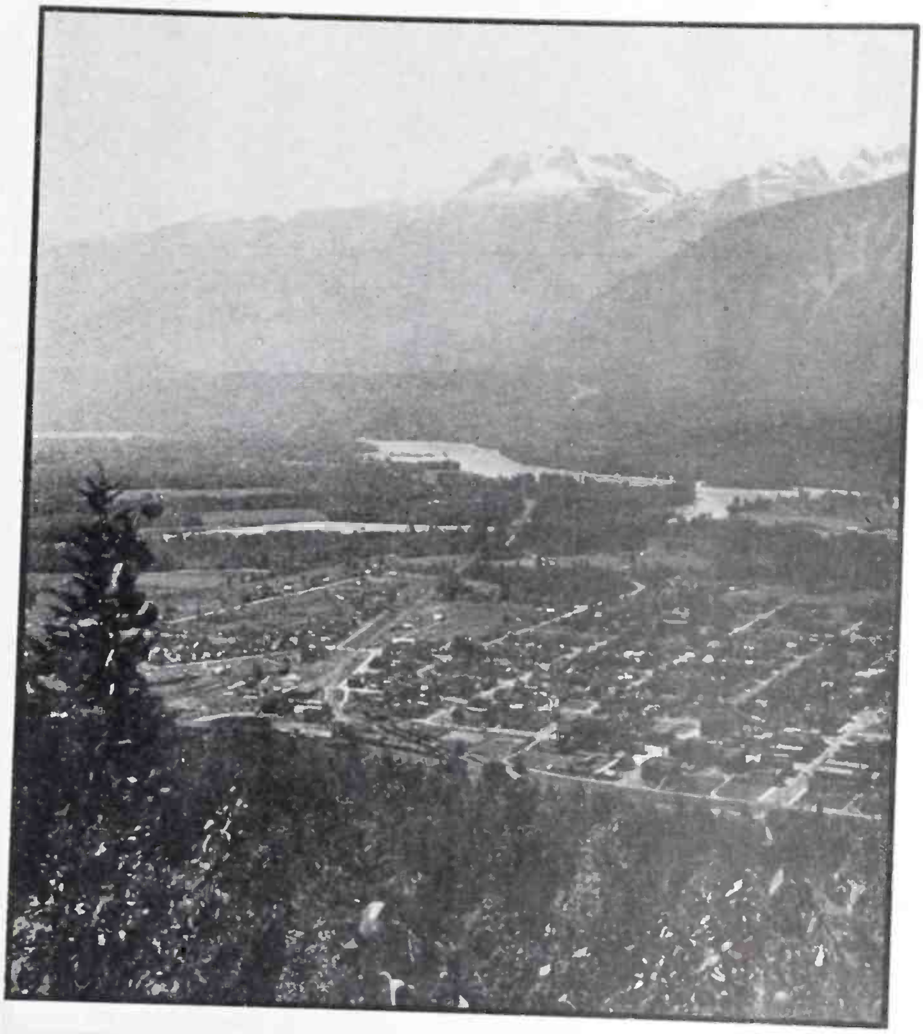


FIG. 1—Revelstoke, B. C., showing the nature of the terrain which renders broadcast service difficult in this Canadian province

THE MOUNTAINS which have made British Columbia so attractive to the tourist and so rich in minerals, present many difficult problems to engineers. Among these is the very real problem of providing satisfactory radio reception for scattered groups of listeners residing in remote valleys among several mountain ranges which divide the province. To the extremely rapid attenuation of the ground wave associated with rocky terrain must be added the adverse effects of radio shadows and reflections from high mountains such as those pictured in Fig. 1 and 2.

Due to these conditions, it soon became evident that adequate coverage could not be provided by one or two high-powered transmitters, regardless of how strategically these might be located. While the use of shortwave transmitters offered a partial solution, the wide angle of transmission required and the distances involved were deciding factors in limiting this means of transmission to auxiliary service. The method finally adopted utilizes numerous low-power transmitters operating on standard broadcast channels. Some of the power from these transmitters is fed into existing wire lines serving the remote valleys and this is the most important feature of the system.

Initial Test Results

Everyone who has made field-strength measurements knows that telephone, telegraph and power circuits act as carrying conductors for radio waves. With this in mind, a test unit was set up with the following objects in view:

(1) To determine the minimum power required to serve a community of from 500 to 5000 population.

(2) To determine the improvement in coverage obtainable by utilizing the carrying effect of nearby copper circuits.

(3) To determine whether or not it would be possible to feed limited power into local copper circuits without creating interference on telephone and carrier-telegraph circuits.

North Bend, a small railway town on the banks of the Fraser River at a point known as the "Gateway to the Cariboo", was chosen as a test site. In view of the nature of the tests to be conducted, the site had much to recommend it. The town is on a narrow ledge between a mountain and the river and on the other side of the river a similar condition prevails. The nearest center of population to the south is at Yale, about twenty-three miles airline, and the nearest center of population to the north is at Lytton, twenty-five miles airline. (A Canadian Pacific Communications repeater station, carrying CBC network service, is located in North Bend and the strongest daytime signal on the broadcast band was somewhat less than 1.0 microvolt-per-meter.)

A Marconi TR50P shortwave transmitter, converted for use on 840 kc and operated under experimental license VE9BC, was installed in the local telegraph repeater station as shown in Fig. 3. The ground lead from the trans-

Broadcast Relay System

Remote valleys in rugged western Canada are difficult to serve by conventional broadcast methods. The problem is solved by installing 25-watt transmitters in local telegraph and telephone offices through which network audio flows and feeding part of the r-f output of these transmitters back into the wire lines, which serve as carrier conductors

mitter was connected to the common equipment ground. The antenna consisted of an inverted L with a flat top 120 ft long, running slightly above and approximately parallel with the telegraph lines.

During field-test periods power output was maintained at 16.2 watts. Peak program modulation was held at 60 percent except during station breaks, at which times the transmitter was switched to icw and the output raised to 20 watts. Even during the latter periods local and distant repeater operators were unable to detect any trace of interference on telephone, telegraph or carrier-telegraph channels.

It was not possible to make many field-strength measurements at the time, but readings on signals radiated directly by the antenna and not aided by telegraph line carrier characteristics indicated approximately 100 microvolts-per-meter at points five miles away from the transmitter. On the other hand, due to the carrying effect of the telegraph circuits, the signal at points up to 500 feet from these circuits and 15 miles from the transmitter gave readings of 300 microvolts-per-meter or more. The signal radiated by the telegraph lines, which could be followed up and down the right-of-way for approximately 40 miles, transferred to local circuits at Yale and Lytton, providing a useable signal even at these points although both are well outside the normal ground-wave service area.

Practical Application

The financial failure and closure of the privately owned station in Revelstoke, in the late fall of 1940, and subsequent requests from listeners in that area for continued

FIG. 2—(above) Relief map of British Columbia. Circles indicate the location of low-power relay stations radiating a portion of their r-f output into telephone, telegraph and power lines as discussed in this article. Triangles show other stations of the CBC and squares identify private commercial stations associated with the network. 1—CBR-CBRX, Vancouver; 2—CFPR, Prince Rupert; 3—CBRG, Prince George; 4—CBRQ, Quesnel; 5—CBRL, Williams Lake; 6—CBRN, North Bend; 7—CBRA, Revelstoke; 8—CBRM, Creston; 9—CBRK, Kimberley; 10—CBRR, Cranbrook; 11—CBRF, Fernie; 12—CJVI, Victoria; 13—CJOR-CKWX, Vancouver; 14—CHWK, Chilliwack; 15—CFJC, Kamloops; 16—CKOV, Kelowna; 17—CJAT, Trail; 18—CKLN, Nelson

FIG. 3—(below) The experimental low-power relay station, installed in a telegraph repeater office at North Bend. It is now in permanent use

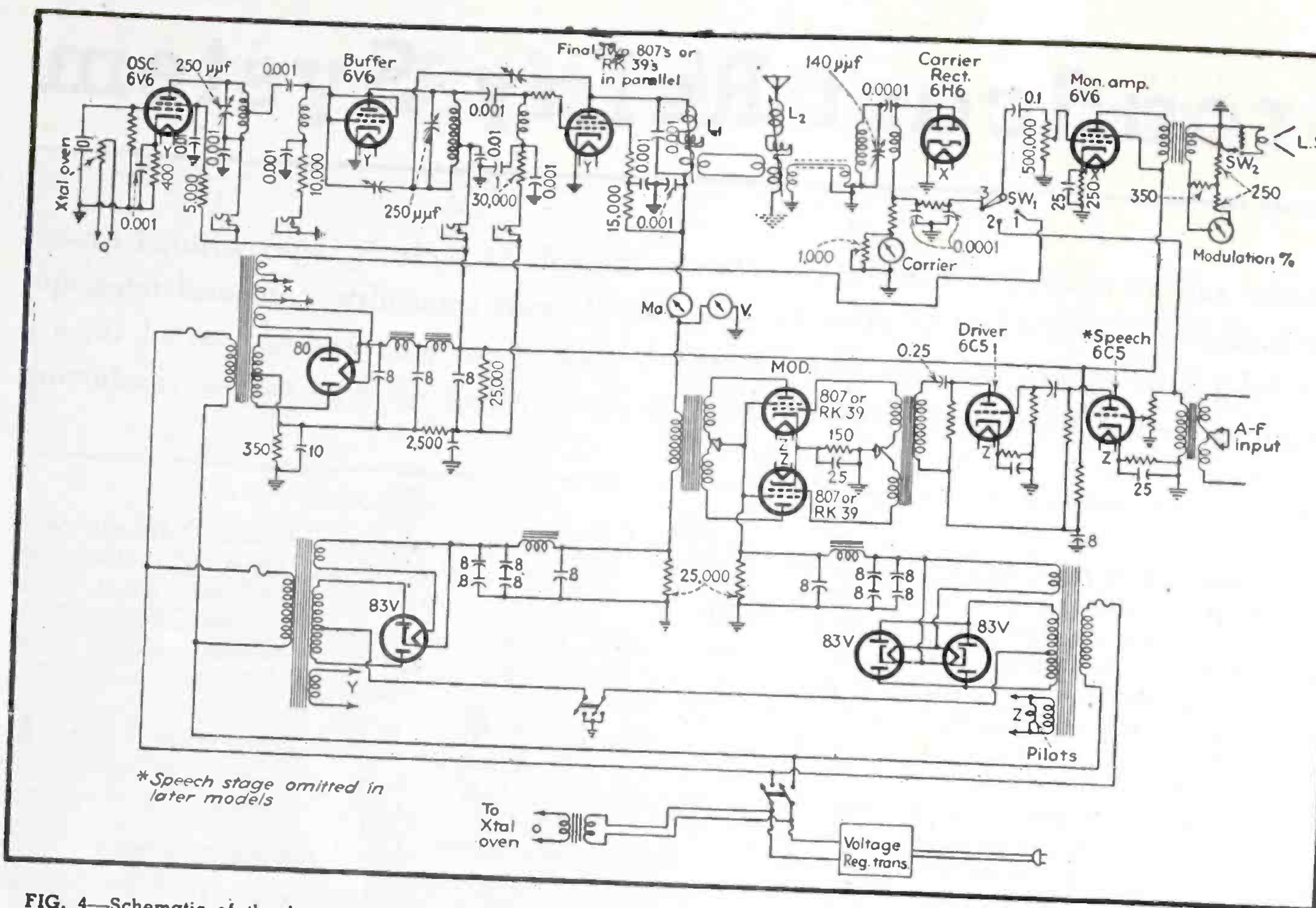


FIG. 4—Schematic of the low-power relay transmitter finally developed for use at a number of locations in British Columbia. The r-f portion of the unit may be seen at the upper left; the associated monitor and its amplifier appear at the upper right, with the modulator and speech amplifier diagramed below the monitor. Other circuits are power supplies

ervice, presented an immediate pportunity for the CBC Engi- eering Division to put the fore- oing experience to practical test. On October 22nd, 1940, the first ow-Power Relay Transmitter", erating under the call CBRA, s installed and placed in opera- n on a sixteen-hour-a-day edule. In the beginning the verted Marconi unit, with some ther refinements such as tem- ature control of the crystal llator, was used. Although transmitter was designed for rmittent service it stood up However, because many r points were demanding im- ed service, the development of ecial transmitter unit which d work into various antennas on erratic local power sup- was undertaken.

requirements were as fol-

The power output should be en 20 and 25 watts.

The tube line-up should be ple and efficient as possible.

(3) The antenna-tuning unit should be relatively free from failure due to static or lightning.

(4) The unit should give long and reliable service on fluctuating or poorly regulated power supply.

(5) A minimum of meters consistent with reliable operation should be used.

(6) Meters should be provided to measure the audio input level, antenna current, percentage modulation, final amplifier plate voltage and final amplifier plate current.

(7) The unit should incorporate a monitor, with provisions to switch the input to either the audio line or the rectified r-f carrier.

(8) As the unit would in many cases be operated by relatively inexperienced personnel, a minimum of adjustable controls should appear on the exposed panel and the operation should be limited to throwing switches on and off and reading the meters.

(9) As an aid to servicing, it was proposed to fuse each major circuit separately and to construct the unit so that individual chassis units could be readily removed when required.

(10) The antenna coupling unit and final amplifier tank should be designed to permit efficient coupling with a minimum of harmonic radiation.

(11) Frequency response should be equal to, or better than, that of the network, or ± 2 db from 100 to 5000 cycles.

(12) The audio input should be arranged for bridging across a 600-ohm line and the input amplifier should have sufficient gain to permit 100 percent modulation peaks to be attained on line levels as low as − 10 to − 20 db.

(13) Last, but most important, all components should be operated well below their rated capacity.

As no equipment meeting all these requirements was available on the market, arrangements were made to cooperate with a local radio manufacturer, Vancouver Radio Laboratories, Ltd., on the design of suitable units. (A number of equipment photos included here were supplied by the Laboratories.) This arrangement proved very satisfactory as the local plant already had considerable experience in the construction of transmitting units to be used in remote districts where long life with a minimum of service were essential factors. The resulting design is shown schematically in Fig. 4.

Requirements 1 and 2 were met by the use of two 807's or RK39's operated in parallel with 390 volts on the plates, as the modulated r-f amplifier, and two similar tubes, operating with 400 volts on the plates, as class-B modulators.

Requirement 3 was met by the use of inductive tuning in the antenna tuning unit and by the use of a three-turn lightning choke, with horn gap to ground on the antenna side of the choke. This choke is installed outside, at the point where the lead-in bus enters the building. A typical antenna installation is shown in Fig. 5.

Requirement 4 was met by the use of a Thordarson 350-watt voltage-regulating transformer between the local power outlet and the 110 volt a-c input to the transmitter.

Items 5 and 6 were met by the use of four meters. Instead of reading antenna current directly, a 0 to 1 ma d-c milliameter reading rectified carrier is used to indicate normal antenna current and at the same time provide a means of maintaining proper current for the operation of the percentage-modulation indicating meter. A 0 db at six milliwatt volume-indicating meter provides both input audio and percentage modulation readings. The rather novel circuit used is discussed more fully later. Final amplifier plate voltage and current meters provide the other essential readings.

Item 7 was incorporated with the input and output V. I. meter circuit.

Item 8 was met by the use of meter jacks and screwdriver-operated controls which are normally concealed and protected by a dress panel.

Item 10 was met by the use of a 0.001 fixed-mica tank capacitor in the modulated amplifier stage and loose link-coupling between the final amplifier tank coil and the antenna tuning unit.

Items 11 and 12 were met by the use of high-quality audio components and by the addition of a single stage of audio amplification before the class-B driver stage.

Transmitter Design Details

The transmitters are made up of three units, as pictured in Fig. 6. The top section contains the speech amplifier, modulator, crystal oscillator, buffer and modulated r-f amplifier, shown in greater detail in Fig. 7. The oscillator and buffer tank coils are mounted in a shield can on top of this chassis, while the final amplifier tank coil and the antenna loading coil are mounted on the inside of the top of the cabinet.

Referring again to Fig. 4, the r-f section of the transmitter consists of a 6V6 crystal oscillator very loosely coupled to a 6V6 operating as a high-mu triode buffer. The buffer is capacitance-coupled to two 807's or RK39's connected in parallel and operating as a class-C modulated amplifier. A 0.001-μf fixed-mica capacitor is connected across the final amplifier tank coil and the circuit is tuned to resonance by means of taps and a rotor in the L_1 coil form.

The antenna circuit is resonated by means of a tapped inductance and a rotor in the L_2 coil form. The tank circuit and the antenna circuit are coupled by means of a link which has fixed coupling at the tank coil end and an adjustable sliding coupling at the antenna tuning coil end.

The oscillator and buffer plate circuits are tuned by means of variable capacitors. The tuning knobs are mounted on the front of the top chassis but are normally concealed by the dress panel. Four jacks are provided on the top chassis for test-metering the oscillator plate, buffer grid, buffer plate and final amplifier grid circuits.

The speech equipment consists of a 6C5 audio amplifier, 6C5 driver and two 807's or RK39's in push-pull as modulators. The input transformer is 10,000 ohms bridging, and the balanced primary terminal and center-tap leads are brought out to the rear.

The center unit contains a 6H6 carrier rectifier and 6V6 amplifier. Four meters are mounted on the

FIG. 5—The telegraph station at North Bend, in which the broadcast rel[ay] transmitter using the call-letters CBRN is installed. The tall white pole j[ust] to the left of the building supports one end of the antenna, which runs [im]mediately above and parallel to the telegraph wires which appear ben[eath]

control panel: carrier meter, volume indicator, milliammeter and voltmeter. The latter two are used to read the input to the final amplifier. Also on this panel are mounted the coarse and fine controls used to set the carrier meter to read mid-scale, the filament "off-on" switch, the plate voltage "off-on" switch, a meter switch and the 6V6 amplifier gain control.

The meter switch SW_1 permits the V. I. meter to be connected to (1) the calibrating voltage, (2) the input from the audio network or (3) to read percentage modulation. With loudspeaker switch SW_2 "on", the meter switch also permits oral monitoring either off the network or off the air.

When the meter switch is in "calibrate" position the V. I. meter-amplifier is connected across a fixed a-c calibrating voltage which, due to the fact that a primary voltage-regulating transformer is used, is reasonably constant. This reading will indicate whether or not there has been any change in the original adjustment or gain of the amplifier. If the V. I. reads other than zero in the calibrate position the amplifier gain control is reset so that the meter reads 0 db. When these readings and adjustments are being made the loudspeaker switch must be in the "off" position. This substitutes a resistive load in place of the voice coil. With the switch set in the "modulation" position and the transmitter turned on and modulated 100 percent at 1000 cycles, the coupling of the sampling coil in the antenna tuning inductance is varied until the V. I. meter reads 0 db (100 percent modulation). The coarse and fine carrier-meter adjustments are then set so that the carrier meter reads 0.5 ma (mid-scale). Thereafter, if the V. I. reads 0 db when the meter switch is set on the calibrate position, the meter will indicate the approximate input level in db when the switch is set to "Input" and will indicate 100 percent modulation when the switch is set in the "modulation" position and the meter reads "0 db".

Three separate power supplies are mounted on the bottom unit. One power unit supplies the heaters on the middle unit and B voltages to the crystal oscillator, buffer and monitor amplifier. The second power unit furnishes the heater power for all of the r-f tubes and B voltage for the class-C amplifier. The third power unit supplies the heaters of the audio tubes and furnishes the B voltage for the modulator tubes.

A separate transformer, which remains energized at all times, supplies the power for the crystal heating unit.

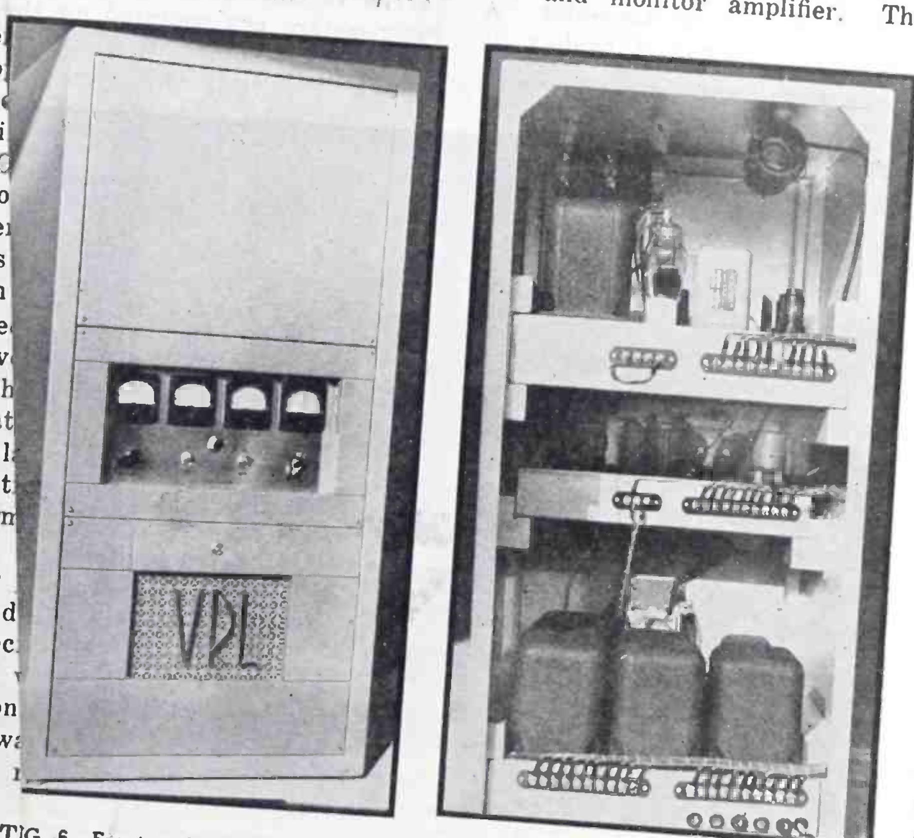


FIG. 6—Front and back views of the transmitter design finally adopted. Because these transmitters are operated by men in telegraph offices and others relatively unfamiliar with such equipment, controls to which they have access are limited. Other adjustments, and meter jacks for use by servicemen and CBC engineers, are concealed behind dress strips on the front panel

Typical Installations

The first of the new units was installed in Revelstoke in July, 1942, as noted in an earlier paragraph. This was followed by installations at North Bend in September, 1942, in the East Kootenay area at Fernie, Cranbrook, Kimberley and Creston in December, 1942, and in the Cariboo area at Williams Lake, Quesnel and Prince George in August, 1943. In addition to the units installed in B. C., three units have been shipped to eastern Canada and are now in service in Sioux Lookout and Nakina, Ontario, and in Edmunston, New Brunswick.

Station CBRF, operating on 940 kc at Fernie, is installed in the Canadian Pacific Railway's communication office in the Fernie railway station. The antenna is an inverted L running NE and SW, parallel with the telegraph lines and railway tracks. The flat top is 112 ft long and 50 ft high. The lead-in runs NW from the SW end of the antenna and is 78 ft long. The ground system is buried in and around the station garden plot. It consists of 500 ft of No. 10 bare copper wire buried under the antenna in the form of three parallel wires cross-connected at the center and at both ends. Each of these wires is securely fastened and soldered to the transmitter ground lead, which is a No. 6 rubber-covered flexible stranded copper cable. The lightning ground lead consists of a similar cable connected to a six-foot ground rod.

As no equipment rack space is available at this point the transmitter is installed on a small table designed to accommodate the transmitter and the voltage-regulating transformer.

As all transmitters are tuned to frequency and neutralized before shipping, the field installation con-sts of bringing the antenna, round, audio and power leads to e transmitter unit and connecting em to the proper terminals. When is has been done the equipment is rned on and the antenna circuit is ned to resonance. The output is en adjusted by means of the vari-le-link coupling and, when prop-ly adjusted, tone from an audio cillator is fed to the input at the rmal peak program level at that int and the balance of the adjust-ents are made so that all meters ad correctly. During the installa-on a cathode-ray oscilloscope and andard impedance and distortion-easuring sets are used to assure rmal operation.

The operators, who are usually embers of the telegraph repeater aff, are instructed in the general eration of the equipment and are own how to detect defective tubes d replace fuses. They are re-ired to check the transmitter at ast four times a day and enter all adings on a log sheet which is ovided. For the first few weeks ese logs sheets are forwarded to e CBC regional engineer's office ce a week, but if the unit operates rmally during the trial period the erators are requested to submit g sheets every two weeks. On re-ipt of these logs the average read-gs for each 10th day of operation e entered on a special sheet and this way there is a permanent cord which shows the gradual ilure of tubes, etc. If no ab-rmal readings or actual off-air riods are noted the units are ecked three to four times a year. e checking is very thorough and similar in most respects to the eck made during the original tallation.

In order to avoid long rush-trips service a single unit which has lled in service, arrangements ve been made with a selected dio serviceman in each locality to ndle emergency calls. This man supplied with a maintenance anual and up-to-date service data eets. The men selected for this rk are ex-amateurs, commercial diophone and code operators, alified radio servicemen or motion cture projectionists. Except for ergency and temporary repairs parts are supplied by the CBC d spare tubes, fuses, etc., form a part of each installation. This method of emergency servicing has proved quite satisfactory in the few cases where it has been required.

Another installation of particular interest is that at North Bend, where local 110-volt a-c power is not available during the day. At this point the transmitter operates, for a part of the broadcast period, on one of the 130-volt repeater storage batteries. The voltage is dropped to 115 volts by means of a series resistor and is converted to 115 volts a-c by means of a type 233 Electronic Labs., Inc. vibrator-converter. As the frequency of the local power is fairly constant and as the battery-charging time-cycle is short, the voltage-regulating transformer was eliminated at this point. When operating on batteries the direct current drain varies from 3.1 (start) to 2.8 (finish) amperes. The normal a-c input to other units averages 248 watts, but the addition of the voltage-regulating transformer naturally increases the input slightly.

Program Pickup Facilities

As these units were designed for operation in the smaller communities and as no associated local studio facilities have been provided, the standard practice is to bridge the transmitter audio input across the CBC's Trans-Canada program circuit. At the termination of a branch network circuit, or where the transmitter is fed from a separate amplifier, a 500-ohm non-inductive resistor is connected across the audio input terminals of the transmitter or this resistor and a 500-0-500 pad having the required loss is used to terminate the circuit. In all cases a 1:1 isolating transformer is connected between the network feed and the audio input to the transmitter. The use of this transformer, together with a separate ground for the r-f output of the transmitter, effectively prevents stray r-f fields.

Connected in this manner, these network satellite transmitters carry all programs on the CBC's Trans-Canada network in the Province in which they are located. Call letters are assigned by the addition of a letter to the call letters of the predominant station in the Province.

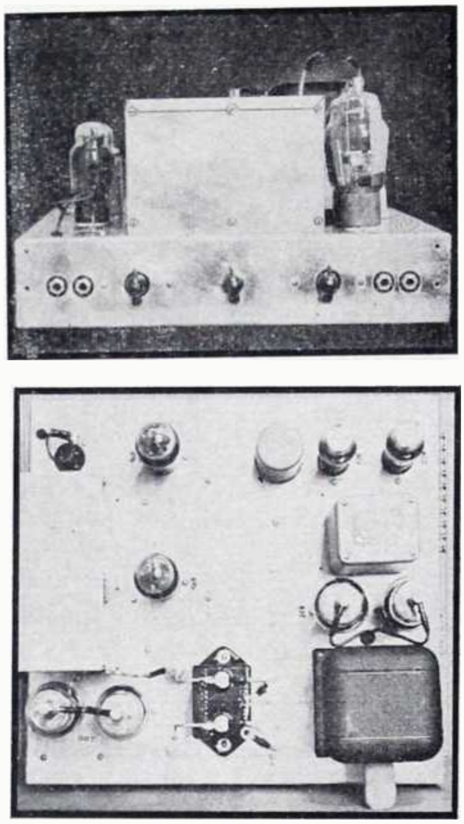


FIG. 7—Front and top views of the r-f and a-f chassis forming the top deck of the CBC low-power broadcast relay transmitter

In British Columbia the predominant station is CBR, hence the network satellite transmitters are assigned calls CBRA, CBRG, etc.

Improvements in Future Units

It requires long periods of service to show where improvements can be made and in the case of existing and new units the following conversions will be made:

(a) Oil-type filter capacitors will be installed to replace all high-voltage electrolytic units.

(b) All toggle switches will be replaced by switches which will handle considerably heavier loads. (The primary power switch sometimes fails in service although operated within the rated load. The contact resistance of the loudspeaker off-on switch increases with use until it becomes appreciable in relation to the relatively low impedance of the voice coil or resistive load).

(c) The loudspeaker unit will be fitted with a volume control.

(d) The first audio amplifier stage will be deleted, as the amplification provided by this stage is not normally required.

In addition to these changes,

(*Continued on page* 304)

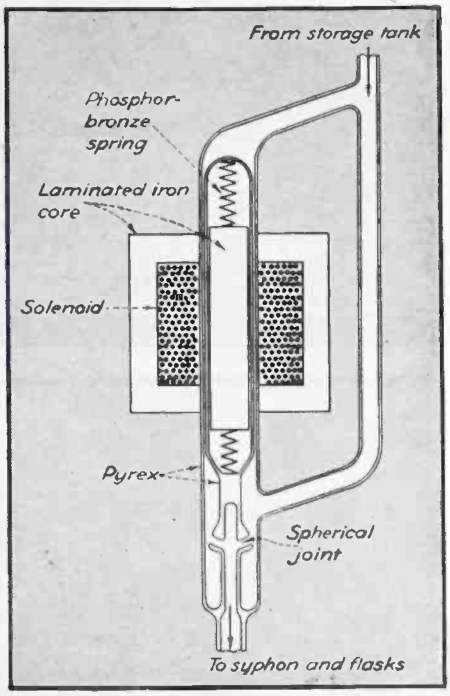


FIG. 1—Electromagnetic valve used to control the flow of water to the boiling flasks

AUTOMATIC Of Stills

By R. E. SHRADER and E. J. WOOD

*RCA Laboratories
Princeton, N. J.*

SOME MATERIALS used in the field of electronics, such as phosphors, electron-emitting coatings and photosensitive surfaces, are of the impurity-sensitive type. The presence of one part in a million of a given impurity may alter some specific property by several orders of magnitude. It follows that any chemical research concerned with such materials will require reagents of the highest purity.

Since water is used in large quantities for almost all chemical manipulations, it is essential that a sufficient supply of very pure water be available. Three distillations will serve to produce water suitable for most uses. Our requirement of approximately 10 gallons per day of double-distilled water and five gallons per day of triple-distilled water makes it desirable that some sort of continuous system be employed which will operate with very little attention.

In the Laboratories, the primary distillation takes place in a conventional commercial still which feeds its product into a large glass-lined storage tank. From there the water is fed by gravity to the second stage of distillation. The second and third distillations are carried out in all-Pyrex stills, completely protected against airborne dust. The two glass stills are connected in series, the first being run at a rate approximately twice that of the second. Thus the first glass still delivers water directly to the boiling flask of the second, and the excess beyond that required to maintain a constant level passes through an overflow to double-distilled water storage. The second glass still delivers to triple-distilled water storage.

Two such combinations are in use and a fifth still is available to augment the double-distilled water production whenever it becomes necessary.

The Control Problem

The problem of automatic control comprises two phases: control of electric heater current, and control of the water level in the glass boiling-flasks. As the heater pow[er] never exceeds seven kw at 110 v, a[n] ordinary electromagnetic switch [is] capable of controlling the heat[er] current. Control of the water lev[el] however, is a more difficult matte[r]. To meet the requirements of an al[l-]glass system well protected again[st] air-borne contaminants, a speci[al] type of valve and level indicator [is] required.

An electromagnetic valve d[e]signed by Ralph H. Plumlee an[d] constructed as shown in Fig. [1] proved satisfactory. The valve [is] of the vertical-lift type utilizing [a] spherical ground-glass joint as se[at] and plunger. A soft-iron laminate[d] core is sealed inside the glass ste[m] which extends into the center [of] a surrounding solenoid. Energiza[]tion of the solenoid lifts the plunge[r] permitting water to flow. When n[o]

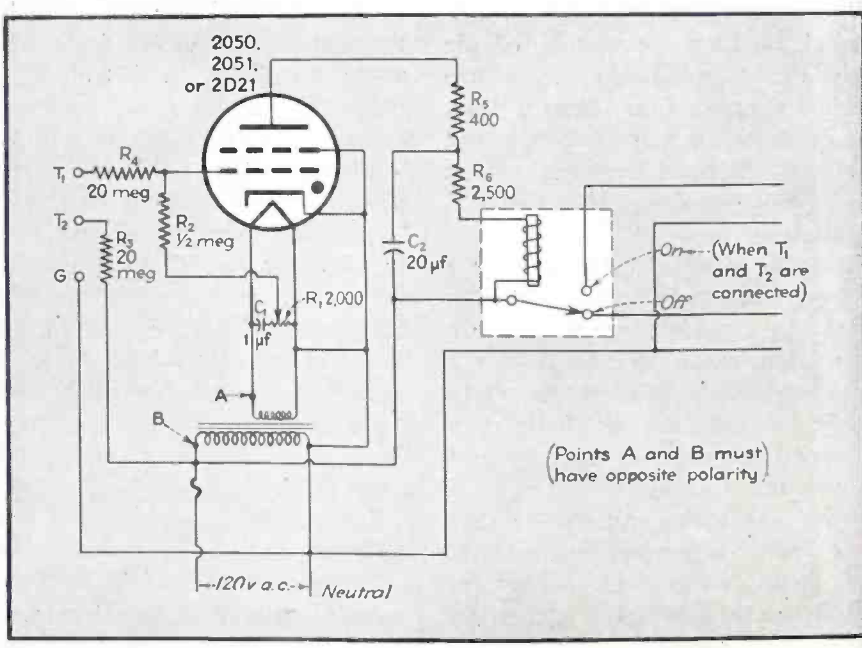
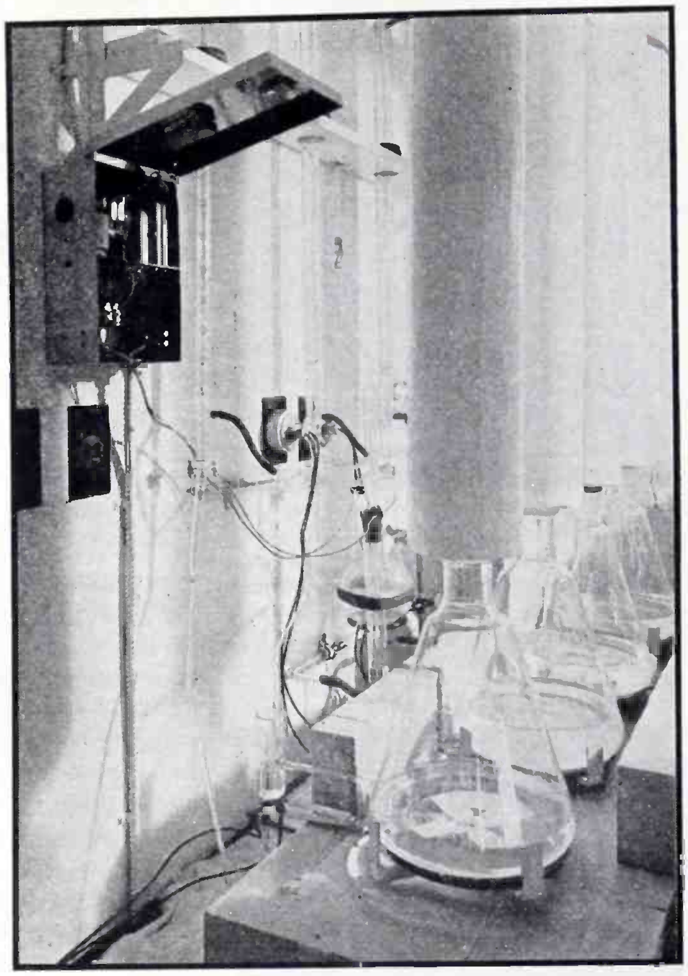


FIG. 2—Circuit of the electronic relay which operates the valve illustrated in Fig. 1 and an electromagnetic switch controlling current-flow to electric heaters beneath the boiling flasks

CONTROL

Current flowing through water between two electrodes sealed in the system operates an electronic relay. The relay operates an electromagnetic valve in the feed line and a switch through which power is delivered to the boiling-flask heaters



Electrically heated stills designed for laboratory use, with insulating brick removed to show the flasks. The electronic control unit may be seen on the wall at the upper left

current is flowing through the solenoid the weight of the core and stem is sufficient to close the valve.

An attempt to use a glass float and mechanically operated level control proved unsatisfactory. This method was unreliable and made it difficult to provide suitable sealing of the system. Various electronic methods of control were considered, including photoelectric cells, radio-frequency devices, and conductivity circuits. The latter seemed to offer the simplest approach.

The Electronic Solution

Although stills use single-distilled water having a low conductivity it was felt that a sensitive relay might be employed which would operate under these conditions. A commercially available electronic relay of the hard-tube type was tried and, although it could be made to operate on the low currents available, it was not suitable for reliable, continuous operation because of the need for constant readjustment. It was felt that a more positive type making use of a gas tube could be constructed.

The action of the unit finally put in use and shown schematically in Fig. 2 is quite simple. When the circuit between T_1 and T_2 is open the gas tetrode is maintained nonconducting during the positive swing of the plate by applying to the grid through R_2 the negative swing from the filament-supply winding of the transformer. The phase is advanced slightly by the capacitance coupling to potentiometer R_1 in order to compensate for the lag introduced by the transformer. The exact amount of phase advance required is determined by individual transformer characteristics.

Tripping of the unit is accomplished by imposing on the grid a sufficiently large voltage in phase with the a-c line (or plate) voltage. This occurs when T_1 and T_2 are connected together. The resistance of this connection (single-distilled water conductivity) may be as high as 60 megohms. Protective resistors R_3 and R_4 may be increased up to

(*Continued on page* 242)

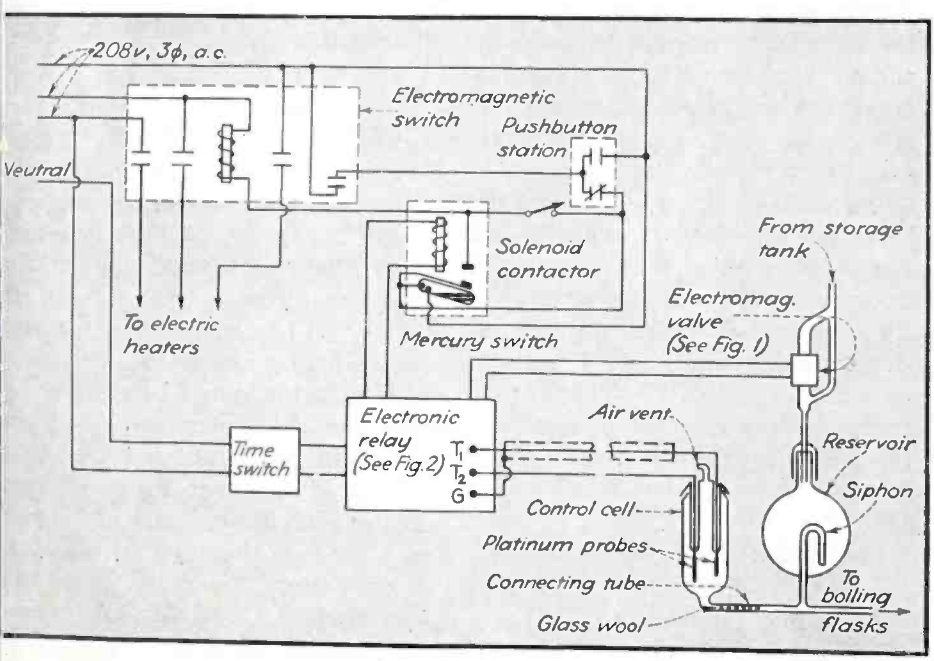


FIG. 3—Schematic of the complete still-control scheme, showing how platinum probes immersed in distilled water within the system provide the necessary conductivity path for operation of the electronic relay

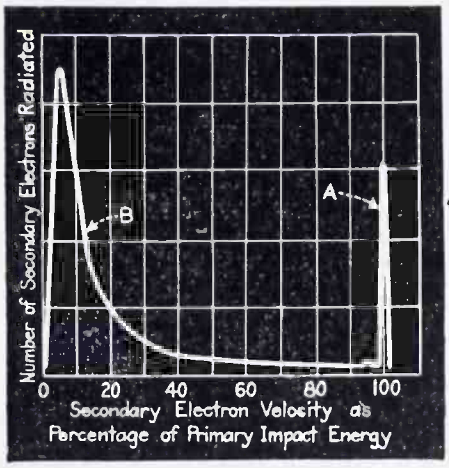


FIG. 1—Energy distribution of secondary electrons produced by the impact of primary electrons having a kinetic energy of 155 volts. The general shape of this curve holds between 20 to 10,000 volts

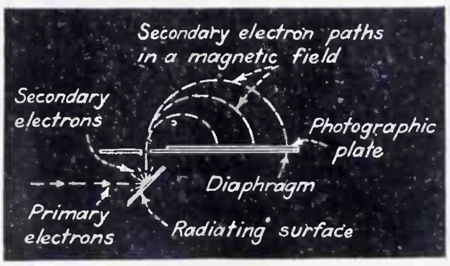


FIG. 2—Photographic method of determining the velocity distribution of secondary electrons. A magnetic field is assumed to exist in the space above the diaphragm, with a direction normal to the plane of the paper

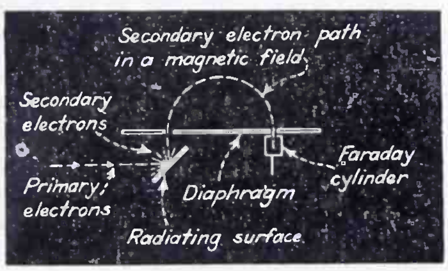


FIG. 3—Another method of arriving at the velocity distribution of secondary electrons. The magnetic field in this case is variable

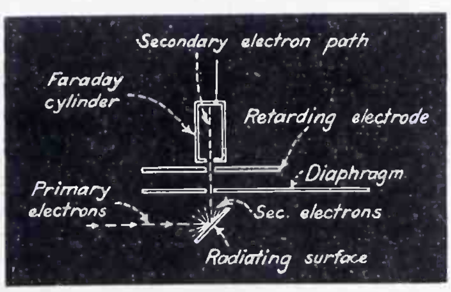


FIG. 4—The retarding potential method of arriving at the velocity distribution of secondary electrons radiated in a specific direction

SECONDARY

By J. H. OWEN HARRIES

Electronics Department
Rediffusion Limited
London, England

When an electron current strikes an electrode surface, or, indeed, any surface, an emission of secondary electrons is produced. There is no known substance in which this effect does not occur. In fact, there is no substance which is known to act as a perfect absorber of any electrons which may impact onto it.

In electronic tubes, secondary radiation is sometimes useful, and sometimes undesirable. The phenomenon is complex, and information about it is scattered in various treatises many of which are commonly read only by those interested in pure physics. Most of these publications deal with the characteristics of secondary radiation, not from any interest in it for engineering purposes, but as a part of investigations into atomic structure.

This paper includes a survey of the existing information on secondary radiation and is presented from the engineering standpoint. It includes references to the original papers.

In most treatises on secondary radiation the electron energies are expressed in volts. The velocity, v, in centimeters per second of an electron which has fallen through an electrostatic potential of V volts is $v = 5.95 \times 10^7\sqrt{V}$. The kinetic energy of the electron is $\frac{1}{2}mv^2$ and is therefore proportional to the voltage V.

Energy Distribution of Secondary Electrons

In many publications on electronic engineering, as distinct from treatises on the physics of seconary electrons, it is sometimes stated that secondary electrons are radiated almost entirely at energies very low compared with the primary impact energy. This is not so.

A typical curve of energy distribution of secondary electrons is shown in Fig. 1. In this graph the number of secondary electrons radiated is plotted against the velocity (energy) with which the secondary electrons are shot out from a radiating surface. These secondary electron energies are plotted as a percentage of the primary impact energy. The primary impact energy is 155 volts. It will be observed that an appreciable number of secondaries are radiated at energies about equal to the primary impact energy, although there are a larger number radiated at very low velocities. Very thorough researches have been made during the last two decades into this question of secondary radiation energy distribution.[1-19]

Methods of Determining Energy Distribution Curve

The general kind of energy distribution of the secondary electrons shown in Fig. 1 appears to hold over quite a wide range of primary impact velocities (20 to 10,000 volts).[3] It has been confirmed very carefully for most of the pure metals, and is known to hold in general for the other materials employed in radio tubes.

This kind of secondary electron energy distribution does not appear to depend on the angle of incidence of the primary beam onto the emitting surface,[13, 20] nor does it appear to depend on the angle of emergence of the secondary electrons, though this point does not appear to have been quite so conclusively demon-

ELECTRON RADIATION

A thorough survey of existing American, British and other information on the subject, arranged for maximum usefulness to electronic engineers engaged in designing electron multipliers, dynatrons, beam tetrodes, pentodes and other tubes in which secondary electrons resulting from electron bombardment are either utilized or suppressed

strated by workers in this field.

In Fig. 2 an electron gun is arranged to produce a beam of primary electrons at a known velocity. The primary electrons are arranged to collide with a surface which then radiates secondary electrons. Some of the secondary electrons can pass through an aperture in a diaphragm into a space in which there exists a homogeneous magnetic field in the direction normal to the plane of the paper. It is a well known property of such a magnetic field that electrons traveling into it as shown will tend to describe circles the radii of which are given by

$$r = 3.37\sqrt{V_s}/B \qquad (1)$$

where B is the magnetic flux density, and V_s is the secondary electron energy in volts.

A photographic plate is positioned as shown. The number of electrons of any given velocity reaching the plate will be indicated by blackening at the appropriate place. This method, however, is not very practicable, because the sensitivity of a photographic plate is rather low.

A Faraday cylinder, which has the property of trapping electrons and the secondaries they produce, can be substituted for the photographic plate as in Fig. 3. By varying the magnetic field, the number of secondary electrons of each velocity may be found.

Another method, shown in Fig. 4, does not use a magnetic field, but instead, employs a retarding potential to sort out the secondary electrons in terms of their energies. The primary electrons hit a secondary radiator at a known energy, and secondary electrons pass through a diaphragm into a Faraday cylinder. The amount which are able to enter depends upon the potential of a retarding electrode positioned as shown and upon the initial energies of the secondaries themselves.

The arrangement of Fig. 5 enables the energies to be obtained for the secondary electrons at all angles. The primary electron beam strikes a radiating surface which is at the center point of a collecting sphere. A retarding potential is applied to this sphere, and the number of electrons reaching it is measured as a function of this potential.

In the arrangements of Fig. 4 and 5, the energy distribution curve is obtained by differentiation of the curve of current to the Faraday cylinder or collection sphere as a function of the retarding potential.

Interpretation of Curve

The general results of all these methods agree. The particular curve shown in Fig. 1 is given by Rudberg[1] and is obtained by the magnetic method.

It is generally agreed that the energy distribution curve of Fig. 1 may be interpreted as follows: Peak A represents that portion of the emergent electrons which retains the full primary energy. At secondary electron velocities between about 98 and 50 percent of the primary velocity, the number of secondary electrons radiated does not change much with the secondary electron velocity. Large quantities of secondary electrons are emitted with low velocities, as indicated by peak B, but the number emitted drops rapidly as secondary velocity approaches zero (at secondary energies of the order of tenths of a volt and less).

Peak A of the curve is produced by electrons which emerge after being elastically reflected. They result from diffraction unaccompanied by loss of energy to the atoms which are being bombarded by the primary electrons. All other parts of the curve are produced by secondary electrons which have been deflected by repeated collision accompanied by considerable energy loss.

Those secondaries contributing to parts of the curve other than A are usually referred to as emitted or true secondary electrons. Those contributing to part A of the curve are usually referred to as reflected electrons. For this reason the phenomenon as a whole is usually referred to as secondary radiation, and the words emitted and reflected are reserved for the special meanings set out.

Action at Low Impact Velocities

With primary impact velocities below about 10 volts it has been found that the energy distribution of Fig. 1 does not hold. The secondary radiation consists almost entirely of reflected electrons which retain the full primary energy, so that the whole of the radiation is contained in a peak like A on Fig. 1.

The percentage of emitted secondary electrons to reflected secondary electrons increases steadily up to primary velocities of the order of 1000 volts, after which it falls once again. As previously mentioned, however, the general shape

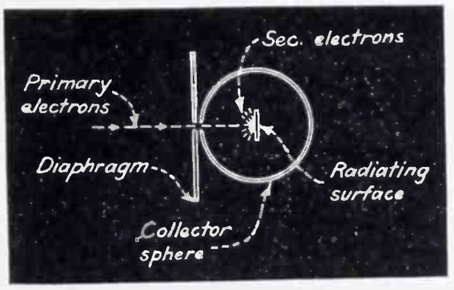


FIG. 5—The retarding potential method of arriving at the velocity distribution of secondary electrons emitted and reflected from a radiating surface

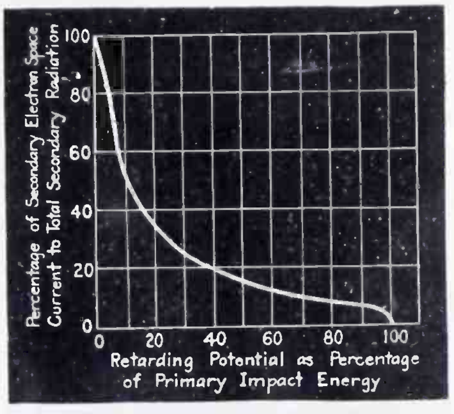


FIG. 6—Ratio of secondary electron current travelling to a collector and the total secondary radiation, plotted as a function of the retarding potential between the radiator and the collector

of Fig. 1 holds between about 20 and 10,000 volts.

Space Potential Considerations

It is important to realize that under electrostatic conditions the velocity of each of the secondary electrons at any point in space will be determined by the space potential V of that point. It follows that an electron emitted at a velocity which corresponds to a voltage V_s will be brought to rest at any point in space where a negative space potential $-V$ numerically equals V_s. This is the principle by which secondary electrons are sorted into their respective velocities (or energies) by means of the retarding electrode or collecting sphere of Fig. 4 and 5 respectively. A potential which is arranged in this way to stop secondary electrons is generally referred to as a retarding potential.

Figure 6, which is obtained by integration of Fig. 1, shows the ratio of secondary electron current to any collector (such as the collector sphere in Fig. 5) to the total secondary radiation current as a function of the retarding potential. This potential is expressed as a percentage of the impact energy in volts.

In pentodes and beam tetrodes, the prevention of the flow of secondary electrons is one of the primary objects of the tube design. With reference to Fig. 5, it will be realized that if the collector sphere is at a potential (with respect to the cathode) which is 90 percent of the impact potential of the radiator (also measured in volts with respect to the cathode), then a retarding potential of 10 percent will exist between the collector sphere and the radiator. Figure 6 shows that under this condition the secondary radiation current flowing to the collector electrode will be 54 percent of the total secondary radiation from the radiator.

All this, of course, assumes quasi-steady-state conditions as regards voltage, (i.e., that the voltage does not vary rapidly with time), and that no appreciable space charge due to the primary or secondary electrons exists in the space between the emitter and the collector sphere. The physics measurements quoted in this paper are all made under static conditions, and care has been taken to avoid space charge effects, but these effects must not be forgotten when applying the information to practical radio tubes. Such tubes when in operation are very seldom free from space charge effects.

TABLE I. MAXIMUM TOTAL SECONDARY RADIATION COEFFICIENTS

Secondary emitter	Max. value of sec. radiation coeff.	Primary impact velocity (volts) at which max. of sec. radiation coeff. occurs
Caesium (compound layer)	8.5	400–600
Rubidium(compound layer)	5.75	700
Beryllium	5.4	600
Calcium	4.95	520
Barium	2.72	530
Potassium(compound layer)	2.5	600
Aluminum	2.4	400
Silicon	1.63	380
Platinum	1.52	1000
Silver	1.47	800
Gold	1.45	780
Tungsten	1.33	625
Nickel	1.3	500
Tantalum	1.3	625
Copper	1.27	600
Iron	1.27	400
Molybdenum	1.27	375
Niobium	1.17	400
Carbon (lampblack)	0.6–1	...

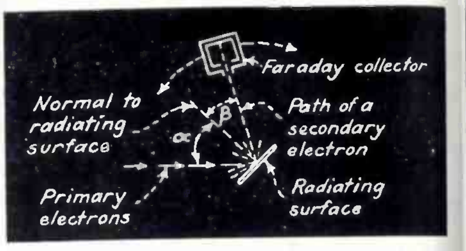


FIG. 7—Use of an angularly adjustable collector to measure the secondary radiation coefficient of both reflected and emitted electrons as a function of the angle of emission to the normal

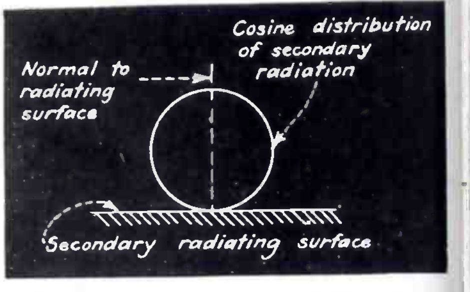


FIG. 8—Distribution of secondary electrons as a function of the angle β of secondary radiation

Some relationship exists between the secondary energy distribution curve and the material of the emitter. This has been found by Sharman[15] to be in agreement with the atomic properties of the material. At voltages of the order of 8000 volts, however, Stehberger[21] failed to find any such connection. The answer to this question is rather vague at present.

Angular Distribution of Secondary Radiation

The relative amount of secondary radiation at various angles from a surface may be determined by apparatus such as that illustrated in Fig. 7. The Faraday collector is rotatable with respect to the radiating surface. The angle of incidence of the primary electrons to the normal of this surface is indicated by α and the angle of secondary radiation by β. The number of secondary electrons per unit angle may thus be determined.

Measurements of angular distribution have been carried out by a number of workers.[21, 22, 23, 24, 25] While there is some experimental evidence[23] of optical reflection of the primary electrons (i.e., $\alpha = \beta$), the

·idence of this effect is by no ·ans generally accepted. At pres- ·t it seems reasonable to assume ·cosine distribution of secondary ·liation, as shown in Fig. 8; that the intensity of the secondary ·liation varies as cos β, and this ·tribution is virtually independ- ·t of α. The maximum value of secondary radiation varies, how- ·r, with α. This effect is discussed greater detail later.

·tal Secondary Radiation Coefficient

The arrangement of Fig. 5 may ·arly be used for measuring the ·al radiation of secondary elec- ·ns if the collector sphere is at a ·ghtly higher potential than the ·liating surface. This measure- ·nt is in fact a summation of the ·ve of Fig. 1, and gives the ratio ·ween the total number of sec- ·dary electrons and the total num- · of primary electrons striking emitter. This ratio is generally ·erred to as the total secondary ·liation coefficient. It must al- ·ys be remembered, when inter- ·ting values of this ratio, that in cases a velocity distribution ·st be assumed. In the case of ·pact energies between about 10 ·ts up to the order of 10,000 volts, ·s distribution would be that of ·. 1.

·n practical electronic devices the ·ual ratio of secondary electron ·rent to a given electrode near emitter to the primary electron ·rent will depend (among other ·ngs) upon this velocity distribu- ·n. Not all the secondary elec- ·ns necessarily contribute to the ·ondary electron current.

The total secondary radiation ·fficient plotted against the pri- ·ry electron impact energy was of the characteristics to be in- ·tigated by the earliest work- [26-30]

Secondary Radiation Coefficient of Pure Metals and Carbon

Typical measurements of the to- secondary radiation coefficient shown in Fig. 9A and 9B. These ·ves have been confirmed by ·ny investigators. The curves ·e to a maximum and then fall as primary impact velocity in- ·ases still further. The maximum ·ue of coefficient obtained lies between about 1.2 and 5.5 in the case of pure metals. Its highest value is of the order of 8 to 11 for compound surfaces of caesium of the kinds used in secondary electron multipliers and the like. Not many substances have coefficients of less than unity. That for carbon varies between 0.6 and 1.0.

Provided that the metal surfaces are clean and are completely degassed, the secondary radiation coefficient is found to be about the same by many different investigators.[31-39]

Table I (from Kollath[40]) shows typical values of the maximum secondary radiation coefficient, and the values of primary impact energy at which it occurs, for a number of substances.

Secondary Radiation Coefficient of Evaporated Layers

Copeland[32, 35, 41] has obtained interesting results by evaporating various substances onto a metal foundation. Evaporating caesium onto gold increased the secondary radiation coefficient of the combination several times over that of gold alone. He also investigated other combinations of layers and foundations. The results appear to be explainable in terms of the degree of penetration of the primary electrons through the surface layer, and the varying absorption of the secondary electrons by the different substances used.

Secondary Electron Coefficient of Composite Surfaces

It was found[35] that composite materials have a high secondary radiation coefficient. For instance, evaporated deposits of calcium onto gold, and lithium onto tantalum, produce coefficients of the order of

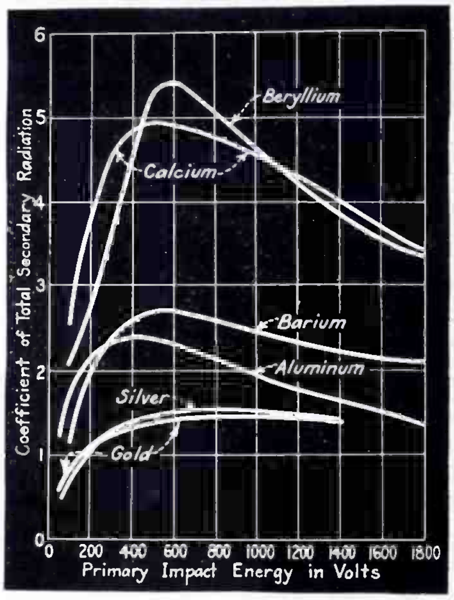


FIG. 9B—Coefficient of total secondary radiation as a function of primary impact energy for various substances

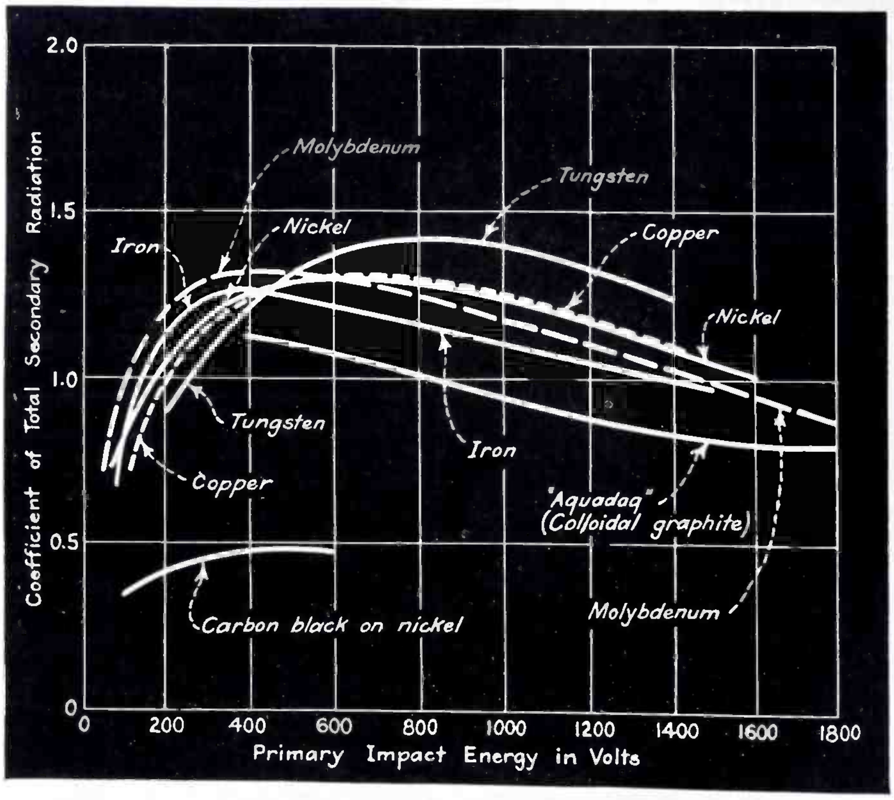


FIG. 9A—Coefficient of total secondary radiation as a function of primary impact energy in volts for the materials commonly used in vacuum tubes

4 to 5. It was observed that calcium and lithium belong to the alkaline-earth group of metals. They have low work functions and they have a high thermionic and photoelectric emission. An investigation of caesium/caesium-oxide/silver was a natural step, and high secondary electron coefficients resulted. It was discovered, however, that neither a low work function nor a high photoelectric sensitivity is the only factor concerned in producing a high secondary electron coefficient. Typical results for composite surfaces on silver are shown in Fig. 10.

The following table is given by Weiss[12] for various values of the maximum secondary radiation coefficient for caesium/caesium oxide deposits on various metal foundations.

The processing of the layer produced is of great importance. The deposit used as the composite surface is probably of the order of monoatomic thickness.

In detail, the production of secondary electron emissive surfaces is, like the production of coated thermionic cathodes, largely an empirical process.

Secondary Radiation Coefficient of Insulators

There is comparatively little information in this matter, but it seems[24, 45] that secondary emission from insulators consists largely of electrons that have a low velocity compared with the primary electron velocity. The cosine law of distribution appears to hold, and the coefficient can exceed unity. There is, however, a difference with regard to the angle of incidence of the primary electrons impacting the radiator. In the case of conductors, the secondary radiation coefficient increases continuously with the angle of incidence, but in insulators this is not so. The coefficient increases up to a critical angle of incidence in either direction from 0 deg, beyond which the coefficient drops sharply and then again increases, as shown in Fig. 11.

This critical angle has been found to be evident only at certain levels of primary impact velocity in the range from 1300 to 3000 volts. The critical angle increases with increasing voltage, and eventually vanishes. It is also affected by temperature. For example, a critical angle which is 35°C at room temperature falls to 15°C at the temperature of liquid air. It vanishes at 150°C. At this and higher temperatures, the phenomenon is the same for insulators as for conductors.[24, 42, 44-50]

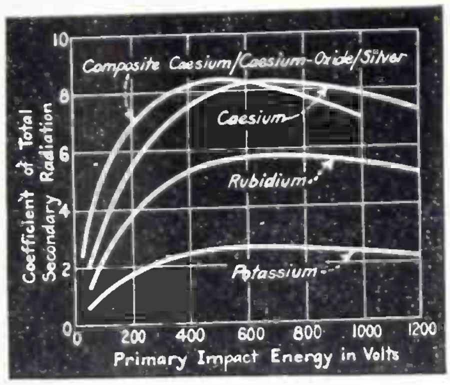


FIG. 10—Coefficient of total secondary radiation as a function of primary energy in volts for pure metals and a composite oxidized layer on silver

Explanations [24, 51, 52] assume that a surface layer of negative space charge is produced on the insulator and affects the emission of secondary electrons. An insulating surface does not necessarily have a negative charge, however. The charge will depend upon the conditions of the experiment and upon the secondary radiation coefficient of the material.

Variation of Secondary Radiation Coefficient With Primary Angle of Incidence

In general, at low primary impact energies (up to about 100 volts or so), the secondary radiation coefficient is the same for all angles of incidence.

TABLE II. MAXIMUM SECONDARY RADIATION COEFFICIENT FOR CAESIUM LAYERS ON VARIOUS METAL FOUNDATIONS

Metal	Max. value of sec. radiation coeff.	Primary impact energy (volts) at which max. of sec. radiation coeff. occurs
Silver	8– 11	600
Magnesium	6.8– 7.5	700
Tantalum	4.1– 5.5	600
Zinc	4.5– 5.4	600
Nickel	4.6– 5.2	550
Aluminum	4.4– 4.7	600
Copper	3.5– 4.0	600
Tungsten	3.8– 3.9	600
Lead	2.3– 3.3	650
Molybdenum	2.5– 3.1	500
Iron	1.9– 2.7	500
Gold	2.3–	600

At higher voltages this is not so. A typical result due to Müller[14] is for a primary impact energy of 2500 volts, and is shown in Fig. 12. It is interesting to note (Kollath[9]) that if the coefficients for various metals are plotted in order of increase of coefficient with incidence, they will then be arranged more or less in descending order of their specific gravities. The secondary radiation coefficient, as a function of the angle of primary incidence to the normal, rises with decreasing specific gravity.[53-56] The results previously described apply to angles of incidence in the neighborhood of the normal unless otherwise specified.

Secondary Emission at High Primary Impact Velocities

Primary impact energies have been investigated which are very much greater than the few thousand volts to which the previous remarks have been confined, but high-voltage results differ little. The velocity distribution curve of Fig. 1 is affected only insofar as peak A increases in relative area (that is, the reflected electrons increase in number).[20, 21, 23, 57, 58]

The secondary radiation coefficient as a whole falls with increasing primary impact energies. The increased penetration of the primary electrons of high velocity into the metal results in the secondary electrons being reabsorbed in the surface layers of the material. This fall in secondary radiation coefficient is to some extent counteracted by primary electrons which emerge in a direction different from the normal to the surface, and cause secondary electrons to be emitted from the surface layer of the material. In fact, this latter effect predominates in producing secondary radiation at very high values of primary impact velocity.[21] The angular distribution of the radiation follows the cosine law.

Consideration of the depth at which emission is produced is of considerable importance where radiation is obtained from both sides of a thin foil through which primary electrons are arranged to pass.[3]

Many investigators[7, 16, 59-63] have shown that the structure of the radiating surface has considerable effect on the coefficient. No effect on 't is noted by Hayakawa[61] at the nagnetic transformation points of erro-magnetic materials, but sud- len changes have been shown to ccur at the points of allotropic nodification of the surface struc- ure. An abrupt variation in the econdary radiation coefficient of ron at the Curie point has, on the ther hand, been recorded by an- ther worker.[62]

Further Investigation Needed

According to Rao[63], a nickel mono- rystal gives a lower secondary ra- iation coefficient than an ordinary olycrystalline nickel surface. An pposite result is obtained by H. E. 'arnsworth[7] with respect to copper. :is result appears to agree with the xperimental fact that the second- ry radiation coefficient of finely recipitated carbon or platinum lack has a particularly low coeffi- ent of secondary radiation.

Further investigation seems to e needed. In the meantime it seems iat either monocrystal surfaces of :fferent materials have different fects on the coefficient, or that iere is perhaps some optimum size f crystal which gives a maximum efficient.

Effect of Temperature on Secondary Electron Coefficient

As far as can be ascertained there no temperature effect. According Kollath[40] this point might, how- 'er, be worth further investiga- on, particularly with regard to the mplex surface coatings now com- only used in commercial practice.

Effect of Gas on Secondary Radiation Coefficient

All materials contain a certain nount of gas before they have en heat treated by the usual valve ube) manufacturing processes hich are necessary to produce a gh vacuum. Occluded gas has a nsiderable effect on the second- y radiation coefficient, and until e radiator is completely degassed peatable results are not obtained. easurements on the effect of gas ve been made by Farnsworth,[7] arnecke,[20] and Ahearn.[61] In gen- al, the presence of gas increases e secondary radiation coefficient. ten several times.

Mechanism of Secondary Electron Radiation

The quantitative analysis of the atomic mechanism of the phenomenon is in a very rudimentary state. In fact, a survey of the subject reduces itself largely to an unsatisfactory recital of disjointed experimental facts rather than to a coherent statement of theory. Kollath's paper[40] gives an excellent outline of the situation up to 1937. The relationship between secondary radiation phenomenon and the atomic structures of various metals gives no very conclusive result, nor has the work function any very useful relationship, though there has been shown to be some proportionality between the secondary radiation coefficient and this quantity. The depth of penetration of the primary electrons has been estimated, and Becker[11] arrives at a calculated depth of penetration of about 30 Angstrom units (about 15 to 20 atomic layers) at primary impact velocities of the order of 500 volts.

Emission Time of Secondary Electrons

As far as the author is aware, no measurements or computations of this quantity have yet been made. It may prove, however, to be very important in view of the increasing use of extremely high frequencies in electronics. So far, the only conclusion appears to be—and this is a unanimous one[65-72]—that the time of emission is less than 10^{-9} second. This is as much as several times the periodic time at the highest radio frequencies now being brought into use. Modern ultra-high-frequency technique might enable the time to be measured. A suggestion due to Kollath[40] involves comparing the times of arrival of electrically reflected primary electrons with those of secondary electrons. Experimental difficulties, appear, however, to be considerable.

Secondary Emission Transit Times

In view of the initial velocity spectrum (Fig. 1) common to all secondary radiation (the fact that secondary electrons are not all emitted at the same velocity), secondary electrons traveling from the emitter to another electrode do so with differing transit times. This effect is of substantial importance to the operation of vacuum tubes at very high frequencies, and is dealt with later in this paper.

SECONDARY RADIATION IN ELECTRONIC ENGINEERING

In electronic engineering, secondary radiation is sometimes found to interfere with the desired operation of the radio tube in which it occurs. Sometimes, on the other hand, it is utilized as an essential part of the mechanism of operation

The Dynatron Valve

In a tetrode valve, when the screen grid is at a higher potential than the anode, secondary radiation from the anode may travel to the screen grid and produce a negative resistance characteristic in the anode circuit over a range of anode voltages. Hence the valve can be made to generate oscillations. This effect was first described by Hull.[73] In considering these results with

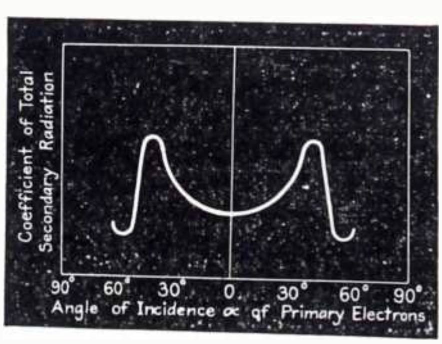


FIG. 11—Coefficient of total secondary radiation from an insulator as a function of the angle of incidence of the primary electrons. A critical angle of incidence will be observed

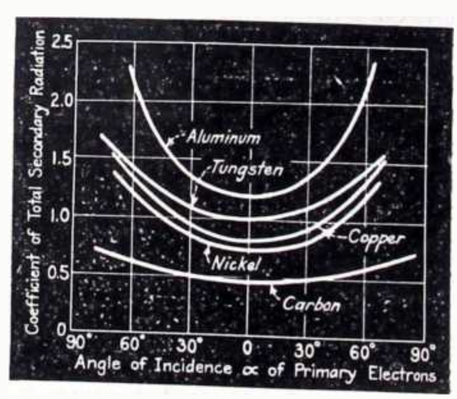


FIG. 12—Coefficient of total secondary radiation from various conductors as a function of the angle of incidence α of the primary electrons. The primary impact energy is 2500 volts

respect to modern radio techniques due regard must be paid to secondary radiation transit angle effects.

Secondary Electron Multipliers

Secondary electron multipliers[74] of both the magnetic and electrostatic types are so well known that it is unnecessary to describe them in detail. In multipliers, the primary electrons strike an emissive surface which is of such a kind as to produce a high ratio (usually between 8 and 11) of total secondary radiation coefficient. Secondary electrons thus radiated are caught by another plate from which further secondaries are again radiated. This process is repeated several times in order to produce a very high total magnification of the original primary electron beam current.

The primary electron beam can be controlled by either photoelectric effects[75] or by voltage control. Greater importance appears to attach to the amplification of photoelectric currents than to voltage control, as the limitations of the latter type cause it to be rather specialized in application.[76] An interesting and comparatively recent example of voltage control has been described by Wagner and Ferris.[77] Control of the primary electrons in secondary multipliers by deflecting them instead of using a control grid appears to have been first described by Hopkins.[78] The composite caesium/caesium-oxide/silver curve in Fig. 10 shows the ratio of secondary emission current to primary current obtained from one of the radiating surfaces in a multiplier.

Since secondary electrons are not emitted with a single velocity, but with a spectrum of velocities, the transit angle between the radiators in the multiplier also has no single value.

In Fig. 13, the ordinates represent the relative number of secondary electrons emitted at each of various relative overall transit angles of the secondary electrons in a 3-stage electron multiplier. The relative overall transit angle is expressed as a fraction of the transit angle which would exist if the secondary electrons were emitted with zero velocity. It will be observed that the transit angles of the individual secondary electrons vary over a wide range. Furthermore, secondary electrons are radiated from different parts of the radiator, and have to travel along paths of different lengths to reach the next electrode.

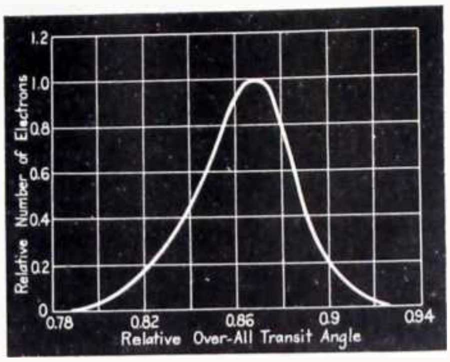


FIG. 13—Variation of transit angle of secondary electrons in a secondary electron multiplier. This variation is due to the distribution of secondary electron energies illustrated in Fig. 1. Note that this graph ignores peak A of Fig. 1

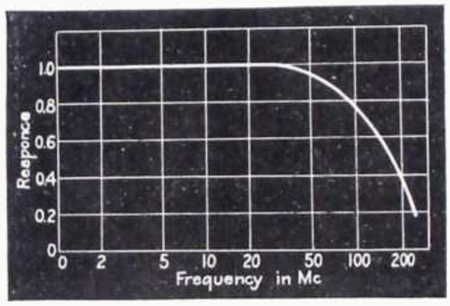


FIG. 14—Frequency response of an electron multiplier, showing fall-off at very high frequencies due to the transit angle effect illustrated in Fig. 13

The result of these combined effects has been shown by Malter[67] to produce a high-frequency cut-off in the response of the multiplier as a whole. The resulting frequency cut-off of a typical multiplier is shown in Fig. 14.

Farnsworth Multipactor

Another application of secondary electron multiplication involves the utilization of transit time to produce high-frequency oscillations. This idea was first put forward by Philo T. Farnsworth.[79]

Reduction of Screen Grid Current

In many screen-grid radio tubes the anode is maintained during operation at a potential higher than that of the screen grid. Secondary radiation of quite a considerable amount is produced at the points of impact upon the screen grid of the primary electrons which constitute the space current. The secondary electrons travel from the screen grid to the anode and so decrease the screen grid current, and increase the anode current, very considerably. This results in an increase in the static transconductance of the tube. It must not be forgotten that due to the varying transit angles of the secondary electrons, this increase will not hold at very high frequencies. The phenomena produced will be somewhat similar to that exemplified above with respect to secondary electron multipliers. There seems to be no published information in this matter.

Secondary Radiation from Cathodes

In certain tubes—notably the magnetron—the cathode may be bombarded by primary electrons which return to it at considerable velocities. By adding to the emission, the resulting secondary radiation may have an appreciable effect on the operating characteristics of the valve.

The Pentode

In the great majority of electronic tubes, secondary radiation is a nuisance and elaborate steps have to be taken to prevent it from interfering with the operation of the tubes. It will be clear from Fig. 5 and the associated text, however, that attempts to prevent the radiation of secondary electrons from the electrodes of radio tubes are foredoomed to failure. In fact, quite early engineering experiments confirmed this.[80]

Since secondary radiation itself cannot be prevented, the only remaining thing to do is to prevent the secondary electrons traveling from one electrode to another. This is the idea behind the pentode.

It is almost unnecessary to describe this well-known tube in detail.[81] The traverse of secondary electrons from the anode to the screen grid when the anode is at a lower potential than the screen grid during operation is prevented partly by the use of a retarding potential. A grid (called the suppressor grid) is interposed between the screen grid and the anode and is maintained at a low potential.

Primary electrons pass through e spaces between the suppressor id wires. A retarding potential ists between these spaces and ıds to reduce the secondary radi- on current from the anode to the een grid to a fraction of the pri- ry electron current (see Fig. 4 d 6). At the same time, due to cosine law of distribution ig. 8), only a small number of secondary electrons are di- ted towards the gaps in the sup- ssor grid. This results in a still ther reduction of the total sec- lary electron current.

A further effect which tends to uce the adverse flow of second- electrons is the addition to the arding potential caused by space rge effects. Both primary and ondary electrons contribute to space charge potential. The ıbination of all these effects (and sibly others) operates in a very nplex manner, and the author is aware of a satisfactory quanti- ive theory, but pentode valves y readily be designed by empiri- means.

Remembering that the potential the spaces between the wires of suppressor grid cannot be zero the primary electrons them- ves would be prevented from ar- ing at the anode), it is untrue to that the operation of a pentode explained merely by the inter- ition of a retarding potential ween the anode and screen grid. etarding potential which did not uce the potential between the es of the suppressor grid to zero ıld still leave a considerable ount of secondaries flowing. This clear from Fig. 6. Curve A in . 15 shows the familiar dynatron racteristic which is produced in absence of a suppressor grid. ve B shows the characteristic nd in a pentode, and curve C ws the type of characteristic t might perhaps be expected if suppressor grid retarding po- tial alone were the only opera- e factor in preventing the flow secondary electrons.

Secondary Electron Traps

Due to the cosine distribution of ondary radiation (Fig. 8), if a m of primary electrons enters enclosed metal cavity (at a positive potential) through a small aperture as in Fig. 16, only a very small part of the resulting secondary radiation will succeed in leaving the cavity. This is the principle of the Faraday cylinder previously referred to (Fig. 3, 4, and 7). Attempts have been made and suggested[80] to utilize such cylinders as the anodes or collector electrodes of practical radio tubes. Since in such radio tubes the effective anode area for the collection of primary electrons must usually be considerably greater than the small aperture illustrated in Fig. 16, these attempts have not been very successful as far as the author is aware.

Critical-Distance Beam Tetrodes

In 1931 the author, working on the production of the then novel idea of producing beams of electrons of appreciable fractions of an ampere at a few hundred volts, found that if the space current in a dynatron type of tetrode is confined into a beam, an optimum value exists for the distance of the anode from the screen grid (accelerating grid; he named this distance the critical distance) at which the passage of secondary electrons from the anode to the accelerating grid is prevented. The anode characteristic then obtained is of the kind illustrated in Fig. 17.[88-89] The sharp knee at the lefthand side of the curve is characteristic of this type of tube and results in a considerably lower distortion level[88, 89] than the more rounded knee of the pentode (Fig. 15).

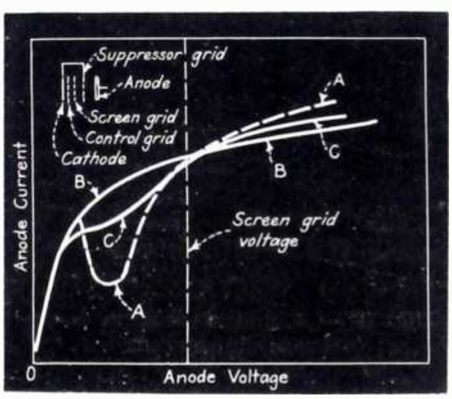


FIG. 15—Curve A is the anode characteristic of a dynatron valve. Curve B is that of a pentode. Curve C is the approximation to the kind of curve that might be expected if a suppressor grid is assumed to operate solely by producing a retarding potential

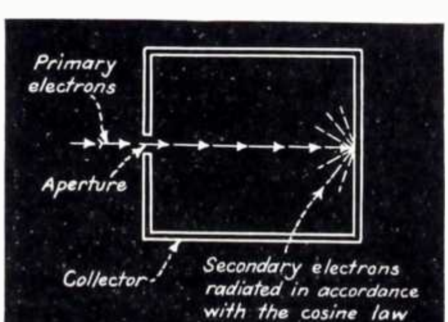


FIG. 16—A Faraday cylinder or electron trap

Tubes of this kind were made in 1931 and were put on the market in England by a commercial firm in 1935. They came into wide use, under the name of beam tetrode when this tube was first marketed (in America) in 1936; yet, like the pentode (the invention of which dates from 1926), there is again no satisfactory published theory. The straight part of the anode characteristic of this valve (Fig. 17) can only be accounted for by the reduction of the traverse of secondary radiation to a very small fraction indeed of the total radiation. By reference to Fig. 6, it will be seen that this appears to infer a retarding potential virtually equal to the primary impact velocity itself.

Attempts have been made to explain this critical-distance characteristic in terms of the potential minimum produced by space charge,[88, 89] but the author has shown[88] that the magnitude of the retarding potentials predicted by this theory is not sufficient (by a factor of several times) to prevent the occurrence of the dynatron kink in the anode characteristics. Moreover, the problem is not merely one of preventing the passage of secondary radiation at one set of values of anode current, anode voltage, and screen voltage. It is, on the contrary, that of maintaining a flat working surface of the characteristic over a wide variation area (Fig. 17). A purely space-charge retarding potential theory leads to no such range of working currents and voltages.

A complete formulation of the problem must include the effects of the formation of the primary electrons into a beam (without which the effect seems not to take place in practice), the variation of the density of this beam with control grid voltage, the energies of the secondary* electrons, the angular distribution of the secondary radiation, the end effects, and the depression of space potential due to the presence of low-potential conductors near the screen grid-anode space. (An approximate theory of the beam tetrode can, however, be produced to take these factors into consideration, and the author hopes to present it in due course when war-time matters permit.)

It has been pointed out by the author some time ago[88] that if the accelerating voltage is higher than a few hundred volts, the critical-distance effect is not produced satisfactorily. This appears to have a relationship to the increase in the area of peak A in the secondary radiation energy distribution curve (Fig. 1) at the higher primary impact velocities.

Secondary Emission from Grids

Grids and other electrodes in electronic tubes which are struck by electrons will emit secondaries which, particularly in tubes where optical images are to be formed, may be very undesirable. Such effects may be minimized, though not eliminated, by treating the surfaces involved. Coating with carbon black or like methods are used (Fig. 9A).

Secondary Radiation from Insulated Electrodes and Insulators in Vacuum Tubes

If an insulated conductor is positioned in the path of a beam of primary electrons, its potential will depend upon the impact energy of the primary electrons and upon the secondary electron coefficient of the conductor.

For instance, referring (Fig. 9A) to the curve for nickel, it will be seen that it becomes unity at a primary impact velocity of approximately 1750 volts. The initial potential of a clean insulated electrode made of nickel will, in the absence of a flow of primary electrons, be that of the space in which it is situated. If this potential, and the impact energy of the primary electrons upon the nickel electrode are both above 1750 volts, then, from Fig. 9A, the total secondary radiation coefficient will be less than unity. The insulated nickel electrode will therefore charge negatively until its potential reaches 1750 volts, when the secondary radiation coefficient is unity, and the number of electrons leaving the electrode will be equal to those reaching it. This, of course, assumes space-charge-free conditions, and assumes further that all the secondary electrons emitted by the nickel are collected by other electrodes in the tube.

If, again, the space potential of the insulated nickel electrode and the initial energy are between about 160 and 1750 volts, then, from Fig. 9A, the secondary radiation coefficient will be greater than unity, and the electrode will tend to charge positively until an equilibrium potential of about 1750 volts is again reached.

If, however, the space potential and the primary impact energy are below 160 volts, then, from Fig. 9A, the total secondary radiation coefficient is less than zero. The insulated electrode will charge up negatively until it reaches zero potential, at which no primary electrons strike it. Therefore, in general, an insulated conductor upon which electrons impinge tends to take up either a potential tending to zero, or a high positive potential. It has been suggested to employ this effect to maintain a suppressor grid in a pentode at the order of zero potential. Clearly, if the electrode is contaminated, or otherwise has a greater secondary radiation coefficient than the pure material (and this may very easily occur in a practical radio tube), the impact potential at which the total secondary radiation coefficient is unity may well become very high.

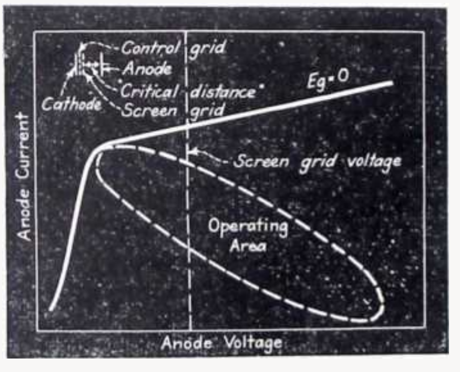


FIG. 17 — A critical-distance beam-tetrode characteristic

The equilibrium potentials of insulators (such as the glass walls of a vacuum tube) due to secondary radiation may vary discontinuously and profoundly affect the space potential in the tube as a whole, and therefore in many instances upset the operation of the device. In the absence of more information on the secondary radiation coefficients of insulators, and because of the complicated nature of their behavior, it is not possible to state any useful theory. In radio tubes care is taken to minimize the results of bulb charging. This is done by causing the electrode assembly to be self-shielding (i.e., semi-enclosed as far as the operative part of the electron beam is concerned) or by putting a conductive film (such as collodial graphite) on the walls of the glass envelope and connecting it to a suitable part of the electrode system. This is found to be necessary in cathode-ray oscilloscope tubes where the beam is not enclosed by the metal electrodes.

Conclusion

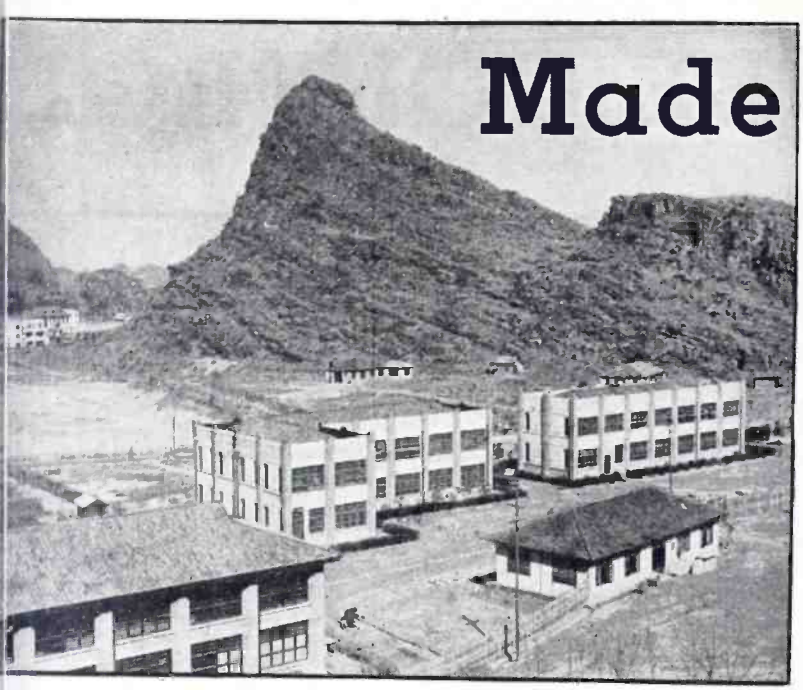
It is remarkable, considering the extreme importance of secondary radiation in electronic engineering, that there are so many gaps in the published information and theory. The author would appreciate any additions or corrections to this paper.

References

(1) Rudberg, E., *Phys. Rev.*, **50**, p. 138, 1936.
(2) Becker, A., *Ann. d. Phys.*, **78**, p. 228 and 253, 1925.
(3) Becker, A., *Ann. d. Phys.*, **84**, p. 779, 1927.
(4) Brinsmade, J. B., *Phys. Rev.*, **30**, p. 494, 1927.
(5) Campbell, N. R., *Phil. Mag.*, **24**, p. 783, 1912.
(6) Dadourian, H. M., *Phys. Rev.*, **14**, p. 434, 1919
(7) Farnsworth, H. E., *Phys. Rev.*, **25**, p. 41, 1925.
(8) Farnsworth, H. E., *Phys. Rev.*, **31**, March 1928, p. 405–413.
(9) Haworth, L. J., *Phys. Rev.*, **37**, p. 93, 1931.
(10) Haworth, L. J., *Phys. Rev.*, **42**, p. 906, 1932.
(11) Haworth, L. J., *Phys. Rev.*, **48**, p. 88, 1935.
(12) Haworth, L. J., *Phys. Rev.*, **50**, p. 216, 1936.
(13) Langenwalter, H. W., *Ann. d. Phys.*, **24**, p. 273, 1935.
(14) Rudberg, E., *Proc. Roy. Soc.*, **127**, p. 111, 1930.
(15) Sharman, C. F., *Proc. Cam. Phil. Soc.*, **23**, Part 5, Jan. 1927, p. 523 to 530.
(16) Soller, T., *Phys. Rev.*, **36**, p. 1212, 1930.
(17) Wells, D. A., *Phil. Mag.*, **5**, p. 367, 1928.
(18) Davisson and Kunsman, *Phys. Rev.*, **22**, Sept. 1923, p. 242 and 256.
(19) Davisson and Kunsman, *Science*, **54**, p. 404, Nov. 25, 1921, p. 522 to 524.
(20) Ch. Füchtbauer, *Physik. Zeitschr.*, **7**, p. 748, 1906.
(21) Stehberger, K. H., *Ann. d. Phys.*, **86**, p. 825, 1928.

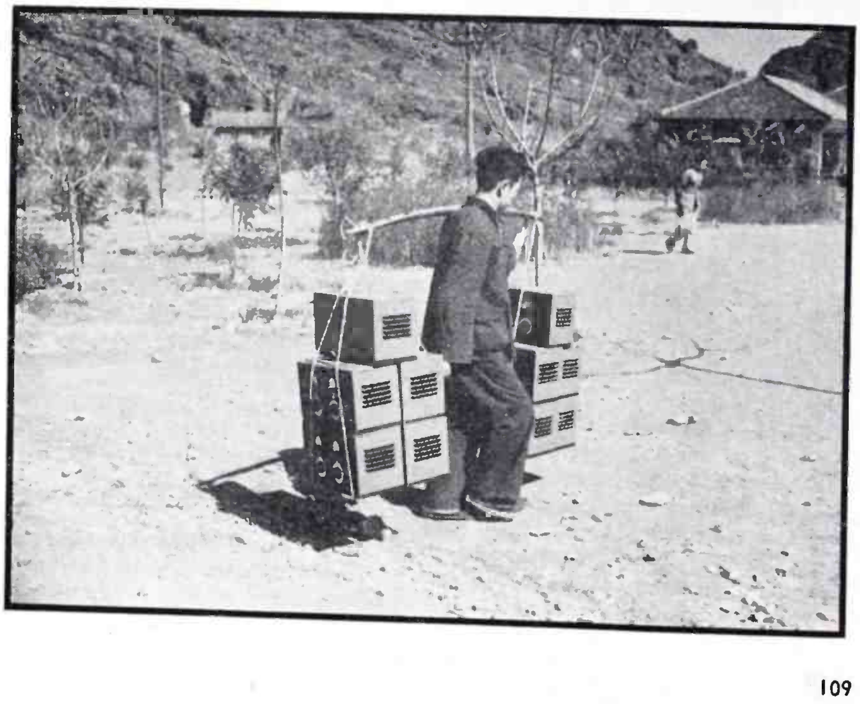
(*Continued on page 180*)

Made in CHINA



In this rugged terrain near Kweilin, capital of Kwangsi Province, native workers make radio equipment used by the Chinese Army and Government-operated broadcast stations. Known as the Central Radio Works, the plant is operated by the National Resources Commission. Note parking lot

Components are assembled as above where capacitors and vacuum tubes receive the dextrous attention of Chinese employees. Below, a worker finishes up the wiring on a transmitter, while a coolie, right, forms the local version of a conveyor line in transporting units around the plant



PHOTOTUBE CONTROL

Flow rates as constant as ± ¼ percent are achieved by a system which combines a rota meter for light-source interruption with phototubes, amplifiers, and thyratrons to contro a motor-driven regulating valve

By ROBERT C. McNICKLE *Engineer Brooke Engineering Co., Inc. Philadelphia, Pa.*

ROTAMETERS are simple instruments which accurately indicate the rate of flow of liquid or gas in a pipe line. They are widely used in chemical process, power, and other industries. The instrument, shown in Fig. 1, usually consists of a vertical, transparent, tapered, glass tube and a metering element inserted inside the tube. The small end of the tube is at the lower portion, and the metering element, variously shaped depending upon fluid requirements, is free to move up or down along the axis of the tube. The position assumed by this element directly indicates flow rate. The gas or liquid being metered flows from the bottom to the top of the tube.

Theory underlying the operation of this type of flow indicator is based on the flow equation, $Q = CA\sqrt{2gh}$, where h is a constant by virtue of the constant net weight of the metering element (commonly called the float or rotor), and A i a variable due to the taper of th tube. The force counter to the floa weight is the head differential in duced by the fluid flowing throug the annular aperture between th outside diameter of the float, an the inside diameter of the tube Thus the rate of flow varies directl as annular area and the calibratio of the instrument is linear.

In other words, forces on the floa are in balance; weight of the floa minus buoyancy equals area of th top of the float, times differentia pressure. If the flow rate increases the differential across the float wi increase, and the float will rise to new position to maintain a fixe differential pressure across it. Rat of flow is accurately measure

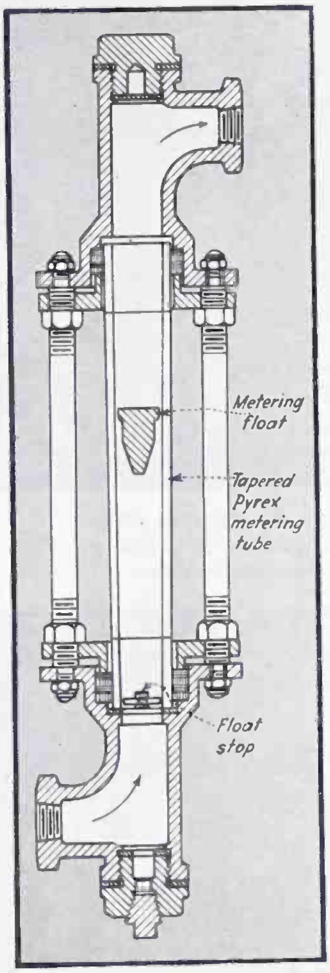


FIG. 1—Construction of a rotameter is shown in this sectional drawing. Position of the float depends on differential pressure which is automatically maintained constant by variations in the annular opening between float and tube as the float rises and falls. Flow-rate indication is linear

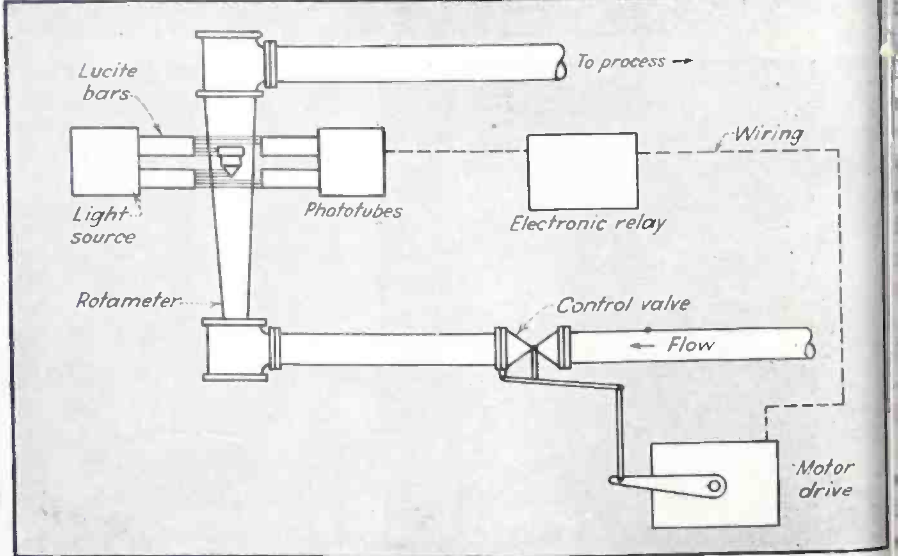


FIG. 2—Block diagram shows general operation of the flow-control unit. Provisions are incorporated to cancel out effects of line-voltage fluctuation and changes in color of the controlled fluid

OF FLUID FLOW

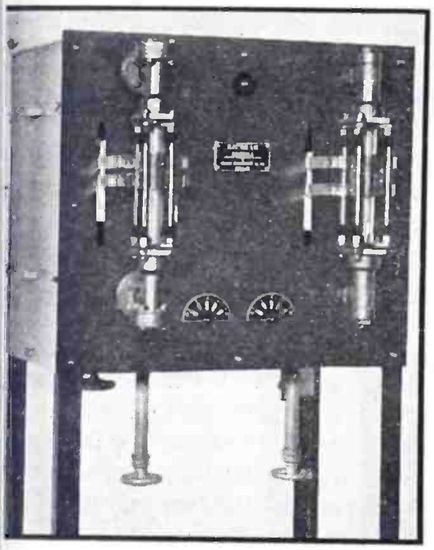
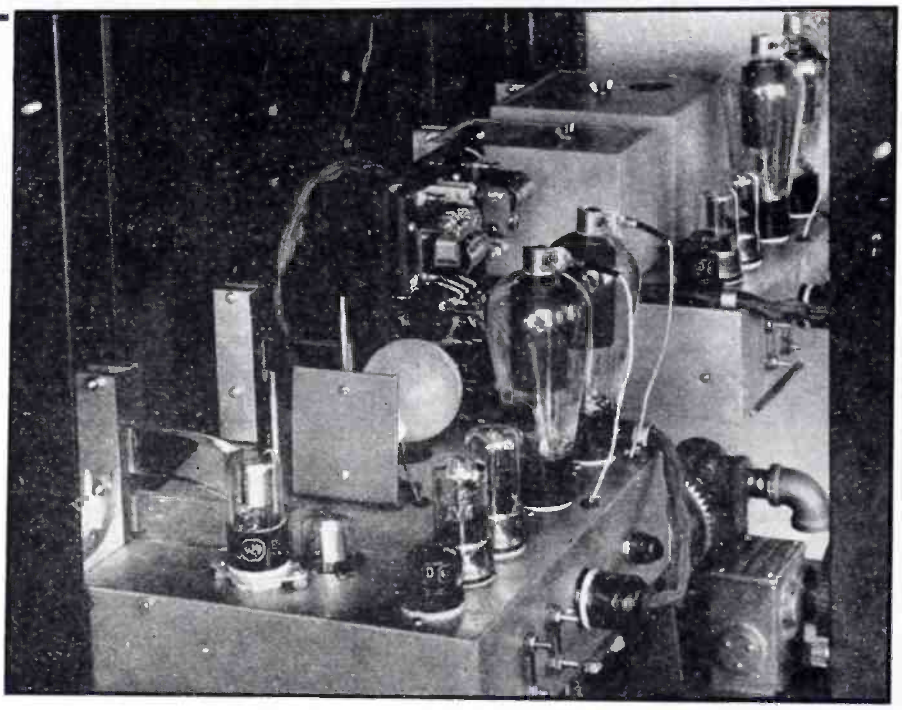


FIG. 3—The complete unit. Elevating handwheels are below and hand-automatic controls are on the front panel of the controller. Plastic light-transmission bars project through slots on either side of the rotameter tubes



Close-up of electronic control unit. Covers have been removed from chassis in the foreground to reveal plastic bars which transmit light from the source to the rotameter glass and back to the phototubes

ıroughout the entire tube range ıe to the variable orifice (fixed fferential) principle, and is not mited to a narrow range such as is ıe case in the fixed orifice type of ›w meters.

Self-supervised Operation

For the past ten years, there has ›en a demand for automatic con- ›l applied to rotameters. Brooke ıgineering Co. developed a con- ›l for this type of meter several ars ago. The control operated on induction principle such as is mmonly used in other types of struments. The float had an iron d which hung down inside a cen- r-tapped coil, mounted below the tameter. This coil was electrically lanced against a similar, remote il having an iron rod that could positioned by hand.

Differences in balance of the two ils when the float moved out of preset balance, were fed into an ›ctronic relay which caused a mo- ‹ to operate. This, in turn, opened closed a valve to correct the flow te. This type of control was not entirely satisfactory, due to the fact that its sensitivity was only plus or minus 1 percent, and phase shifts caused unstable operation if the control point was not near the center of the coil. Also, it could not be used on small sizes of rotameters, because the magnetic effect of the coil on the iron rod attached to the float was so great as to affect the sensitivity and accuracy of the rotameter.

About a year ago, a large refinery had a process in which they wished to maintain the flow rate of a fluid to $\pm\frac{1}{4}$ percent and it was decided to use a fully compensated electronic relay, receiving its signals from phototubes. This system had been in successful operation for many years, measuring the smoke density of large industrial boilers and adusting the air supply to maintain a fixed smoke color at the boiler outlet.

For the rotameter application, it was decided to use two light beams, one shining across the top of the float, and the other across the bottom of the float. Each light beam was applied to a phototube, and the outputs of the phototube amplifiers were electrically balanced against each other to cancel out the effects of voltage changes and color deviation of the liquid.

If the float in the rotameter moved due to a change in flow, one phototube received more light and the other, less light. This unbalance caused a thyratron to operate a motor with compensation and with full torque at all times. This motor changed a control valve in the correct direction to restore the float to the set value within $\pm\frac{1}{4}$ mm (0.0098 in.)

Disposition of Parts

Arrangement of the various pieces of equipment is shown in Fig. 2. The rotameter is mounted on a stand, in front of a panel as in Fig. 3. The electronic relay, with its light source common to both beams, and its phototubes, amplifiers, thyratrons, and allied equipment, is mounted behind the panel, as in Fig. 4. Lucite or Plexiglass bars are used to transmit the light

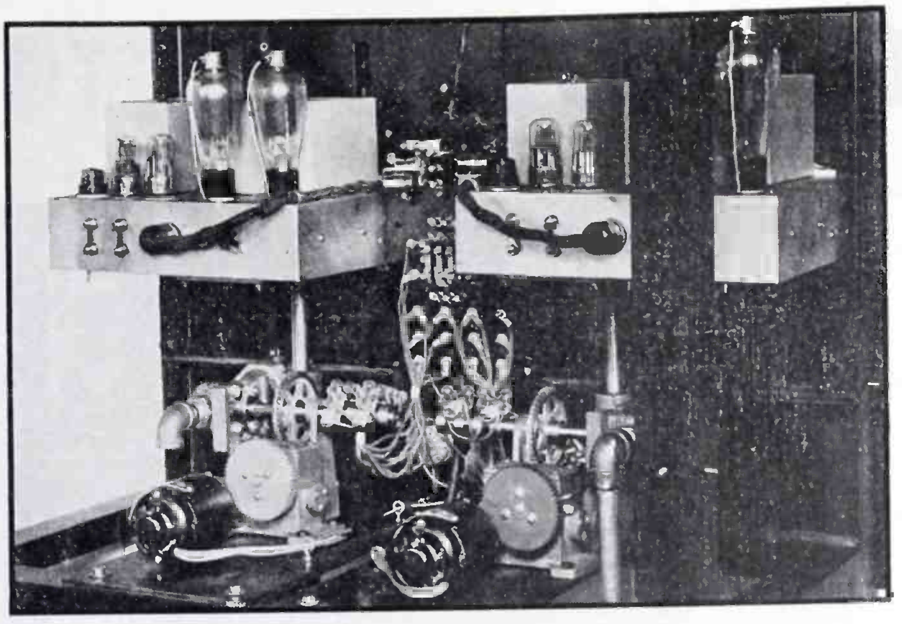


FIG. 4—In a rear view, motor drives and control valves appear below the electronic relays. Mercoid units mounted on the valve shafts include limit switches and extras which can be used to operate relays on terminal panel for automatic shut-down feature

out to the rotameter and back to the phototubes. The electronic relay is mounted on an elevator assembly which permits the operator to raise or lower the entire assembly to change the rotameter control setting. The unit is also supplied with a switch which permits the operator to remove the control from "automatic", and to raise or lower the flow to any desired value.

In addition to the compensated controlling action, described later, other features may be included in the electrical circuit when required. For example, automatic shut-down if any of the fluids in the process cease flowing or go beyond predetermined values, or if tubes or light source fail.

In most cases, a lock-in circuit must be employed to return the float within the range of the light beam if the characteristics of flow are such that an occasional surge in the fluid will raise or lower the float out of the light beam. This lock-in feature is most important. Essentially, it consists of electromagnetic relays which are actuated by the phototube amplifiers just before the float leaves the light beam. The lock-in feature discerns which way the float moved and operates the motor at full speed to return the float to the light beams where the thyratron can come into operation.

Referring to the circuit diagram in Fig. 5, when the output of V_3 goes beyond a predetermined limit, as set by R_{13}, a type 2050 thyratron in the lock-in circuit fires to energize a relay. When energized, this relay disconnects the cathode of an opposing 2050 so that it cannot operate, and puts a high positive voltage on the grid of the thyratron V_6 to run the motor at full speed. The lock-in circuit does not come into play until the float is about ready to leave the light beam.

The electronic relay employed converts impulses from a pair of phototubes into signals sufficiently large to run a reversible motor. Net movement of the motor is proportional to the signal and the motor has full torque at all times. The electronic relay provides electrical compensation by means of a circuit which varies the thyratron grid voltage by charging and discharging a capacitor at variable rates. Such compensation is similar in results to mechanical throttling and reset but is accomplished electrically without the use of relays, open contacts, or moving parts.

The light source is a 120 v bulb directed through two pieces of Lucite or Plexiglass to form two light beams shining across the rotameter. They are spaced so that when the float is in balance, one half of each light beam is blocked out and the other half of the beam passes through the fluid and metering tube to other bars of Lucite, and thence to the phototubes. The phototubes are of the high-vacuum type and are not appreciably affected by voltage changes.

Circuit Details

Direct-current bias for the phototubes, amplifiers, and thyratrons is furnished by the 6H6 rectifier. One half of the tube acts as an ordinary high-voltage half-wave rectifier, taking voltage drop across a load resistor, while the other half utilizes the drop across the tube, giving low voltage. Both plate outputs are filtered. Resistors R_1 and R_2 provide grid bias for V_3 and V_4 while C_1 and C_2 provide a-c grid-to-cathode return.

Phototubes V_1 and V_2 are so connected to their amplifiers V_3 and V_4, that the more light received by the phototubes, the lower the amplifier plate output. With this arrangement, it is possible to keep a nearly constant plate output of the amplifiers with a variable voltage. For instance, if the voltage falls, the light source dims, plate voltage of V_3 and V_4 drops, and the phototubes decrease the negative grid voltage of the amplifiers, thereby increasing plate output to approximately the same value as at the higher voltage. This will take care of line voltage changes in the order of ± 5 v at 115 v. For greater changes of voltage the plate outputs of V_3 and V_4 will vary up or down together, but since these plate outputs are balanced against each other in T, it will not affect the control. With the amplifier plates balanced against each other, color changes of the liquid in the rotameter will also cancel out.

The plate of V_3 is connected to one half of the primary of push-pull transformer T, and the plate of V_4 is connected to the other half. Assuming the float is in neutral, light on V_1 equals light on V_2, plate outputs of V_3 and V_4 will be equal and cancel each other in the primary of T, and there will be no voltage developed in the secondary. If the float moves down from the neutral position, V_1 receives more light, and V_2 less light, therefore the grid of V_3 will become more negative, and the grid of V_4 less negative. The plate output of V_4 will become rater and that of V_3 less, causing voltage to be developed in the secondary of T. Since the primary voltage is pulsating half wave, an a-c voltage will be developed in the secondary.

A fixed, negative d-c bias of approximately 10 v is maintained on the grids of V_6 and V_7 by the rectifier when the float is in balance. If the float falls, as assumed above, the positive half of the a-c voltage developed in one half of the secondary reduces the negative grid voltage to approximately 2 v and V_7 fires to run the motor in a direction which changes the valve to restore the float to neutral. Note that the emission of tubes V_3 and V_4 is 180 deg out of phase with the emission of V_6 and V_7.

Anti-Hunt Compensation

It can readily be seen that if the motor were to run at full speed until the float reached its neutral position hunting would occur. To introduce compensation C_3 is used in the following manner. When V_7 fires to run the motor, its plate becomes approximately 70 v negative. This negative voltage, in addition to running the the motor, charges C_3 through R_{11}, R_{10}, and R_9, to put a high negative voltage on the grid of V_7 to stop it from firing. Then, C_3 discharges through R_9, R_{10}, R_{11}, and the motor. Thyratron V_7 cannot fire again until C_3 discharges.

While the motor is not running, the float has a chance to come to rest. If its point of rest is not the neutral position, a signal from T will again cause the motor to run. If the float moves a great distance from neutral, a strong signal will be developed by T, and the motor will have to run a long time before C_3 is charged with a high enough voltage to overcome the effect of the secondary voltage of T. The motor will then have a long time delay. If the signal from T is weak, the motor will only be energized a short time to charge C_3 a small amount, and the time of delay will be short. In other words, the net rate of movement of the control valve will be proportional to the amount the float moves from neutral.

Capacitor and resistor values are so chosen that if the float moves a great distance, the motor will run at full speed without interruptions. As the float approaches neutral, the motor begins to step at a speed proportional to the distance from neutral. Capacitor-resistor combinations C_4-R_5 and C_5-R_7 also have a somewhat compensating effect but on a relatively small scale.

If the float had moved in a direction to fire V_6, a negative feedback voltage would have been induced in the motor field not being used. This induced voltage would be equal to the voltage running the motor, and would cause compensation as described above.

By this system the motor always has full torque, regardless of how close the float is to balance. This is extremely important for highly sensitive controls,—otherwise, should the valve stick, the torque delivered by the motor near the neutral point would not be sufficient to restore the float to its original balance point. This is often a limiting factor in many control devices.

Successful field operation of 64 of these units for several months has demonstrated that an extremely accurate control can be applied to devices where it is necessary to maintain a movable body in a fixed position. If greater sensitivity is required, concentrated light beams can be employed. By this method, a slight change in float movement will cause a greater signal change.

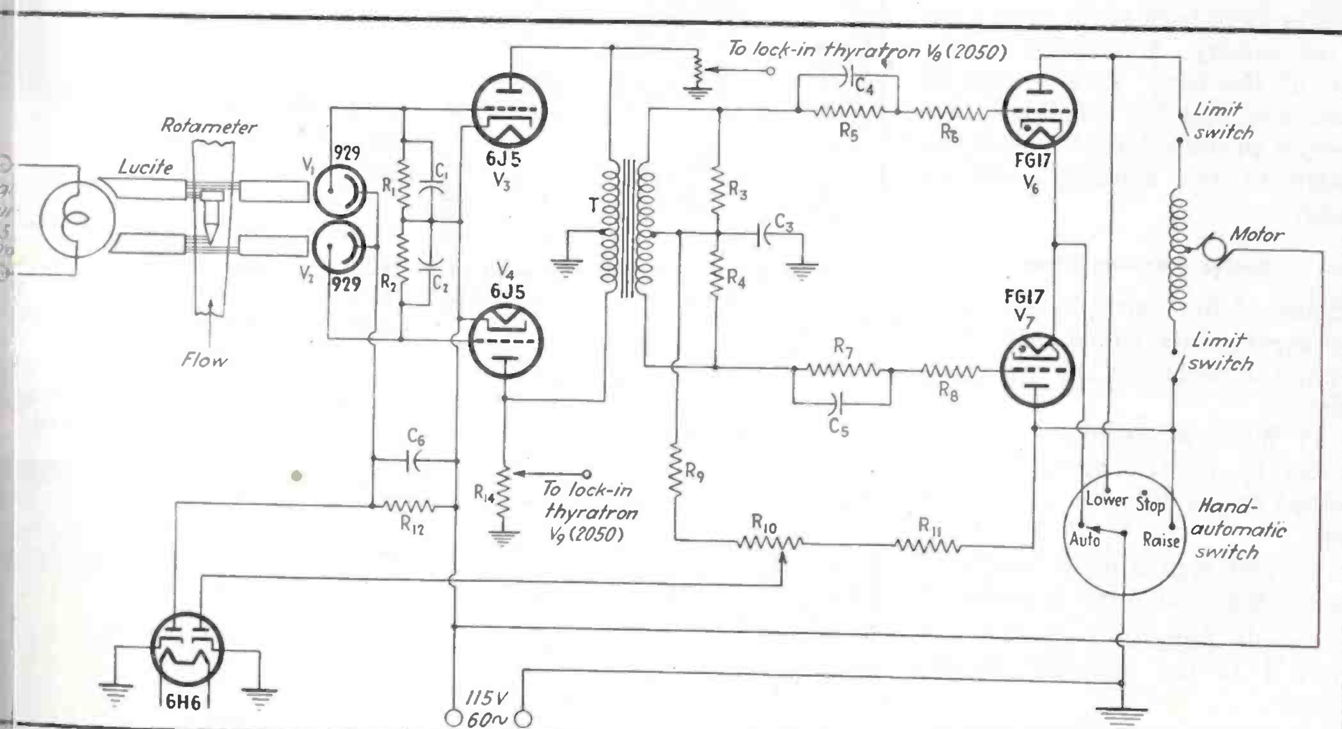


FIG. 3—Basic circuit of electronic relay includes a pair of FG17 thyratrons which can be replaced with FG57 type where a large motor is required for valve operation. Light source, shown as directly connected to the line, is sometimes put in series with the filaments of the rectifier and amplifier tubes for long operating life at reduced voltage

A Generator of Damped

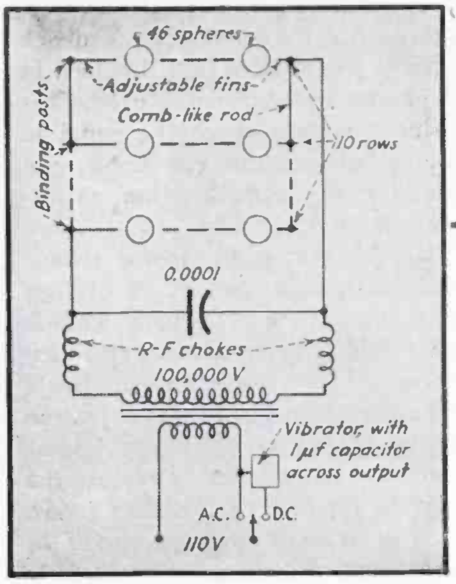


FIG. 1—Schematic of the generator

Spark discharges between 460 series-paralleled metallic spheres develop ½ watt of power at 7,000 Mc for the irradiation and stimulation of cells in biological studies

APPARATUS which has for its purpose the production of power at extremely high frequencies is usually associated with radio transmission but that described here was designed for use in the field of biology.

The generation of damped electromagnetic waves by means of spark discharges between metallic spheres dates back to the beginning of the century. A complete discussion of the early work is out of place here, and for hypotheses and theories on the subject we refer the reader to the appended bibliography.

Design Considerations

Some of the conclusions of earlier experiments which were kept in mind in designing the apparatus follow:

(a) When a metallic sphere is excited by electric sparks, highly damped trains of waves are generated.

(b) The approximate length of the fundamental wave is given by Thomson's formula $\lambda = 2\pi d/\sqrt{3}$, where d is the diameter of the sphere.

(c) The surface of the spheres must be and must remain highly polished, otherwise the discharge ceases to be oscillatory and becomes aperiodic.

(d) The energy of the electromagnetic waves generated by discharges between small spheres is of the order of 10^{-3} watt.

In order to utilize these conclusions in a practical way a large number of metallic spheres were fixed in a non-conducting frame, individually insulated, and at convenient terminals high voltage was applied. (The excitation of the spheres may be in parallel, in series or in series-parallel. The last disposition was preferable.)

Figure 1 shows a schematic arrangement of the circuit of the apparatus. It follows the theory of the spark-gap circuit once widely used in radiotelegraphy with damped waves, except for the fact that in this instance the spheres oscillate and radiate at the same time.

Description of Apparatus

The apparatus, shown in Fig. 2, is mounted on top of a cabinet in which a transformer is housed. Two

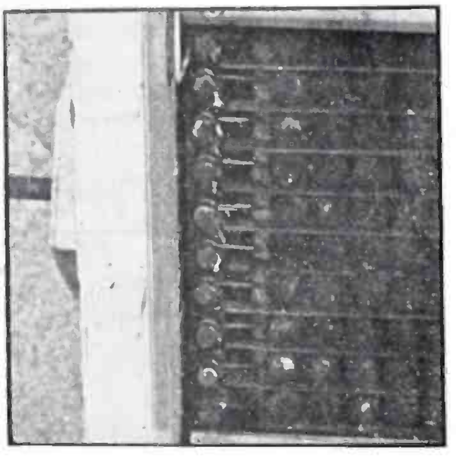


FIG. 3—Close-up of the left edge of the unit, showing how binding-posts which may be seen in a vertical line are used to permit adjustment of fins

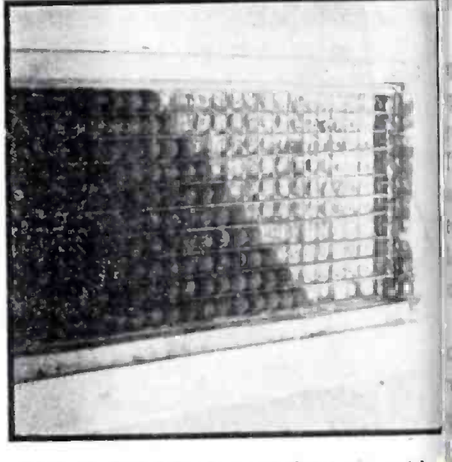
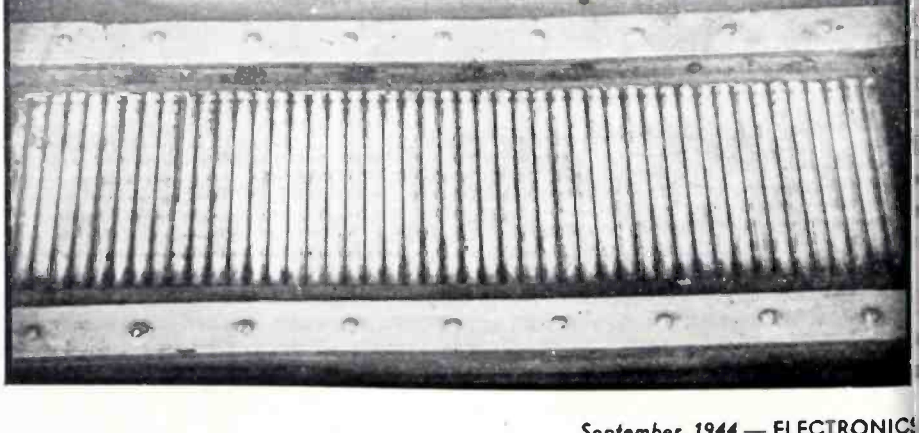


FIG. 5—Partial view of the unit, with some spheres removed to show how treated wooden strips provide horizontal spacing

FIG. 4—Paralleled round porcelain rods provide vertical grooves in which spheres may be placed, keeping them equally spaced and well insulated



Microwaves

By ANGELO MONTANI

ltable arms at the sides sup-
ort a cylindric-parabolic reflector
ı which the radiating element is
ɔsitioned.

The transformer used was taken
·om an old x-ray machine, and is
ıted at 100,000 v r.m.s., 500 w. Its
ırminals are connected through
gh-frequency chokes to two comb-
ꞇe rods, each of which has ten ad-
ıstable "fins." The rods are
ɩuipped with binding-posts which
ırmit adjustment of the fins. A
t of binding-posts associated with
ıe of these rods may be seen in a
ırtical line in Fig. 3.

Ten parallel rows of metallic
heres, each row having 46
heres in series, constitute the
nerating and radiating element.
ıe spheres are plain metallic balls
ch as those used in ball bearings,
ated with platinum to prevent as
ıg as possible rusting due to
one produced by the sparks.

To obtain individual insulation
each sphere straight porcelain
ds, 47 in all, were assembled
ainst a flat wooden back to con-
tute a corrugated surface having
grooves, in each of which 10
ıeres could be located in a verti-
row, as shown in Fig. 4. With
s disposition every sphere is
rizontally spaced the same
ıount from the spheres to the left
d right, which is important for
ı even distribution of sparks.
rizontally between each row of
ıeres long strips of treated wood,
re inserted as shown in Fig. 5.
hold the 460 spheres against the
·celain rods a sheet of flat glass
s provided to cover the entire
·face of the radiant element.

The diameter of the spheres is
mm, and therefore the funda-
ntal wavelength is approxi-
tely 43.4 mm. The power radiated by the whole system of 460 spheres at the fundamental wavelength is around ½ watt. (Assuming that the power of the harmonic waves decreases according to the square of the number of their natural sequence, the power of the tenth harmonic, or 4.3 mm, would be ½ 10^{-2}w, and the power of the one hundredth harmonic, or 0.43 mm. would be ½ 10^{-4}w.)

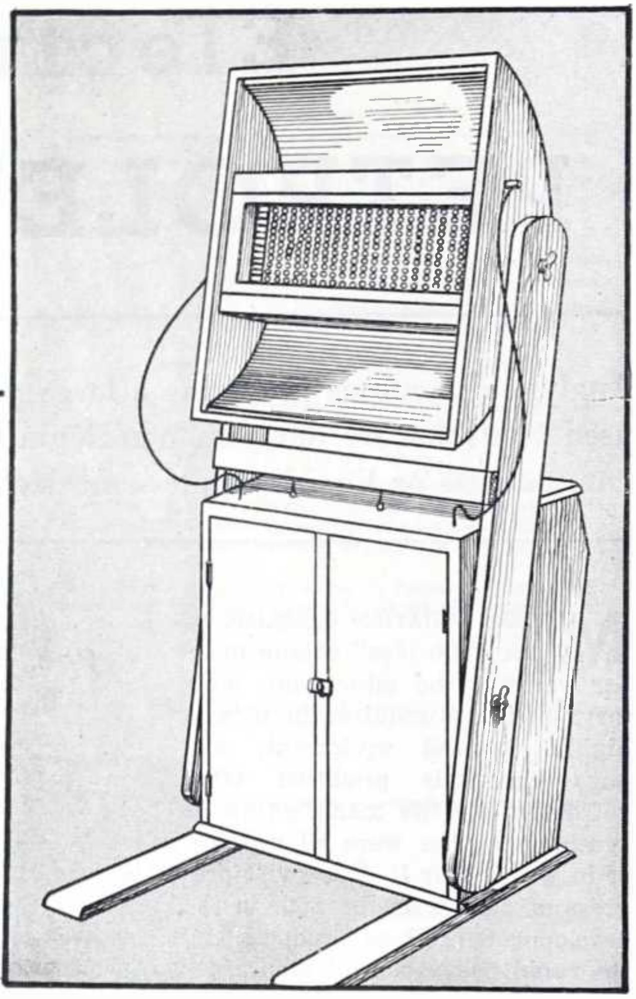


FIG. 2—The complete generator, consisting of a metallic-sphere spark-discharge unit and sheet-metal parabolic reflector to concentrate radiation. The cabinet on which the generator-radiator is mounted contains the high-voltage supply transformer

Purpose of Apparatus

The purpose of the apparatus was to make available in the biological field those radiations which fall between the centimeter waves and the heat rays, and to find out if such radiations might be of use in therapy.

Living things are made up of billions of individual "cells." These cells generally vary in size 10^{-1} cm and 10^{-4} cm, and are larger in vegetals and smaller in viruses. If we want to stimulate a cell we can do so by irradiating it with waves of the same order of magnitude, since under these conditions at least partial resonance may be expected.

Rays shorter than light excite the electrons of the atoms which form the cells, no matter where those electrons are. They may belong to a neuron or to a rock. On the other hand, short waves as used in diathermy cause in the tissue as a whole variable charges which, associated with the osmotic and capillary phenomena, alter the circulation of the liquids of the body. In both instances, the cellular metabolism that ensues is not a specific direct reaction of the cells to the radiation, but a derived effect. Cells in tissues represent a tridimensional grating, and with waves of proper dimensions it may be possible in the future to institute a new kind of spectroscopy of the living tissues and determine if there exists a kind of selective absorption peculiar to every type of cell.

Biological Use

Between March and June, 1941, six biological experiments were performed with the above apparatus

(*Continued on page* 306)

Electronics in PETROLEUM PLANTS

Analytical methods involving a large portion of the electromagnetic spectrum are being used continuously today in petroleum production and research to identify molecules in complex gas or liquid samples and determine the exact concentration of each component

By
F. P. HOCHGESANG and C. H. SCHLESMAN

Socony-Vacuum Oil Co., Inc.
Research and Development Division
Paulsboro, N. J.

MODERN AVIATION GASOLINE of the "100 plus" octane number variety, the all-purpose military lubricants required in today's highly stressed equipment, and pure chemicals produced from petroleum for the manufacture of synthetic rubber were all unheard of in World War I. The swift progress of petroleum research in the development of these products and the rapid translation of laboratory processes for their manufacture into vast commercial operations has spurred on the analytical chemist to new heights. Without the participation of the electronics industry, this progress would have been impossible.

In the past the simplest methods served to control the manufacture of gasoline and lubricating oils. Today, measurement of such simple properties as gravity, viscosity, and boiling range is not sufficient. Modern research demands far more explicit information. Usually the research chemist, and often the production engineer also, will not settle for anything less than knowing the complete composition in terms of the molecules present. When new methods developed for research purposes are applied to industrial control, our dependence upon stable amplifiers and electronic detectors and recorders becomes complete.

These modern radiation methods have again stressed the importance of the electromagnetic spectrum to the petroleum chemist. The regions most frequently employed in this field include the x-ray, ultraviolet, visible and infrared portions of the spectrum. Naturally the technique resembles that of the physicist more than that of the chemist. The chemist endeavors to make materials react with specific reagents to yield a unique product which will identify some component of the original sample and which can preferably be weighed or titrated to determine the concentration of the unknown component in the sample.

The physicist, on the other hand, usually makes measurements on the sample as received, often returning the sample still in its original condition. Such physical measurements yield new and direct information concerning the sample. These methods are frequently much more rapid than wet methods and only a small amount of the sample (sometimes less than a milligram)

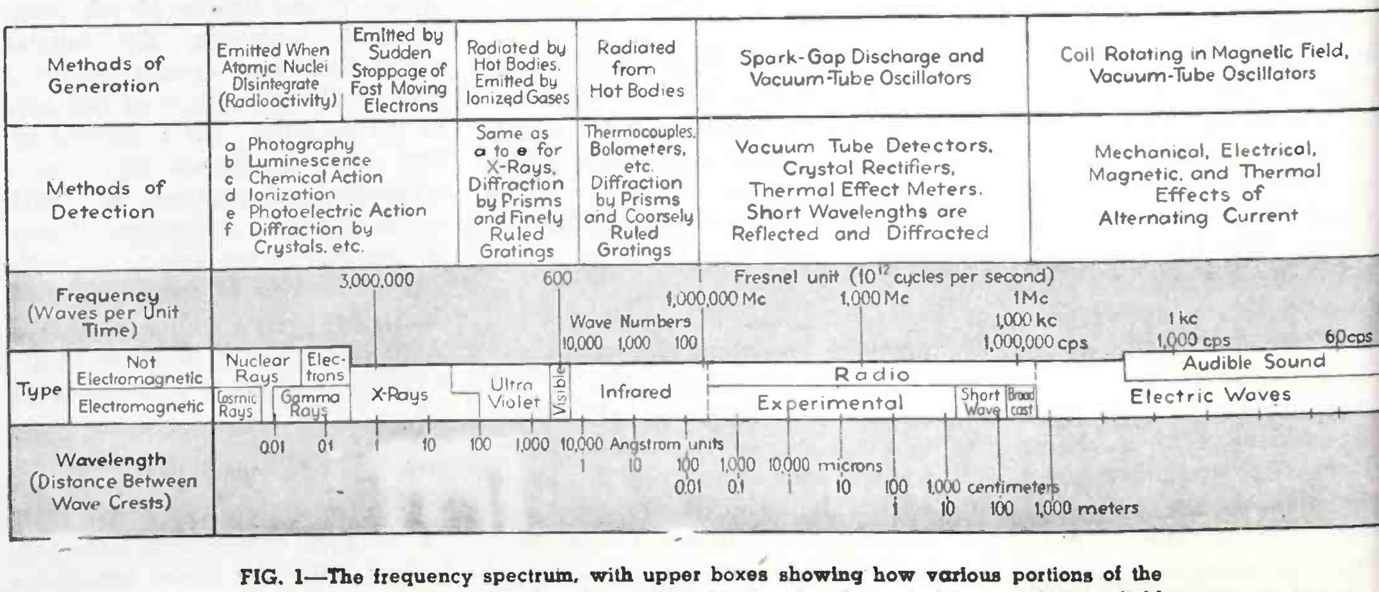
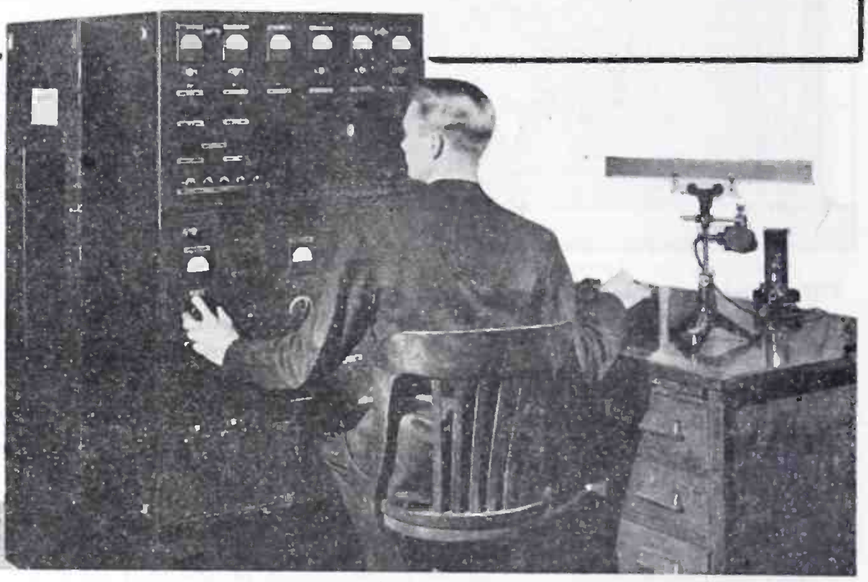


FIG. 1—The frequency spectrum, with upper boxes showing how various portions of the spectrum can be generated and detected for use in the petroleum analytical field

SUMMARY OF ANALYTICAL METHODS USED IN PETROLEUM PRODUCTION AND RESEARCH

Method	Principal Use in Petroleum Industry	Remarks
Mass Spectrometry	Determination of low molecular weight hydrocarbons, such as analysis of the petroleum "gas cut."	Principally useful for mass-production analysis of routine gas samples. Instrument time is ¼ to ⅓ hour per sample but calculating time may require several hours. Extended range, high speed, pen and ink electronic recorders and automatic calculators are needed.
Infrared Absorption and Raman Spectrography	Determination of molecular components and identification of functional groups within molecules, such as analysis of aviation gasoline after fractional distillation or determination of mercaptans (S-H) in gasoline base stock.	Sample may be a gas, liquid or solid but must not contain more than about six molecular components if complete identification is desired. Most infrared samples must not contain water and Raman samples must not contain much fluorescent material. The electronics industry could greatly increase the usefulness of either method by supplying completely electronic detecting and recording circuits.
Ultraviolet Absorption Spectroscopy	Determination of aromatic and conjugated olefinic compounds, such as toluene in paraffinic base or butadiene for synthetic rubber manufacture.	Electronic detecting and recording systems are available in this field. A not-too-expensive instrument which automatically scans the entire spectrum is needed.
Emission Spectrography	Determination of metals and metalloids, such as analysis of catalysts for trace metals.	Good for rapid qualitative survey of sample or for quantitative determination of metals present in low concentration. The adaptation of electronic detecting and recording systems to replace the photographic emulsion would be very useful in most cases.
X-ray and Electron Diffraction	Determination of compound identity of crystalline materials; aids in the investigation of crystal structure and structure of colloidal or amorphous materials.	X-ray tubes and generating systems are designed to meet present requirements but electronic detection and recording is much needed in the x-ray diffraction field.
X-ray Microradiography	Tool to supplement useful metallurgical microscopy.	
Electron Micrography	Extends the range of ordinary microscopy so that smaller objects can be seen, and increases detail due to its great depth of focus.	A "reflecting" electron microscope seems to be the next step in this field.



Westinghouse mass spectrometer used for separating molecules of synthetic rubbers and oils according to their mass. Molecules of each mass in turn are made to enter a collector, and the resulting ion current is amplified and read with the galvanometer on the desk

s needed for the complete analysis. The application of the same princi-les to continuously recording nits operating from plant streams s equally practicable. However, uch equipment may often be quite omplex and expensive in first cost.

The Frequency Spectrum

Most uniform oscillatory wave notion belongs to the electromag-etic spectrum which is shown chematically in Fig. 1. Sound, lectrons, some nuclear rays, re-iprocating mechanical motion, etc., re not electromagnetic in charac-er and their wavelength or fre-uency regions can be shown only pproximately. The radio spectrum s now well known up to about 1000 Ic,[2] but from here on to 1,000,000 Ic lies a relatively unexplored egion which promises to be very nportant in the future.

The infrared region is somewhat rbitrarily said to begin at about ,000,000 Mc or 300 microns, but ne region from 300 to 30 microns s largely only of academic interest t present. The region from 30 nicrons (300,000 Angstroms) to .03 Angstrom is that in which the nalytical methods described in nis paper operate. In the short-st wavelengths are found hard x-ays and gamma rays. In the past two or three years gamma rays have been used to "log" oil wells and determine where oil-bearing strata might occur even though metal casing has already been set within the well.

With the advent of the cyclotron and similar atom smashers, nuclear rays have been used in numerous novel experiments involving radioactive "tracers". Atoms of a specific element can be "tagged" by making them artificially radioactive and then followed throughout the course of a reaction by following the progress of the radioactive atoms.

Cosmic rays, the most penetrating radiation known, are generated outside the earth's atmosphere. They have been found to discharge electroscopes after penetrating 18 feet of lead. Day and night we are subject to bombardment by cosmic rays.

The energy per quantum of electromagnetic radiation varies directly with the frequency, as shown in Table I. It is instructive to inspect briefly this energy variation, for this in part dictates the troubles encountered in detecting the radiation and dictates the energy available for photochemical reac-

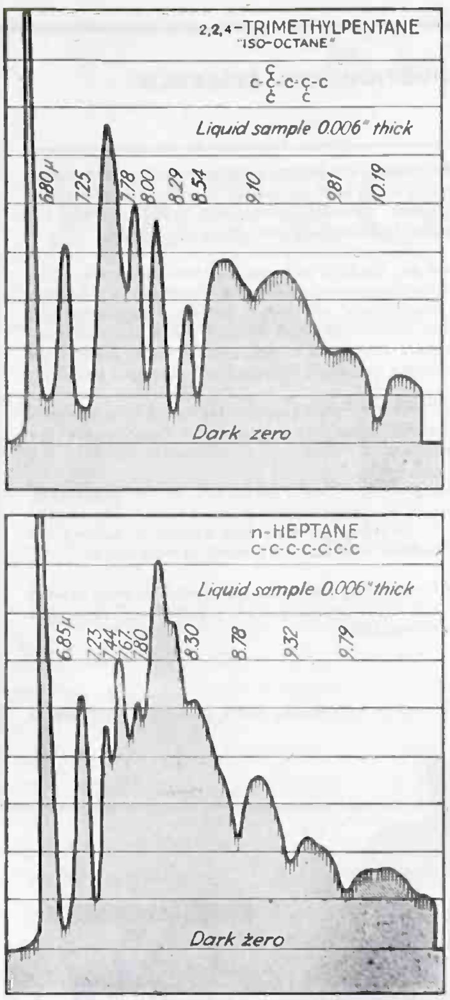


FIG. 2—Infrared absorption spectra obtained automatically with an infrared spectrograph covering the wavelength region from 7 to 10 microns, for two hydrocarbons that are difficult to separate by distillation. Characteristic absorption peaks provide positive identification of gas or liquid samples

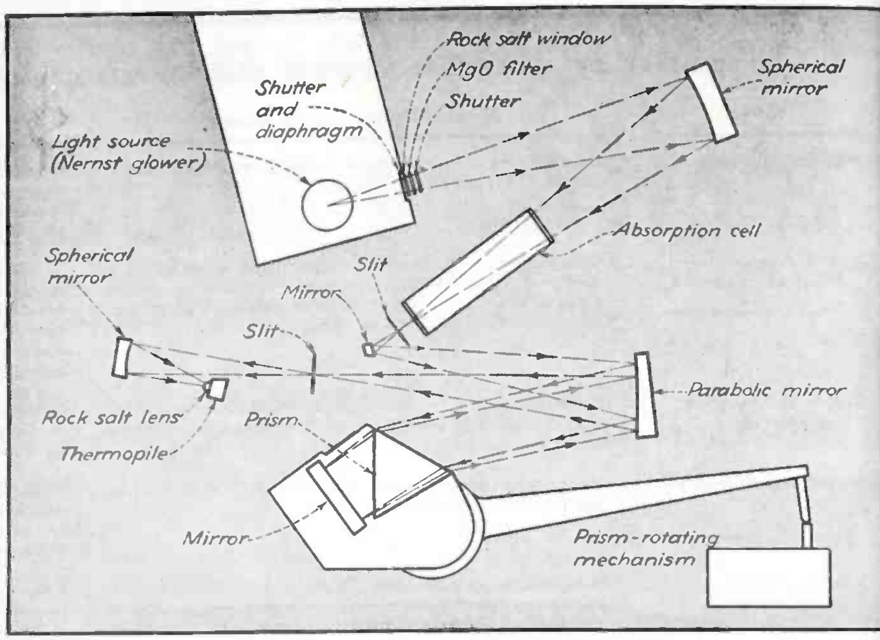


FIG. 3—Optical arrangement of infrared spectrophotometer made by National Technical Laboratories. The gaseous sample to be analyzed is placed in the absorption cell. The thermopile (or thermocouple) output is read on a sensitive galvanometer mounted in a draft and vibration-proof housing

tion. Thus, the short wavelength radiation such as x-rays and ultraviolet rays readily enters into photochemical reactions. Ultraviolet and visible radiation readily activates photoelectric surfaces. The long-wavelength infrared and radio waves in general cannot enter into photochemical reactions because the energy per quantum of radiation is too small. Radiation of wavelength longer than about 2 microns cannot expel photoelectrons from photoactive surfaces which would be stable at room temperature.

Mass Spectrometry

The newest of the new analytical tools applied to petroleum problems is the mass spectrometer. Commercial instruments are capable of routine refinery control work to provide accurate petroleum gas analyses in amazingly short times on samples so small that their size is dictated by sample handling techniques in collecting and transporting the sample rather than the amount required for analysis. Mass spectrometry finds its greatest usefulness within the petroleum industry[3, 4] as a method that replaces tedious low-temperature fractional distillation and accompanying techniques for the control of refinery gaseous streams.

In the rapid spectrometric methods devised to analyze the petroleum "gas cut", the instrument time required is about ¼ to ½ hour per sample and results from the data obtained can be calculated in from a few minutes to several hours depending upon the problem. This method soon proves its value when one realizes that other methods require from 4 hours to several days to do the same job. Usually the results from the mass spectrometer are more accurate and the method is less subject to operator errors.

The mass spectrometer is so named from certain similarities it possesses to an optical spectrometer. The latter separates light into its various component wavelengths by the dispersion obtained in passing light through prisms or gratings. The mass spectrometer separates gas molecules according to their mass by ionizing the gas, accelerating these ions, and deflecting them in a magnetic field. Gas from the sample is made to pass through several tiny orifices, so that a constant flow occurs into the spectrometer tube in which a high vacuum is maintained by continuous pumping. Electrons from a heated filament are accelerated by passing through a potential gradient and fall on the entering gas stream, causing ionization and dissociation of some of the gas molecules. The molecules not thus excited are drawn out of the system by the exhaust pump. The ions and ion fragments thus formed are urged toward a slit in a plate by a small potential difference and then are accelerated to very high velocity by an electrode arrangement similar to that in an electron gun. The resulting high-velocity ions are directed into a magnetic field. Only certain ions having the correct mass-to-charge ratio will travel through the center of the analyzer tube and ultimately lose their charge to the ion collector from whence their current is amplified and measured.

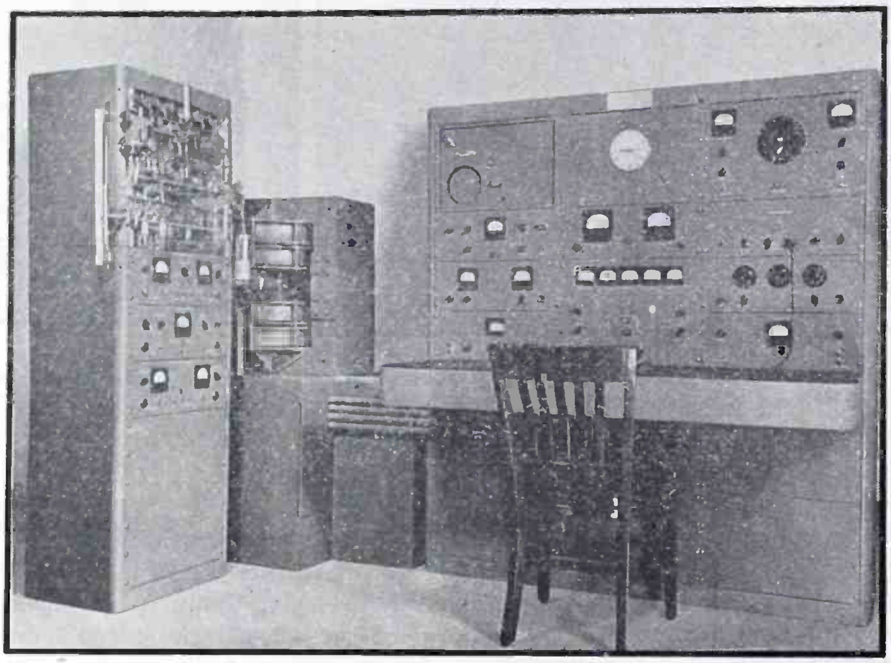
By variation of the accelerating potential and/or the magnetic field, such an instrument can be made to determine the relative abundance of various weight ions. This data can be converted to the relative abundance of the various molecules in the initial sample by comparing the unknown mass spectrum with ie mass spectra of known pure hy-rocarbons, since the unknown iass spectrum can be considered s a summation or superposition of ie mass spectra of all the compon-nts of the sample.

Infrared Absorption

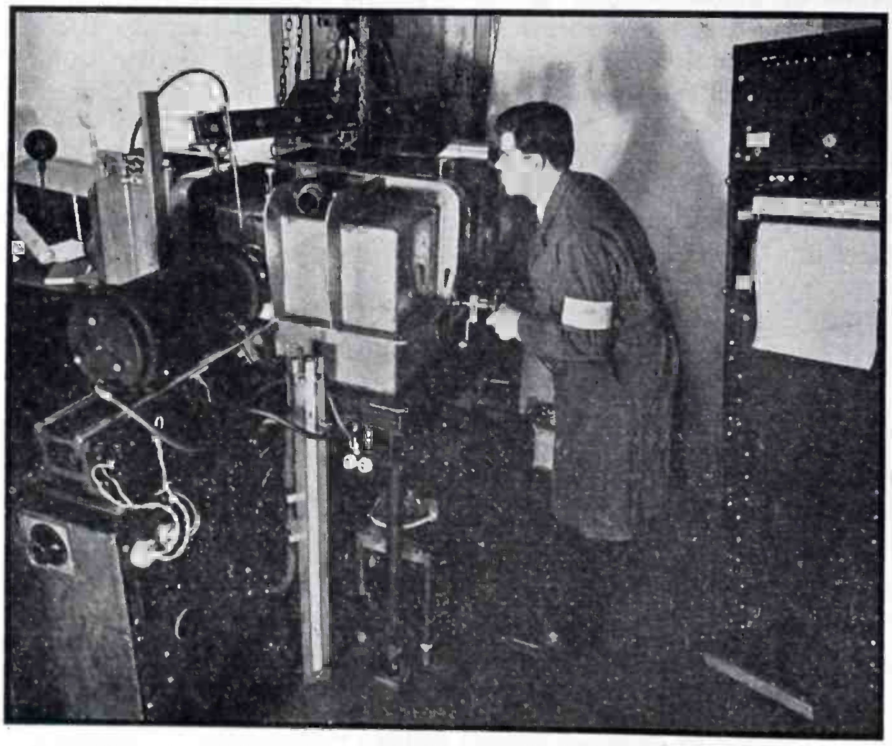
At the present time the mass ›ectrometer is used in the petro-um industry primarily to deter-ine the molecular composition of ›mplex mixtures of gaseous mate-als. Other spectroscopic methods ·e generally used to determine the ›mposition of liquid or higher-olecular-weight samples and cer-in rather simple gas mixtures. ›r example, in high-octane avia-›n gasoline, it is well known that ›rtain types of molecules are de-rable and others undesirable. But any of both the good and bad olecules are very much alike in all ›eir physical properties and often ›nnot be isolated by even the best actional distillation techniques. ›us, n-heptane has zero octane ımber and isooctane has 100 oc-ne number. Present-day aviation iracles would be impossible if uch n-heptane was present in the el, but n-heptane and isooctane n be separated by distillation, if all, only by very laborious pro-dures. Infrared spectroscopy[8, 9, 10] adily differentiates between these ›drocarbons, as is illustrated in g. 2.

All this is possible because the equency of the 1-to-30 micron in-ared region corresponds to the bration frequencies of atoms or oups of atoms in hydrocarbon ›lecules. As long as any molecule not at absolute zero, the atoms thin the molecule are constantly ›illating about their positions of uilibrium. For example, a hy-ogen atom vibrates against a car-n atom in aliphatic hydrocarbons th a frequency corresponding to wavelength of 3.4 microns. This ›ration is a simple stretching ›ration wherein the frequency of cillation is, to a first approxima-›n, determined by the mass of the ›rating atoms and the valence rces which bind them together. A ysical analogy is the resonance ›ration of two spheres of given ›ights connected by a spring. If e tension of the spring is in-›ased the resonance vibration will occur at a faster frequency and this happens in molecules also. In ethane, H_3C-CH_3, the carbon atoms are connected by a single bond and vibrate against each other at 993 cm^{-1}. In ethylene, $H_2C=CH_2$, the carbons are connected by a double bond or stronger spring. The vibration is more rapid, at a frequency of 1623 cm^{-1}. [$1\ cm^{-1} = 1/\lambda$ (cm).]

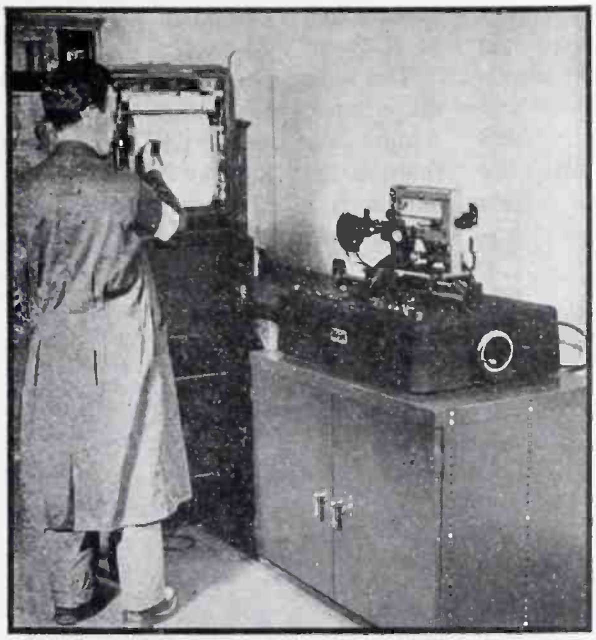
The vibrations just described are all simple stretching vibrations. Atoms also may vibrate in such fashion that angular motion occurs and such vibrations are called deformation or bending vibrations.



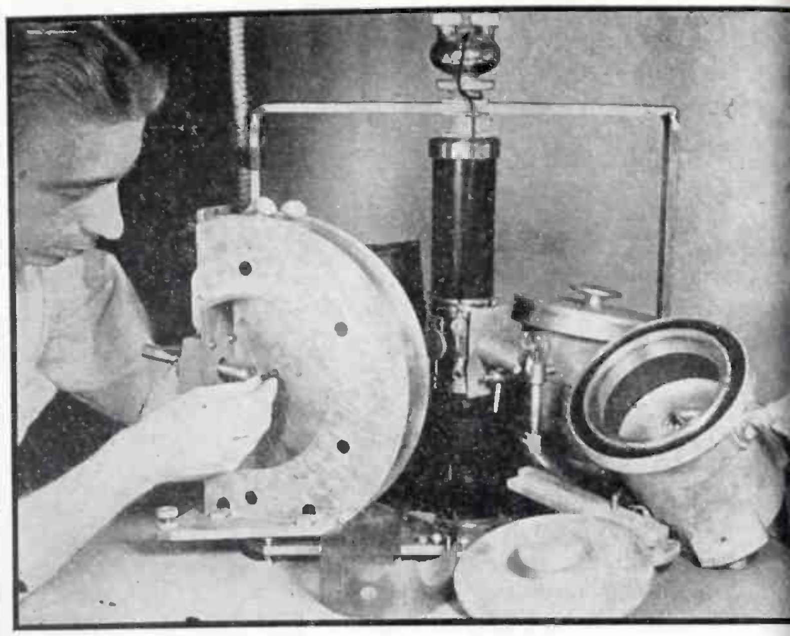
In this mass spectrometer made by Consolidated Engineering Corp., several cabinets full of electronic equipment are needed to provide an automatic record showing how many ions of each mass are present in a gas. From left to right, the cabinets contain gas introduction systems and vacuum gages; the magnet, with the mass spectrometer tube between the pole pieces; and the power supplies, ion current amplifier, recording oscillograph and automatic mass scanning device



Infrared spectrograph used in Socony-Vacuum Laboratories. The spectrograph proper is in a metal housing to permit evacuation for removal of water vapor and carbon dioxide. On the rack at the right is the pen and ink recorder that traces out the spectrum of the material being analyzed



This Leeds and Northrup recording microphotometer can be used to measure the optional density of each spectral line on a photographic plate produced by an emission spectrograph



Operator is placing a sample on a spindle in the center of a large-diameter cylindrical x-ray diffraction camera. Smaller cameras, a pinhole camera and a Philips-Metalix x-ray tube used as a source of radiation for these cameras can also be seen

For example, an H-C-H or CH_2 group in aliphatic hydro-carbons has a strong deformation vibration at 1,460 cm^{-1}. Atomic groups may rotate with respect to one another, thus yielding still another type of motion having a characteristic frequency. Many combinations of the above types occur to yield combination frequencies. Any molecular vibration which is accompanied by a change of dipole moment is "infrared active" and will absorb, by resonance, radiation corresponding to the frequency of vibration.

Raman Spectroscopy

Raman spectroscopy[5, 6] supplies essentially the same information concerning molecular composition as infrared absorption studies but accomplishes the task in a different manner. In Raman spectrography, light of characteristic and usually visible wavelength, such as that from a mercury discharge tube, is allowed to illuminate the sample. Light originating in the sample at a direction perpendicular to the incident beam is dispersed in a large-aperture spectrograph and the resulting spectrum photographed and examined. This scattered and/or re-emitted light coming from the sample contains light of frequencies corresponding to that of the incident beam plus or minus the frequencies of various vibrating groups within the sample, and thus can be used to identify the parent molecules. Samples for Raman investigation must be well fractionated just as with infrared.

The photographic process complicates quantitative interpretation of Raman spectra, and a direct-reading, automatic-recording detecting system for the visible light emanating from a Raman spectrograph would greatly enhance its industrial usefulness. Multiplier phototubes have already been successfully applied to this problem[7].

Experimental Difficulties with Infrared Spectroscopy

Infrared spectroscopy is used at present in the petroleum industry to a much greater extent than Raman, even though the experimental difficulties in infrared work constitute a formidable list. To mention a few, ordinary optical materials will not transmit infrared radiation in the wavelength region used and prisms and windows of sodium chloride, potassium bromide and lithium fluoride are used in conjunction with front-surfaced mirrors.

These are now available in large perfect crystals of synthetic manufacture but the chloride and bromide are readily attacked by water vapor and must be handled accordingly in use. Gratings are not useful for general survey work because overlapping orders of spectra

TABLE I. Quantum Energy of Some Electromagnetic Radiations

WAVELENGTH		APPROXIMATE COLOR	ENERGY		
Angstroms	Microns		per quantum (ergs)	per einstein* (kilo-cal.)	relative
300,000	30	Infrared	0.066 x 10^{-12}	0.95	0.33
100,000	10	Vibration infrared	0.196 "	2.85	1
10,000	1	Photographic infrared	1.96 "	28.5	10
7,000	0.7	Red	2.81 "	40.7	14.3
6,200	0.62	Orange	3.17 "	45.9	16.1
5,800	0.58	Yellow	3.39 "	49.1	17.2
5,300	0.53	Green	3.71 "	53.8	18.9
4,700	0.47	Blue	4.18 "	60.5	21.3
4,200	0.42	Violet	4.68 "	67.8	23.8
3,000	0.30	Ultraviolet	6.55 "	94.8	33.3
1,000		Vacuum Ultraviolet	19.6 "	285	100
100		Long X-rays	196 "	2,850	1,000
1		X-rays	19,600 "	285,000	100,000
0.1		Gamma Rays	196,000 "	2,850,000	1,000,000

* The einstein is similar to the faraday or chemical equivalent of electrical energy.

re difficult to identify in this re-ion. Even the water vapor and arbon dioxide in the air must be liminated from the optical path 1rough the instrument or a cor-ection made. The optical arrange-ient of one such instrument is 1own in Fig. 3.

The radiation involved in spec-roscopy is of very low inherent nergy, as shown in Table I. It can-ot be photographed at wavelengths nger than 12,000 A or 1.2 microns, nd will not actuate photo electric ells above about 1.7 microns. It in only be detected by tiny ther-iocouples, bolometers, radiometers, c. Such instruments must detect mperature changes with a limit f error equal to, or less than, 00005 deg C. The most commonly sed detector is the thermocouple. microvolt output of the ther-iocouple must develop about full-ale deflection on the recording in-rument used. Since the usual re-stance is only about 15 ohms and e period about 1 second, electronic nplification is difficult. Sensitive alvanometers with their accom-inying vibration troubles must be lied upon. The authors know of st one case where, in the past few onths, a thermocouple has been ade with sufficiently small mass so at its period is faster than 1 sec-id and electronic amplification of e thermocouple output has become ssible. The spectrograph in use the Socony-Vacuum Laboratories es a bolometer as a detector. Elec-onic amplification is used and re-ilts to date indicate that this com-nation marks an important step rward.

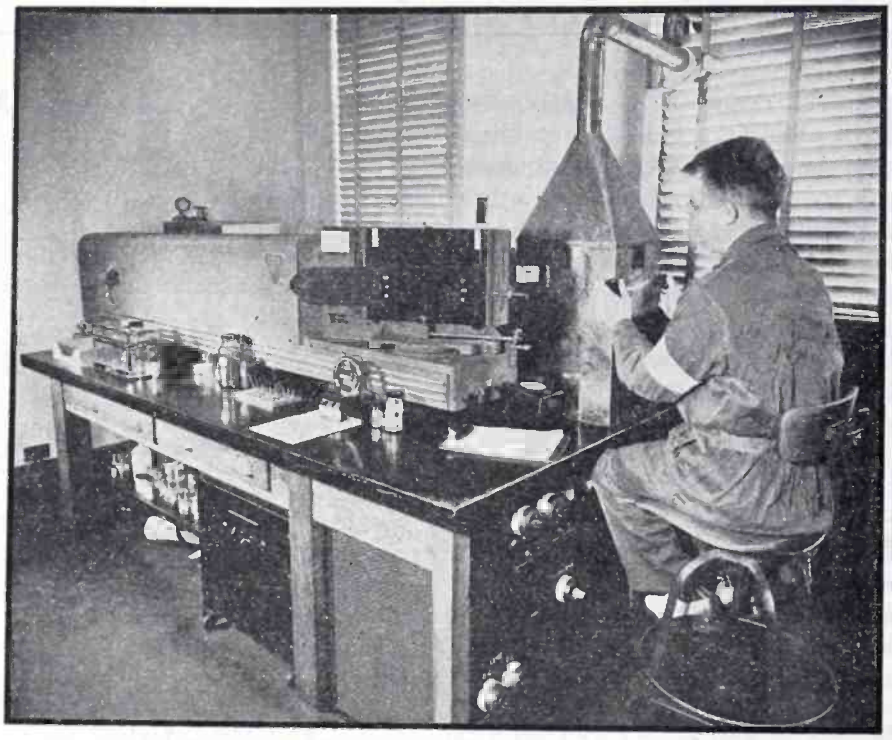
ltraviolet Absorption Spectroscopy

The readily accessible ultraviolet gion of the spectrum from 2,000 up to the visible region also dis-ays phenomena related to the ructure of molecules. Molecules iich contain resonating groups, ch as diolefins which contain con-gated unsaturated carbon groups, hibit selective absorption of ul-aviolet light.

Of particular interest to the troleum industry, aromatic hydro-rbons[11] and drying oils and res-s[12] yield characteristic ultraviolet sorption spectra by means of iich such molecules can be identi-d. Saturated hydrocarbons do not absorb appreciably in this region. Thus, the identity and concentration of some aromatic compounds (those which may be present in gasoline) can be determined without separation from the paraffinic hydrocarbons.

An analysis has been reported wherein straight-run or saturated naphtha is split into five fractions over the range of 125–150 deg C and these fractions analyzed for ethylbenzene and the three xylenes with an accuracy better than that of any other available procedure. More

(*Continued on page* 308)



In this emission spectrograph, the samples to be analyzed are burned in an electric arc or spark in the hood at the right. The light emitted is broken into its spectrum by a quartz prism, and the spectrum is recorded on film

At the right are four evacuable powder cameras in position around the x-ray tube of an x-ray diffraction unit. High-voltage equipment is under the table, enclosed by metal screening. The operator is adjusting the intensity of the x-ray beam. This unit was built in Socony-Vacuum Laboratories about six years ago, but complete and versatile commercial equipment is now available

INFLUENCE OF FEEDBACK

Analysis of the use of negative feedback to reduce source impedance in amplifier stages and transmission lines, as required in video design and other applications where high-frequency response must be improved or loudspeaker "hangover" must be eliminated

By RICHARD W. CRANE

INVERSE FEEDBACK is widely used in amplifiers today to stabilize gain, improve frequency response, and reduce distortion. One other extremely valuable feature of negative feedback is the apparent reduction of source impedance it may cause; this is not only important in itself, but may also serve as a basis for analyzing all the other features of feedback.

Impedance Consideration

Let us then derive a formula for the variation in source impedance with feedback. The gain of a feedback amplifier is

$$\alpha' = \frac{\alpha}{1 - \alpha\beta} \qquad (1)$$

where α' = gain with feedback, α = gain without feedback, and β = ratio of feedback voltage to output voltage, or the fraction of output voltage fed back (negative for degeneration).

As the load impedance approaches infinity the equation

$$\alpha = \frac{-\mu Z_L}{Z_L + R_P} \qquad (2)$$

approaches the value $\alpha = -\mu$, and α' approaches the value $-\mu/(1 + \mu\beta)$, where μ = amplification factor of the tube, R_P = plate resistance of the tube, and Z_L = load impedance.

In Fig. 1, which is the equivalent circuit of an amplifier stage, one method of finding the source impedance would be to connect a load of such value that the voltage at T_1T_2 measured exactly half the value it would have if the load impedance were infinite, in which case Z_L would equal R_P. Practically, this would mean choosing a value of Z_L such that $\alpha = -\mu/2$. The same reasoning holds true for an amplifier with feedback, where $R_P = Z_L$ when

$$\alpha' = \tfrac{1}{2}\left(\frac{-\mu}{1 + \mu\beta}\right) \qquad (3)$$

Substituting Eq. (2) in Eq. (1),

$$\alpha' = \frac{\dfrac{-\mu Z_L}{Z_L + R_P}}{1 + \dfrac{\beta\mu Z_L}{Z_L + R_P}} \qquad (4)$$

To find the apparent plate impedance we need only substitute the value of α' given by Eq. (3) in Eq. (4) and solve for Z_L, which will be the value of load impedance required to make α' equal one half its maximum value, and will therefore also be the source impedance of the amplifier:

$$\tfrac{1}{2}\left(\frac{-\mu}{1 + \mu\beta}\right) = \frac{\dfrac{-\mu Z_L}{Z_L + R_P}}{1 + \dfrac{\beta\mu Z_L}{Z_L + R_P}}$$

Solving for Z_L,

$$Z_L = R_P' = \frac{R_P}{1 + \mu\beta} \qquad (5)$$

(In this equation μ must be negative. Strictly speaking, it should always be, because of the 180 deg phase reversal in an amplifier stage).

From this formula it can be seen that negative feedback in effect reduces the plate resistance of a tube, and in a practical case can make a pentode or beam power tube have a source impedance as low as that of a triode, or lower.

It is well known that pentode and beam power output stages have poor frequency response and appreciable distortion. These defects are manifested mainly in two ways.

Defects of Pentode and Beam Tubes

First, the speaker tends to have "hangover"; that is, the cone and voice coil assembly tends to vibrate at its own natural period when a transient or a steep wave front signal is applied, and the amplifier's output will be far above normal when a signal is applied whose frequency is equal or close to the mechanical resonant frequency of the speaker. This does not occur in a triode because the low-impedance source shunts the speaker's counter emf and effectively damps the vibration. A pentode or beam tube with enough feedback to approximate a triode's plate resistance will behave similarly.

The second effect is a response which rises with increasing frequency; this happens because the primary inductance of the output transformer presents an appreciable (and, of course, varying) load to the tube throughout the audio spectrum. In a triode stage the

FIG. 1—Equivalent circuit of an amplifier stage connected to a load

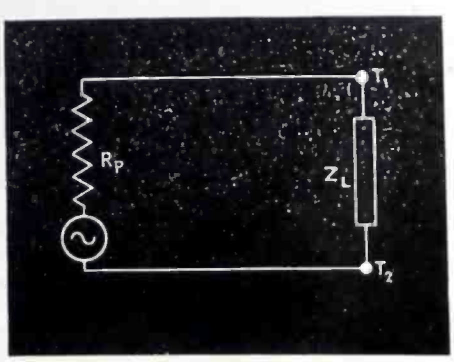
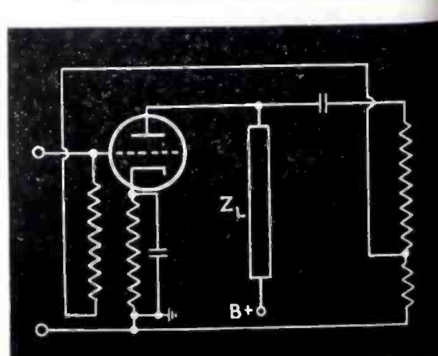


FIG. 2—Voltage feedback circuit using a portion of the output voltage



ƆN SOURCE IMPEDANCE

ansformer primary's inductive actance is high compared to the be's plate resistance except at the ry lowest audio frequencies, and us a fairly uniform response is tained. As in the first case, feed-ck will enable a beam power or ntode tube to give similar per-rmance.

Pentode voltage amplifiers can e feedback advantageously also, · it will lessen the effect of the)ut capacitance of the next tube d therefore improve the high-fre-ency response.

[n general, it may be said that erse feedback will improve the ion of any tetrode or pentode plifier whose load contains shunt ictive components.

Current Feedback Circuit

The foregoing discussion and de-ation assume that β is constant ardless of changes in load im-lance. This is true in the circuit Fig. 2 or in any circuit where a rtion of the output voltage is fed k. If we consider Fig. 3, how-r, we see a network in which a tage is fed back which depends the output current rather than output voltage, and β is not stant but depends on Z_L. In this e β is determined by the ratio he voltage drop across R_F to the age drop across Z_L. Therefore,

$$\beta = -\frac{i_P R_F}{i_P Z_L} = -\frac{R_F}{Z_L} \qquad (6)$$

he circuit of Fig. 3, Eq. (2) be-es

$$\alpha = \frac{-\mu Z_L}{Z_L + R_P + R_F} \qquad (7)$$

Eq. (4) becomes

$$\alpha = \frac{\dfrac{-\mu Z_L}{Z_L + R_P + R_F}}{1 + \dfrac{\beta \mu Z_L}{Z_L + R_P + R_F}} \qquad (8)$$

Substituting Eq. (6) in Eq. (8),

$$\alpha' = \frac{\dfrac{-\mu Z_L}{Z_L + R_P + R_F}}{1 - \dfrac{\mu R_F}{Z_L + R_P + R_F}}$$

Simplifying,

$$\alpha' = \frac{-\mu Z_L}{Z_L + R_P + (1-\mu) R_F} \qquad (9)$$

Eq. (9) is identical with Eq. (2) except that α becomes α' and R_p be-becomes $[R_P + (1-\mu)R_F]$. Our formula for apparent source imped-ance, considering μ negative as in Eq. (5), is

$$R'_P = R_P + (1-\mu) R_F \qquad (10)$$

Thus in Fig. 3 or in any current feedback circuit, the tube's plate resistance is increased, and hence the output current tends to be stab-ilized, rather than the output volt-age as in a voltage feedback circuit. Current feedback will not improve frequency response because if the load impedance varies with fre-quency β will also vary. For this type of feedback Eq. (1) becomes

$$\alpha' = \frac{\alpha}{1 + \dfrac{\alpha R_F}{Z_L}}$$

Current feedback is especially un-desirable in power amplifiers for it tends to stabilize the output transformer's magnetizing current (i.e., make it sinusoidal), and thus produce a distorted output voltage.

Phase Inverter

The circuit in Fig. 4 represents a phase inverter network which utilizes feedback. Half the load re-sistance is in the plate circuit and the other half is in the cathode cir-cuit, hence $\beta = -0.50$, $\alpha' = 2$ and $E_1 = -E_2$. This is, apparently, quite a good circuit for phase inversion; however, if we examine it in the light of the above discussion we can see an interesting problem. Look-ing back into the plate circuit we see a current feedback arrange-ment and a high-impedance source. On the other hand, the cathode load sees a voltage feedback circuit and a low-impedance source; thus it is apparent that the network will not give perfect phase inversion. A pentode would give especially poor results in such a circuit; however, the writer has obtained satisfac-tory results by using a low-μ triode with a low value of load re-sistance in such an arrangement.

Load in Cathode Circuit

Figure 5 is an interesting appli-cation of voltage feedback. The en-tire load is placed in the cathode circuit, so that $\beta = -1$, and from Eq. (5) R'_P very nearly equals R_P/μ or $1/G_M$. This circuit is use-ful where a very low source imped-ance is required, as for instance in certain video applications.

Conclusions

A significant fact to remember is that by using Eq. (5) and the circuits in Fig. 2 and Fig. 5 it is possible to match any tube to any load whose value is equal to or greater than $1/G_M$.

Inverse feedback reduces the gain of an amplifier of course, but this is no problem with present-day high-gain tubes, and the advan-tages of feedback offset this.

3—Current feedback circuit using drop in cathode resistor

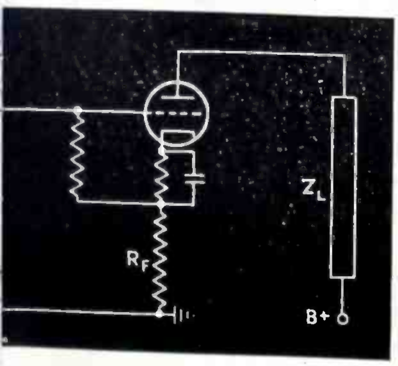


FIG. 4—Circuit using feedback for phase inversion

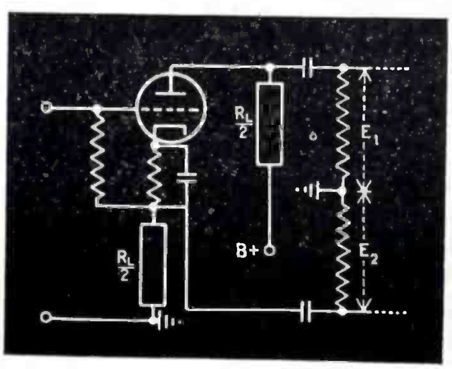
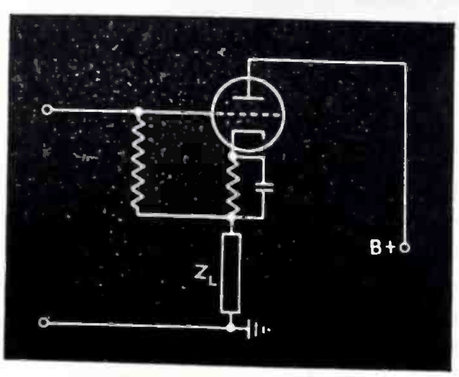
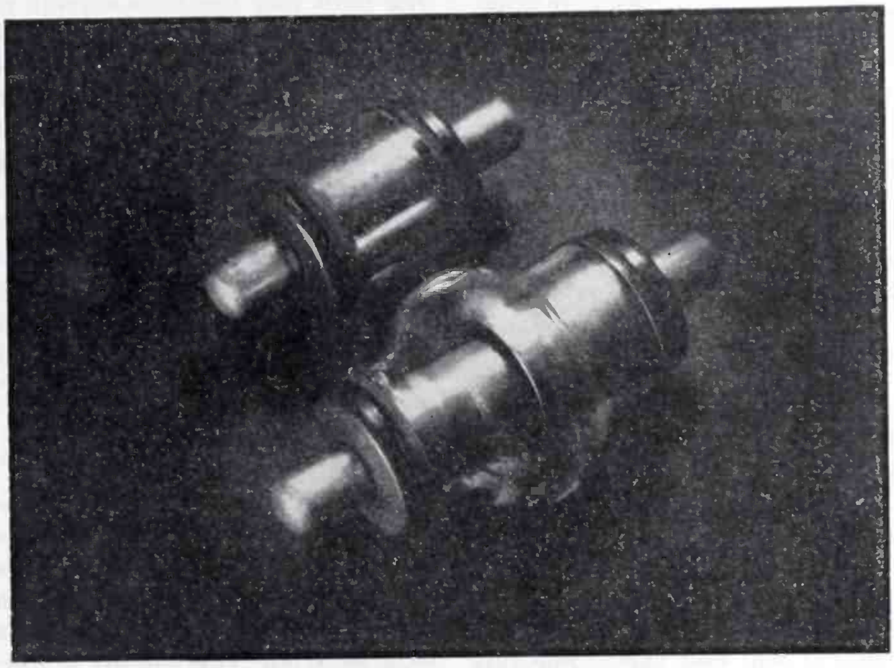


FIG. 5—Cathode-loaded circuit with extremely low source impedance



Gas-Filled and

Significant features are reviewed. These include low power loss, high breakdown voltage, space economy, stable dielectric constant, low temperature coefficient, high efficiency, good dielectric strength, and self-healing capabilities



Vacuum capacitors for 7500 peak voltage in 25 and 50 $\mu\mu f$ sizes are supplied by General Electric Co. in the style at the left. Applications for the same capacitances at 16,000 peak volts are filled by the type at the right. Size comparisons with air capacitors give these units ten-to-one advantage for the same voltage rating

By HERBERT B. MICHAELSON

New York, N. Y.

In modern radio and electronic apparatus, the conventional air capacitor is often suitable because its power losses are ordinarily so small as to be almost unmeasurable. However, both air and solid dielectrics have certain limitations, many of which can be obviated by the use of vacuum or gas-filled capacitors.

Vacuum Capacitors

Electrodes of vacuum capacitors are coaxial cyinders or bell-shaped plates sealed in evacuated glass envelopes, with leads brought out to metal end-cups. Capacitive edge effects are minimized by the coaxial construction, and, because electrostatic field strength has an essentially constant value at all points on the polished surfaces, a uniformly high breakdown voltage is achieved. Electrode spacing is of the order of 0.06 in., height of the cylindrical plate being less than an inch in a typical 50-$\mu\mu$f unit.

Metal must be a type that will not give up occluded gases and thus reduce the high vacuum. Tantalum has been used successfully by some manufacturers.

Air pressure within a typical vacuum capacitor is as low as can be obtained by pumping alone—or less than one micron of mercury. When flashover occurs, the plates, as described by George H. Floyd, General Electric Co., have a tendency to clean up, rather than to corrode or become pitted, because of the extreme scarcity of oxygen and other gases within the envelope. Fixed vacuum capacitors are available in sizes ranging from 3 to 250 $\mu\mu$f, with ratings varying from 5,000 v to 35,000 v peak. In practice, these ratings are extended where necessary by use of series-parallel combinations, forming an unusually compact capacitor bank for very high voltages. A typical 50-$\mu\mu$f unit has an overall length of 3-5/16 in., a diameter of 1-⅝ in., and a rating of 7,500 v. peak. Manufacturers of vacuum capacitors include: Eitel-McCullough, General Electric, General Electronics, and Jennings Radio Mfg.

Electrical Characteristics

Breakdown of a gaseous dielectric does not occur until the potential is great enough to cause collision ionization. The breakdown rating of an air gap within a glass envelope decreases, as air is exhausted, until a certain barometric pressure is reached. Down to this point, the mean free electron path is being lengthened, and the mobility of gaseous ions is increasing, aiding ionization.[1] After this point, further exhaustion of air results in a sharp increase of dielectric strength because ionization is now actually hampered by a scarcity of gas molecules. Sparking potential then depends mostly upon the number of gas particles between the plates[2].

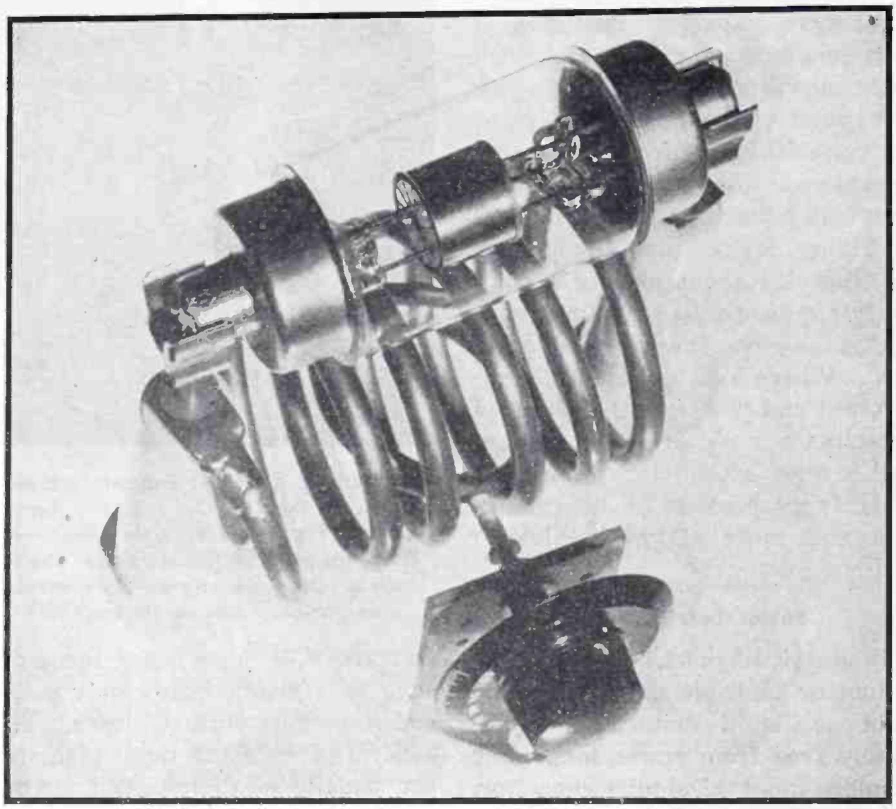
Figure 1 gives typical voltage breakdown curves of plane electrodes, spaced at 1 and 2 cm, at various air pressures. Voltage breakdown in a uniform field is actually a function of the product of gas pressure and plate spacing, as given by Paschen's Law. However, this does not apply accu-

Vacuum Capacitors

ely at very low or at very high ıssures, where sparking poten- l depends to a considerable ex- t on surface condition and ma- ial of the electrodes.[3]

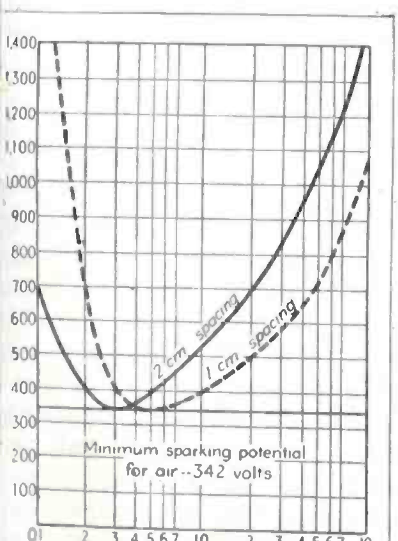
Minimum sparking-potential for spacing in air is 342 v. In er words, for any given electrode cing, (1 cm., for example) akdown voltage will decrease as pressure is reduced, down to a tain point. When a breakdown tage as low as 342 is reached, l air pressure is further de- ased, breakdown voltage will v start to increase, as shown in g. 1. The same is true for any ctrode spacing, whether it be 1 n, 10 cm, or 100 cm. The shape l position of the curve for dif- ent spacings will, of course, y, but the lowest point of any ve will be exactly 342 v., where gas between electrodes is air. himum sparking potential for er gases is not identical with t of air.

Boiled down to its essential fact, ular theory holds that a gas will ize most readily when a certain imum number of gas molecules sts between the electrodes. When s number is decreased, electrons not pass from one electrode to other readily, because of the rcity of gas particles which could form an ionized path. On the other hand, when there is a large number of molecules, the electrons collide too frequently with them, losing most of their speed, and thus never reaching the opposite plate.



Tank circuit utilizes vacuum capacitor of Eitel-McCullough design. Internal construction features rigidity for the maintenance of stable capacitance values

Obviously, from Fig. 1, very high break-down gradients can be reached with short electrode spacings and low atmospheric pressures. Millikan suceeded in obtaining breakdown ratings as high as 600,-000 v. per mm in high vacuum. Air at normal pressure (76 cm of mercury) and 25 deg. C is rated at about 3,000 v. per mm., (Townsend) assuming a uniform electrostatic field. Certain grades of good mica, 3 mm thick, are rated at 58,000 v. per mm.[4] and polymerized styrene of the same thickness, about 2,400 v. per mm.



. 1. Curves show that sparking in air er various pressures, about parallel- plates, always takes place at 342 v

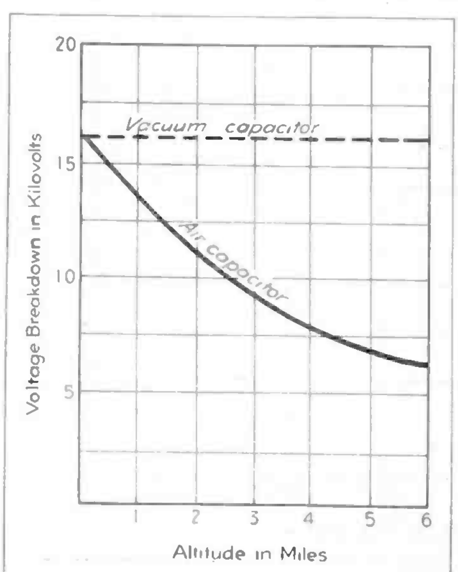


FIG. 2. Altitude-voltage breakdown curves for vacuum and air capacitors demonstrate the former's advantage for use in aircraft

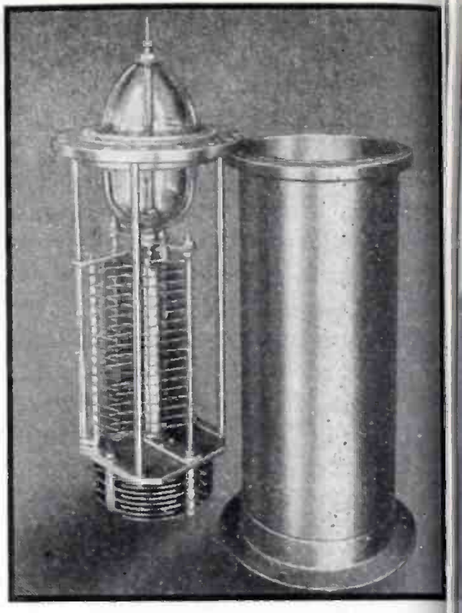
Altitude Reduces Breakdown Voltage

As shown in Fig. 2, flashover ratings of air capacitors decrease with a rise in altitude. Also, an increase of humidity causes a thin film of moisture to form on the plates and spacing insulators of a typical air capacitor, thus appreciably affecting the flash-over voltage. This humidity-voltage variation may be as much as 7 percent in practice.[5] Corona losses, too, become an important consideration as the decreasing breakdown rating approaches applied voltage in an

aircraft capacitor. Absence of internal corona and stability of voltage ratings make vacuum capacitors well suited to aircraft applications.

Where a capacitor has a solid dielectric such as mica, breakdown potential varies with the frequency of applied voltage, temperature of the material, moisture present, and thickness of dielectric. Somewhat irregular ratings are often the case at higher frequencies because of the difficulty about placing a solid dielectric in perfect contact with the plates—even under great pressure. Where high rf potentials are involved and where a small lumped capacitance is required, the vacuum unit is more satisfactory than most other types because of its smaller size and more stable breakdown rating.

Pressurized, gas-filled capacitors made by E. F. Johnson Co. follow a basic design. Fixed and variable units both have copper-plated, drawn-steel shells in 6-in. diam. Miter-gear drive serves on variable version shown here



Disposition of internal elements is here illustrated for an early Johnson pressure capacitor. This type is described as partially variable. Diameter is 10 in. and the shell is thick-walled, seamless, and heavily copper plated

Power Loss Factors

Dielectric of most capacitors has a dual or multiple nature, and no solid or liquid material is completely free from power loss. For example, in a typical mica capacitor, there is mica between the plates, and there is also some insulator such as a plastic or ceramic material in contact with the leads. The general effect of this outer insulator can usually be disregarded, except at ultrahigh frequencies or in devices of very small capacitance. In vacuum units, the glass envelope acts as an outer dielectric, but the area of contact with the end-cups is so small, and the dielectric path so long, that the effects of the glass are negligible. For all practical purposes, the high vacuum can be considered the sole dielectric, and the capacitor has an exceptionally high Q.

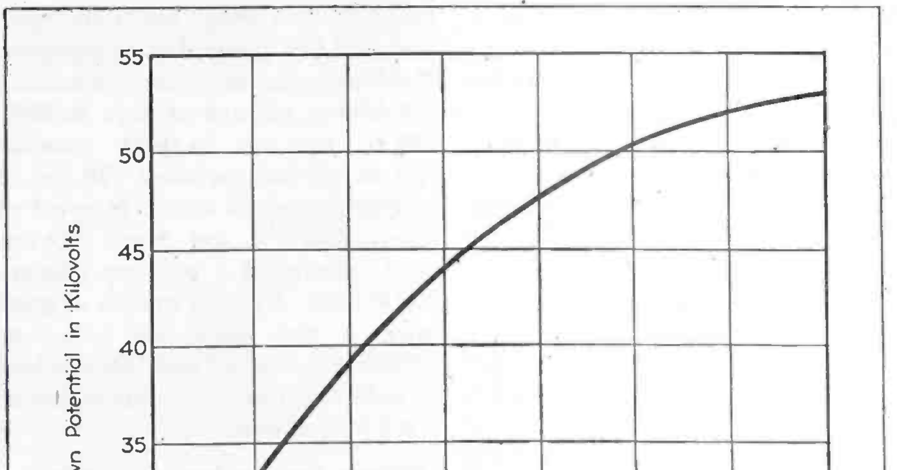


FIG. 3. Rise in breakdown potential with pressure increase in this curve results from greater opportunities for collision between a travelling electron and nitrogen molecules as more of them occupy a given space. This inhibits ionization

Power losses of solid and liquid insulators include those due to insulation resistance, dielectric absorption, and hysteresis. These losses are a function of frequency, rising sharply at very short wavelengths. Loss factor is probably the best criterion of the efficiency of a capacitor, and can be found by multiplying the dielectric constant by the power factor. Phase displacement due to the glass and high vacuum dielectrics of a vacuum capacitor is obviously very slight, resulting in a low loss angle and a correspondingly-low loss factor. Resistance of the plates and leads, skin effect, and eddy currents are other minor sources of power loss, but dielectric absorption and hysteresis losses in this kind of capacitor are approximately nil.

There is, then, an extremely high ratio of susceptance to conductance, because of low dielectric loss. The only other possibility of power loss would be a conduction current of an ionic character through the

...ro sizes of Lapp Insulator Co. pressurized capacitors show aluminum ...als, gear head drives, and indicator ...essure gages. Also featured are adjustable provisions for external flashover

...ges of gas between the plates. ...is occurs, however, only at dc or ...-frequency audio voltages above ...00 v. At higher audio frequen...s, this power loss disappears. ...al resistance losses in a vacuum ...acitor have been found to be ...ligible up to 50 Mc or more. ...e unusually high Q of this type ...kes it useful for tank circuits of ...diotelephone transmitters, where ...of the resonant circuit must be ...ge enough to avoid splatter of the ...nal due to amplification of stray ...monics.

Frequency Affects Capacitance

...t frequencies below about 50 ..., the capacitance of any unit ...eglecting edge effects) depends ...ly upon the type of dielectric, ... effective surface area of the ...tes, and the spacing between ...m. However, the permittivity ...practically all insulators varies ...ewhat when a voltage of very ...h frequency is applied. This ...iation may be the result of a ...nge in volume of the insulator ... to electrostriction or electro...ic heating, evaporation of ad...bed moisture, or possibly other ...tors.[1] The only exceptions are ...w types of solid materials, such ...polymerized styrene, whose di...tric constant is virtually inde...dent of frequency over a wide ...ge.

Fluctuation of permittivity is not the only cause of frequency variation of capacitance, however. For example, typical variable air capacitors are relatively stable, but their capacitance is likely to be affected somewhat by atmospheric moisture, temperature change, age and vibration. The dielectric constant of dry air at normal pressure is about 1.000585,[1] and that of water, about 85. Thus, a slight increase of humidity will raise the capacitance of such a unit. The dielectric constant of the vacuum capacitor is probably very close to 1, and is materially unaffected by external factors.

Mechanical Structure

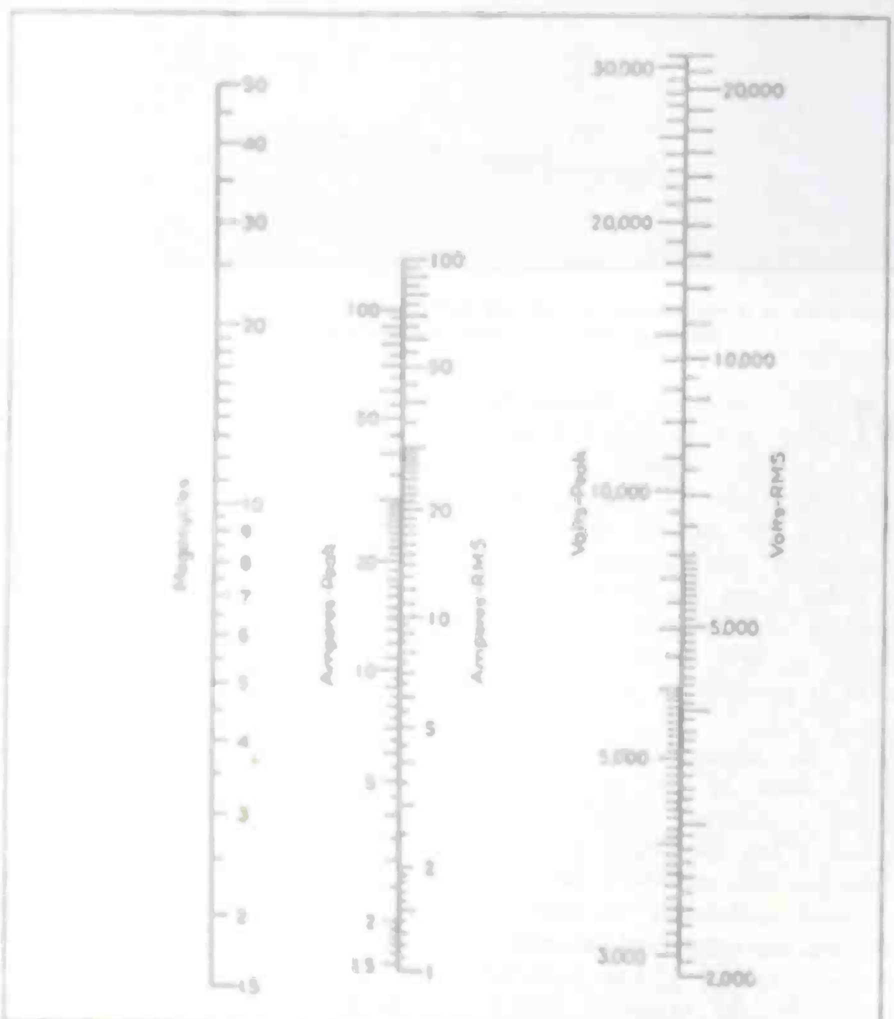
Certain types of vacuum capacitors are designed so that thermal expansion of the boro-silicate glass is the same as that of the metal end-cups which are iron-nickel-cobalt alloy. This careful matching of temperature coefficients prevents change of capacitance with temperature. Rugged, cylindrical-plate construction also leads to more stable values than those of clamped, parallel-plate, air units. These are usually subject to stresses in the insulating supports due to vibration, aging, or bending of plates.

Geometric capacitance is not identical with effective capacitance—the value actually used in practice. For example, equivalent series capacitance of an air, vacuum, or pressure unit is given by the equation

$$C_e = \frac{C}{1 - LC\omega^2} \quad (1)$$

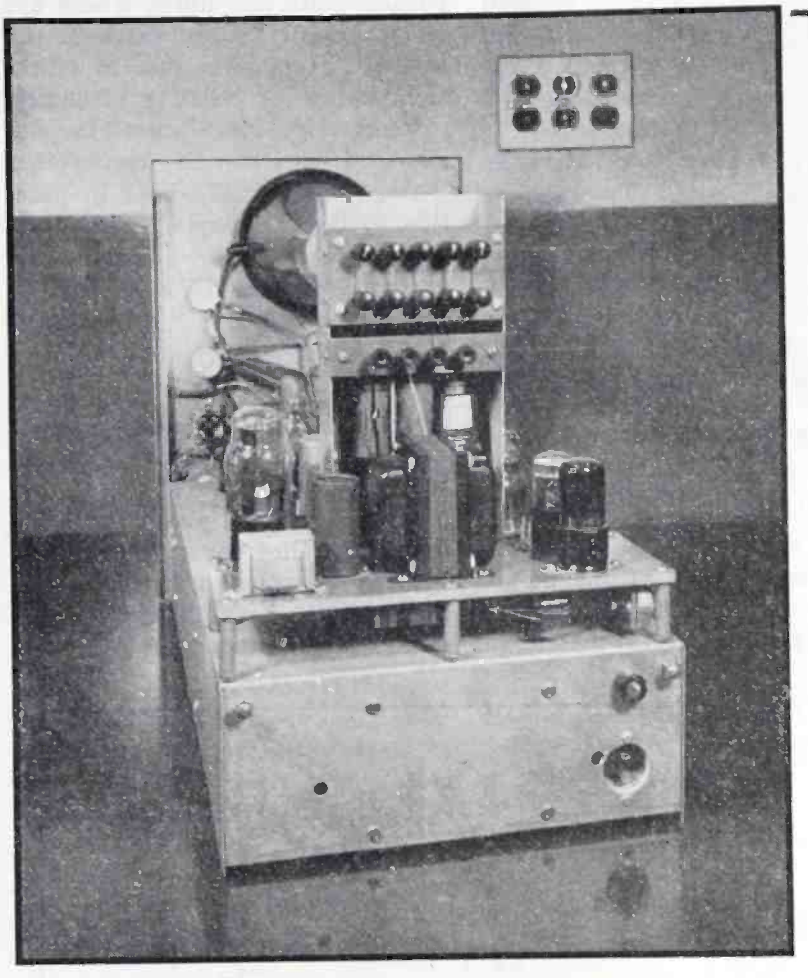
where C is total geometric capacitance, L is inductance of the plates and leads, and $\omega = 2\pi f$. From this it can be seen that plates and leads of the capacitor cause a rise in effective capacitance with increasing frequency. A good quality variable

(Continued on page 320)



Relationships between current, voltage, and frequency for 50μμf vacuum capacitors of the types in an accompanying illustration are established for reference on this nomograph. Straight line passing through any two factors reveals the third

Beam Blanking



Rear view of a commercial cathode-ray oscilloscope in which the beam-blanking circuit has been incorporated

A three-tube electronic unit permits photographing a complete transient trace on a cathode-ray oscilloscope screen with high detail and no fogging. Arrival of transient trips a trigger circuit, releasing the blanked beam, and provides a dotted "Z" timing wave

By WALTHER RICHTER

Allis-Chalmers Manufacturing Co., Milwaukee, Wisc.

MOST modern cathode-ray tubes are provided with a grid by means of which it is possible to interrupt the electron beam producing the spot on the screen. Commercial oscilloscopes containing these tubes are provided with a control which applies a negative voltage to this control grid and makes it possible to interrupt the beam at will.

For the photography of transients, some of the instruments provide a so-called "single-sweep" feature. When the single-sweep circuit is put into operation, the beam is biased sufficiently so that the spot does not appear on the screen, but the starting of the transient or any desired tripping impulse is used to sweep the spot across the screen just once. This is a highly desirable addition, but there are two points which prove to be somewhat undesirable.

First, even with the beam biased so as not to strike the screen, there are scattered electrons striking the screen, leading to a reasonably strong background illumination. If for any reason the camera shutter has to be opened an appreciable time before the expected transient begins, an undesirable amount of fogging of the film takes place.

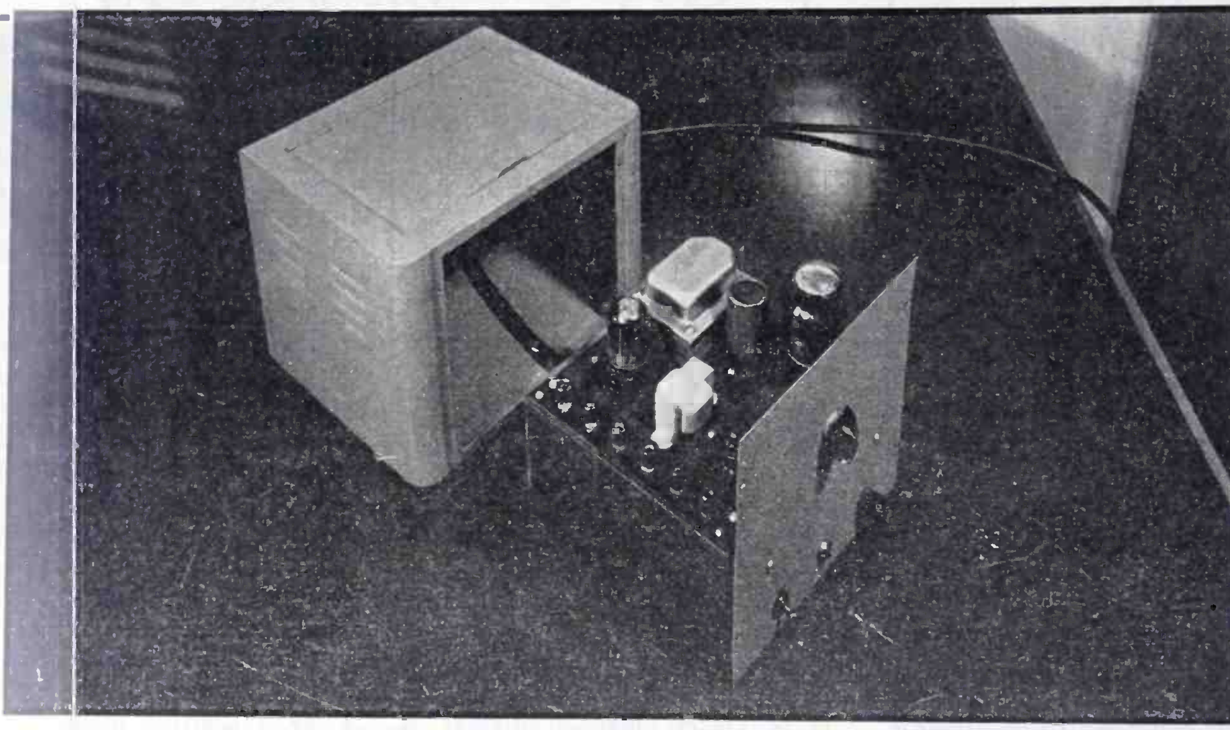
Secondly, if it is desired to obtain a picture of the complete transient, then it is of course necessary to adjust the rate of the single sweep to such a value that the time taken by one sweep is equal to the total time of the transient. The resulting oscillogram can therefore not be any longer than a single sweep. It is quite obvious that considerable detail of the transient may become lost in the picture due to the need of compressing it into a single sweep.

Suppose now that instead of only one, we permit five sweeps, with the rate of sweep adjusted to such a value that one sweep will take place in a time equal to one-fifth of the time of the transient, or in other words, the time of five sweeps will equal the duration of the transient. The oscillogram will then consist of five branches, each one representing one-fifth of the transient.

An example of a transient as it would appear with a single sweep appears in Fig. 1(a), while Fig. 1(b) shows this same transient spread over five sweeps. Corresponding segments in the two traces are similarly marked.

With the number of sweeps limited to a reasonable value, such as 5, there is usually no difficulty in piecing the individual branches properly to each other since the displacement from the zero line and the slope must be the same at the right and left hand edges of the oscillogram. The piecing together of the segments may be further facilitated by having enough brilliancy so that the return sweep produces a faint trace which then connects the proper branches with each other. It is

Circuit for Oscilloscopes



Complete beam-blanking equipment built as a separate unit for use with any oscilloscope

ident tha such a picture will veal finer detail of the transient.

Film ogging Problem

It is entiely feasible to obtain is result y designing an elecnic circu that will make the eep reper itself for a definite mber of cles, but this still does t remove he possibility of fogng. Therore a more desirable ution woid be one in which the eep oper es continuously, and e beam is released only for the sired expcure. In principle, this a rather simple procedure; all e has to) is to keep the grid the cathoe-ray tube sufficiently gative to cause cut-off of the am, and reuce this negative bias the prope value for the time of posure.

From a pactical point of view, wever, the is a serious handi- standing n the way of an easy ution, due to the following con- ion: wher operating a cathode- tube, e average potential the defle ion plates should be ar the ance potential. This con- ion is ordiarily met by placing anode othe cathode-ray tube or near gund potential, which in turn places the cathode at a negative potential amounting to a thousand volts or more with respect to ground. Since the grid must be made negative with respect to the cathode, this means that the operating potential of the grid is also one to several thousand volts negative with respect to ground.

Insulating Problems

With this in mind, it is clear that the problem of shifting the grid potential with respect to the cathode by 100 volts or so is not too easy. One could install a relay, the coil of which would be insulated sufficiently from the contact structure and by means of which the grid voltage could be shifted from one value to another, but any mechanical device of this nature with its mechanical and electrical inertia and the possibility of bouncing contacts is practically ruled out.

The circuit described in the following paragraphs is nothing but a trigger circuit which can be tripped by an impulse transmitted through a capacitor to the proper point in the circuit. The whole trigger circuit and its power supply is insulated from ground for a voltage equal to the operating voltage of the cathode-ray tube. The components are mounted on an insulating panel or on a steel chassis which in turn is insulated from its housing or from the chassis of the oscilloscope.

The only special component needed is a power transformer for the trigger circuit, the primary winding of which is insulated from the core and the other windings for a voltage equal to the operating voltage of the cathode-ray tube. If such a transformer is not available, a 1:1 insulating transformer may be employed which permits the use of any standard small power transformer for the trigger circuit.

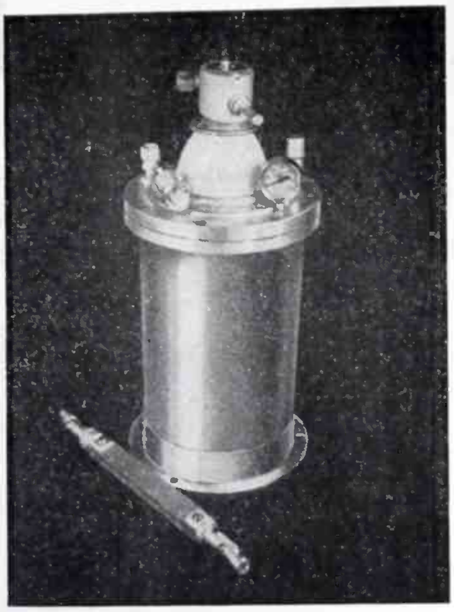
Provisions are also made to apply a dotting or "Z" signal to the grid of the cathode-ray tube. The circuit is so arranged that dotting and tripping do not interfere with each other.

Operation of Trigger Circuit

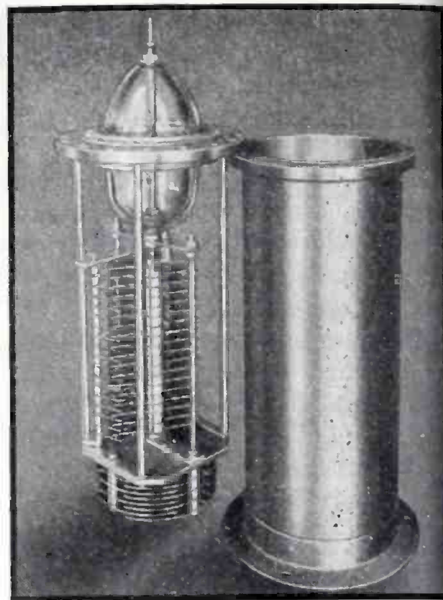
Figure 2 shows the diagram of the complete circuit. The tripping circuit consists of a double triode, VT_1, which with its associated resistors R_1, R_2, R_3, and R_1', R_2' and R_3' forms a trigger circuit. When one

aircraft capacitor. Absence of internal corona and stability of voltage ratings make vacuum capacitors well suited to aircraft applications.

Where a capacitor has a solid dielectric such as mica, breakdown potential varies with the frequency of applied voltage, temperature of the material, moisture present, and thickness of dielectric. Somewhat irregular ratings are often the case at higher frequencies because of the difficulty about placing a solid dielectric in perfect contact with the plates—even under great pressure. Where high rf potentials are involved and where a small lumped capacitance is required, the vacuum unit is more satisfactory than most other types because of its smaller size and more stable breakdown rating.



Pressurized, gas-filled capacitors made by E. F. Johnson Co. follow a basic design. Fixed and variable units both have copper-plated, drawn-steel shells in 6-in. diam. Miter-gear drive serves on variable version shown here



Disposition of internal elements is here illustrated for an early Johnson pressure capacitor. This type is described as partially variable. Diameter is 10 in. and the shell is thick-walled, seamless, and heavily copper plated

Power Loss Factors

Dielectric of most capacitors has a dual or multiple nature, and no solid or liquid material is completely free from power loss. For example, in a typical mica capacitor, there is mica between the plates, and there is also some insulator such as a plastic or ceramic material in contact with the leads. The general effect of this outer insulator can usually be disregarded, except at ultrahigh frequencies or in devices of very small capacitance. In vacuum units, the glass envelope acts as an outer dielectric, but the area of contact with the end-cups is so small, and the dielectric path so long, that the effects of the glass are negligible. For all practical purposes, the high vacuum can be considered the sole dielectric, and the capacitor has an exceptionally high Q.

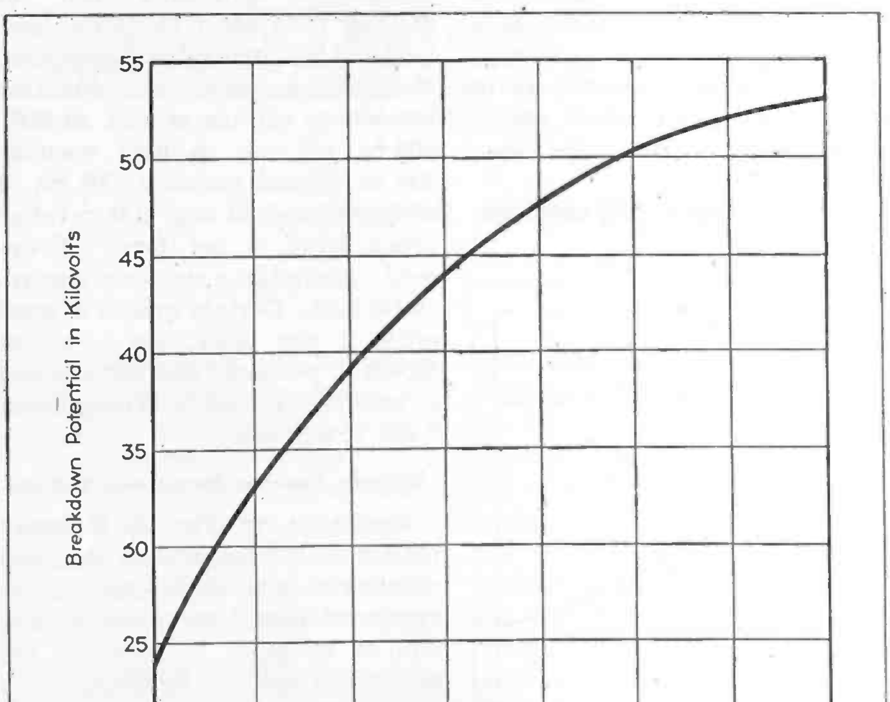
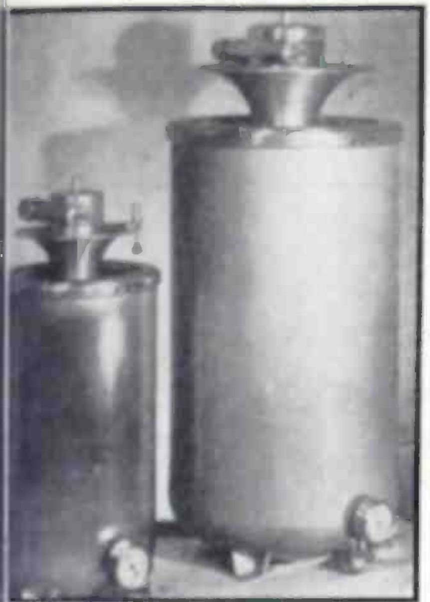


FIG. 3. Rise in breakdown potential with pressure increase in this curve results from greater opportunities for collision between a travelling electron and nitrogen molecules as more of them occupy a given space. This inhibits ionization

Power losses of solid and liquid insulators include those due to insulation resistance, dielectric absorption, and hysteresis. These losses are a function of frequency, rising sharply at very short wavelengths. Loss factor is probably the best criterion of the efficiency of a capacitor, and can be found by multiplying the dielectric constant by the power factor. Phase displacement due to the glass and high vacuum dielectrics of a vacuum capacitor is obviously very slight, resulting in a low loss angle and a correspondingly-low loss factor. Resistance of the plates and leads, skin effect, and eddy currents are other minor sources of power loss, but dielectric absorption and hysteresis losses in this kind of capacitor are approximately nil.

There is, then, an extremely high ratio of susceptance to conductance, because of low dielectric loss. The only other possibility of power loss would be a conduction current of an ionic character through the



wo sizes of Lapp Insulator Co. pressurized capacitors show aluminum shells, gear head drives, and indicator pressure gages. Also featured are adjustable provisions for external flash-over

...ces of gas between the plates. ...is occurs, however, only at dc or ...-frequency audio voltages above ...00 v. At higher audio frequen...s, this power loss disappears. ...tal resistance losses in a vacuum ...acitor have been found to be ...gligible up to 50 Mc or more. ...e unusually high Q of this type ...kes it useful for tank circuits of ...liotelephone transmitters, where ...of the resonant circuit must be ...ge enough to avoid splatter of the ...nal due to amplification of stray ...monics.

Frequency Affects Capacitance

...t frequencies below about 50 ..., the capacitance of any unit ...glecting edge effects) depends ...ely upon the type of dielectric, ... effective surface area of the ...tes, and the spacing between ...m. However, the permittivity ... practically all insulators varies ...newhat when a voltage of very ...h frequency is applied. This ...iation may be the result of a ...nge in volume of the insulator ... to electrostriction or electro...tic heating, evaporation of ad...bed moisture, or possibly other ...tors.[4] The only exceptions are ...ew types of solid materials, such ...polymerized styrene, whose di...tric constant is virtually inde...dent of frequency over a wide ...ge.

Fluctuation of permittivity is not the only cause of frequency variation of capacitance, however. For example, typical variable air capacitors are relatively stable, but their capacitance is likely to be affected somewhat by atmospheric moisture, temperature change, age and vibration. The dielectric constant of dry air at normal pressure is about 1.000558,[4] and that of water, about 85. Thus, a slight increase of humidity will raise the capacitance of such a unit. The dielectric constant of the vacuum capacitor is probably very close to 1, and is materially unaffected by external factors.

Mechanical Structure

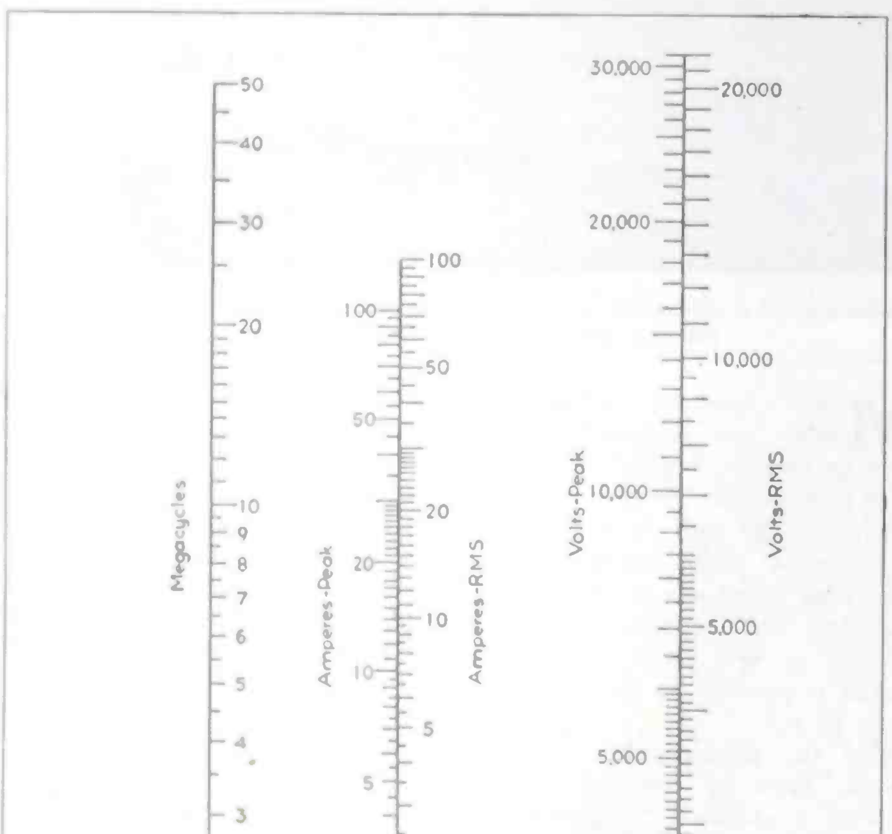
Certain types of vacuum capacitors are designed so that thermal expansion of the boro-silicate glass is the same as that of the metal end-cups which are iron-nickel-cobalt alloy. This careful matching of temperature coefficients prevents change of capacitance with temperature. Rugged, cylindrical-plate construction also leads to more stable values than those of clamped, parallel-plate, air units. These are usually subject to stresses in the insulating supports due to vibration, aging, or bending of plates.

Geometric capacitance is not identical with effective capacitance—the value actually used in practice. For example, equivalent series capacitance of an air, vacuum, or pressure unit is given by the equation

$$C_s = \frac{C}{1 - LC\,\omega^2} \qquad (1)$$

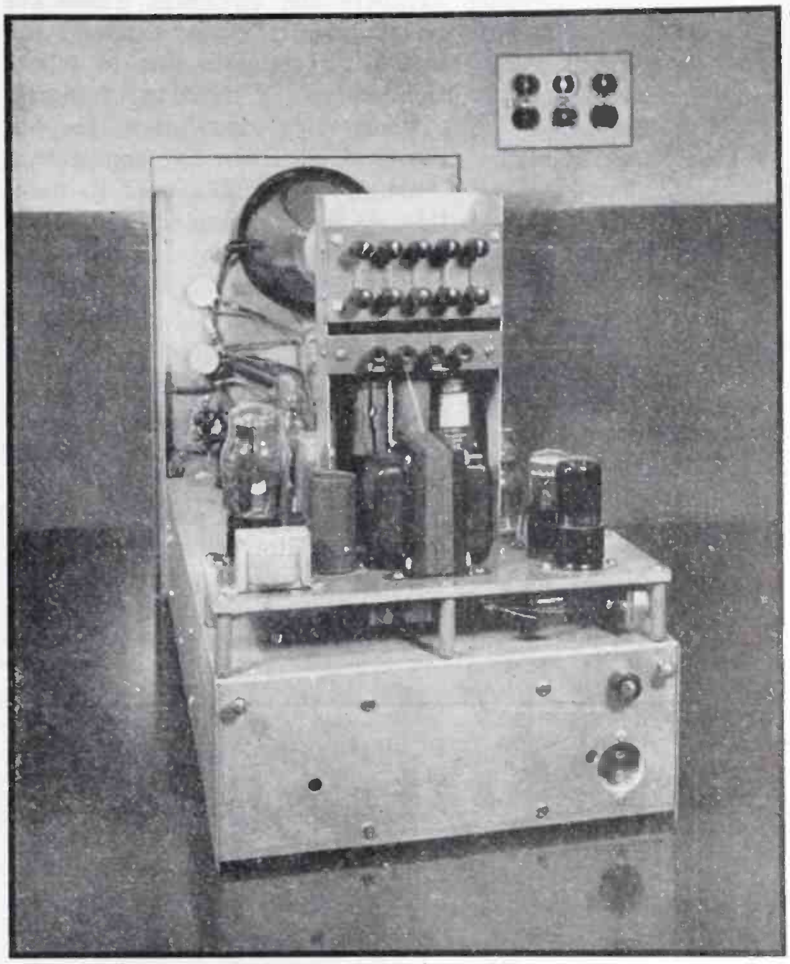
where C is total geometric capacitance, L is inductance of the plates and leads, and $\omega = 2\pi f$. From this it can be seen that plates and leads of the capacitor cause a rise in effective capacitance with increasing frequency. A good quality variable

(*Continued on page* 320)



Relationships between current, voltage, and frequency for 50$\mu\mu f$ vacuum capacitors of the types in an accompanying illustration are established for reference on this nomograph. Straight line passing through any two factors reveals the third

Beam Blanking



Rear view of a commercial cathode-ray oscilloscope in which the beam-blanking circuit has been incorporated

A three-tube electronic unit permits photographing a complete transient trace on a cathode-ray oscilloscope screen with high detail and no fogging. Arrival of transient trips a trigger circuit, releasing the blanked beam, and provides a dotted "Z" timing wave

By WALTHER RICHTER
Allis-Chalmers Manufacturing Co., Milwaukee, Wisc.

MOST modern cathode-ray tubes are provided with a grid by means of which it is possible to interrupt the electron beam producing the spot on the screen. Commercial oscilloscopes containing these tubes are provided with a control which applies a negative voltage to this control grid and makes it possible to interrupt the beam at will.

For the photography of transients, some of the instruments provide a so-called "single-sweep" feature. When the single-sweep circuit is put into operation, the beam is biased sufficiently so that the spot does not appear on the screen, but the starting of the transient or any desired tripping impulse is used to sweep the spot across the screen just once. This is a highly desirable addition, but there are two points which prove to be somewhat undesirable.

First, even with the beam biased so as not to strike the screen, there are scattered electrons striking the screen, leading to a reasonably strong background illumination. If for any reason the camera shutter has to be opened an appreciable time before the expected transient begins, an undesirable amount of fogging of the film takes place.

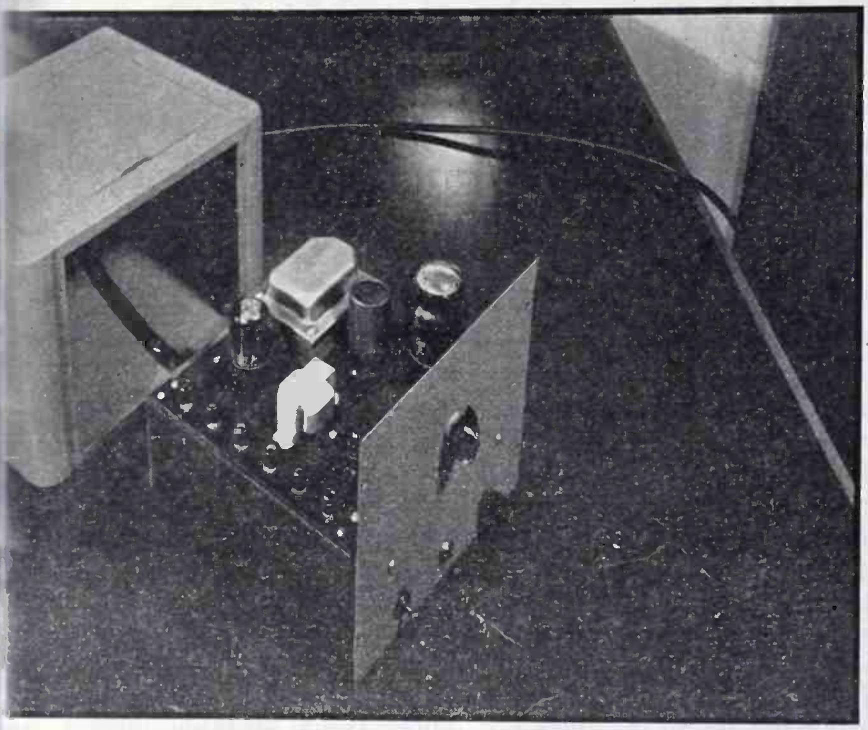
Secondly, if it is desired to obtain a picture of the complete transient, then it is of course necessary to adjust the rate of the single sweep to such a value that the time taken by one sweep is equal to the total time of the transient. The resulting oscillogram can therefore not be any longer than a single sweep. It is quite obvious that considerable detail of the transient may become lost in the picture due to the need of compressing it into a single sweep.

Suppose now that instead of only one, we permit five sweeps, with the rate of sweep adjusted to such a value that one sweep will take place in a time equal to one-fifth of the time of the transient, or in other words, the time of five sweeps will equal the duration of the transient. The oscillogram will then consist of five branches, each one representing one-fifth of the transient.

An example of a transient as it would appear with a single sweep appears in Fig. 1(a), while Fig 1(b) shows this same transient spread over five sweeps. Corresponding segments in the two traces are similarly marked.

With the number of sweeps limited to a reasonable value, such as 5, there is usually no difficulty in piecing the individual branches properly to each other since the displacement from the zero line and the slope must be the same at the right and left hand edges of the oscillogram. The piecing together of the segments may be further facilitated by having enough brilliancy so that the return sweep produces a faint trace which then connects the proper branches with each other. It is

or Oscilloscopes



uipment built as a separate unit for use with any oscilloscope

in turn places the cathode at a negative potential amounting to a thousand volts or more with respect to ground. Since the grid must be made negative with respect to the cathode, this means that the operating potential of the grid is also one to several thousand volts negative with respect to ground.

Insulating Problems

With this in mind, it is clear that the problem of shifting the grid potential with respect to the cathode by 100 volts or so is not too easy. One could install a relay, the coil of which would be insulated sufficiently from the contact structure and by means of which the grid voltage could be shifted from one value to another, but any mechanical device of this nature with its mechanical and electrical inertia and the possibility of bouncing contacts is practically ruled out.

The circuit described in the following paragraphs is nothing but a trigger circuit which can be tripped by an impulse transmitted through a capacitor to the proper point in the circuit. The whole trigger circuit and its power supply is insulated from ground for a voltage equal to the operating voltage of the cathode-ray tube. The components are mounted on an insulating panel or on a steel chassis which in turn is insulated from its housing or from the chassis of the oscilloscope.

The only special component needed is a power transformer for the trigger circuit, the primary winding of which is insulated from the core and the other windings for a voltage equal to the operating voltage of the cathode-ray tube. If such a transformer is not available, a 1:1 insulating transformer may be employed which permits the use of any standard small power transformer for the trigger circuit.

Provisions are also made to apply a dotting or "Z" signal to the grid of the cathode-ray tube. The circuit is so arranged that dotting and tripping do not interfere with each other.

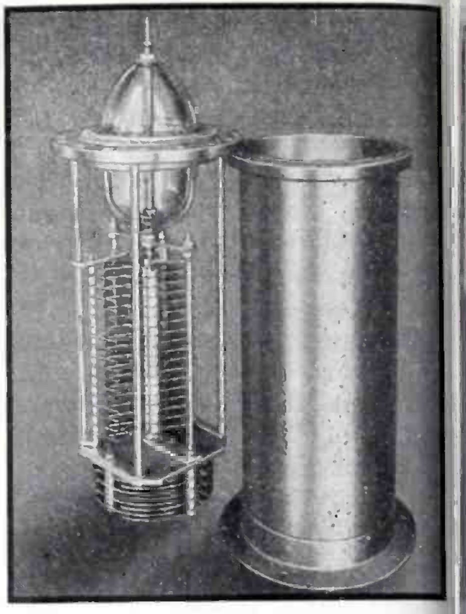
Operation of Trigger Circuit

Figure 2 shows the diagram of the complete circuit. The tripping circuit consists of a double triode, VT_1, which with its associated resistors R_1, R_2, R_3, and R_1', R_2' and R_3' forms a trigger circuit. When one

aircraft capacitor. Absence of internal corona and stability of voltage ratings make vacuum capacitors well suited to aircraft applications.

Where a capacitor has a solid dielectric such as mica, breakdown potential varies with the frequency of applied voltage, temperature of the material, moisture present, and thickness of dielectric. Somewhat irregular ratings are often the case at higher frequencies because of the difficulty about placing a solid dielectric in perfect contact with the plates—even under great pressure. Where high rf potentials are involved and where a small lumped capacitance is required, the vacuum unit is more satisfactory than most other types because of its smaller size and more stable breakdown rating.

Pressurized, gas-filled capacitors made by E. F. Johnson Co. follow a basic design. Fixed and variable units both have copper-plated, drawn-steel shells in 6-in. diam. Miter-gear drive serves on variable version shown here



Disposition of internal elements is here illustrated for an early Johnson pressure capacitor. This type is described as partially variable. Diameter is 10 in. and the shell is thick-walled, seamless, and heavily copper plated

Power Loss Factors

Dielectric of most capacitors has a dual or multiple nature, and no solid or liquid material is completely free from power loss. For example, in a typical mica capacitor, there is mica between the plates, and there is also some insulator such as a plastic or ceramic material in contact with the leads. The general effect of this outer insulator can usually be disregarded, except at ultrahigh frequencies or in devices of very small capacitance. In vacuum units, the glass envelope acts as an outer dielectric, but the area of contact with the end-cups is so small, and the dielectric path so long, that the effects of the glass are negligible. For all practical purposes, the high vacuum can be considered the sole dielectric, and the capacitor has an exceptionally high Q.

Power losses of solid and liquid insulators include those due to insulation resistance, dielectric absorption, and hysteresis. These losses are a function of frequency, rising sharply at very short wavelengths. Loss factor is probably the best criterion of the efficiency of a capacitor, and can be found by multiplying the dielectric constant by the power factor. Phase displacement due to the glass and high vacuum dielectrics of a vacuum capacitor is obviously very slight, resulting in a low loss angle and a correspondingly-low loss factor. Resistance of the plates and leads, skin effect, and eddy currents are other minor sources of power loss, but dielectric absorption and hysteresis losses in this kind of capacitor are approximately nil.

There is, then, an extremely high ratio of susceptance to conductance, because of low dielectric loss. The only other possibility of power loss would be a conduction current of an ionic character through the

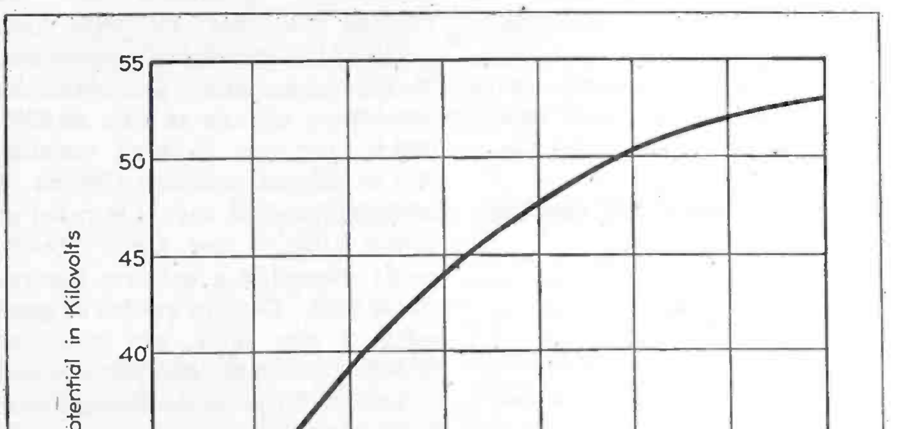
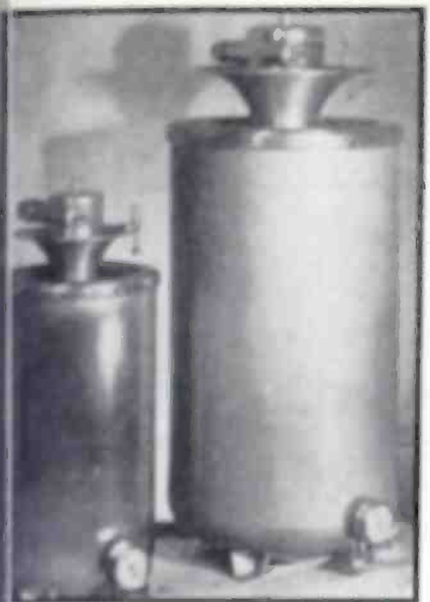


FIG. 3. Rise in breakdown potential with pressure increase in this curve results from greater opportunities for collision between a travelling electron and nitrogen molecules as more of them occupy a given space. This inhibits ionization



...wo sizes of Lapp Insulator Co. pressurized capacitors show aluminum shells, gear head drives, and indicator pressure gauges. Also featured are adjustable provisions for external flash-over

...ures of gas between the plates. ...is occurs, however, only at dc or ...-frequency audio voltages above ...00 v. At higher audio frequen...s, this power loss disappears. ...al resistance losses in a vacuum ...acitor have been found to be ...ligible up to 80 Mc or more. ...e unusually high Q of this type ...kes it useful for tank circuits of ...iotelephone transmitters, where ...of the resonant circuit must be ...h enough to avoid splatter of the ...nal due to amplification of stray ...monics.

Frequency Affects Capacitance

At frequencies below about 50 ... the capacitance of any unit ...glecting edge effects) depends ...ly upon the type of dielectric, ... effective surface area of the ...tes, and the spacing between ...m. However, the permittivity ...practically all insulators varies ...ewhat when a voltage of very ...h frequency is applied. This ...iation may be the result of a ...nge in volume of the insulator ... to electrostriction or electro...ic heating, evaporation of ad...ed moisture, or possibly other ...tors.[1] The only exceptions are ...w types of solid materials, such ...polymerized styrene, whose di...tric constant is virtually inde...dent of frequency over a wide ...ge.

Fluctuation of permittivity is not the only cause of frequency variation of capacitance, however. For example, typical variable air capacitors are relatively stable, but their capacitance is likely to be affected somewhat by atmospheric moisture, temperature change, age and vibration. The dielectric constant of dry air at normal pressure is about 1.000558,[3] and that of water, about 85. Thus, a slight increase of humidity will raise the capacitance of such a unit. The dielectric constant of the vacuum capacitor is probably very close to 1, and is materially unaffected by external factors.

Mechanical Structure

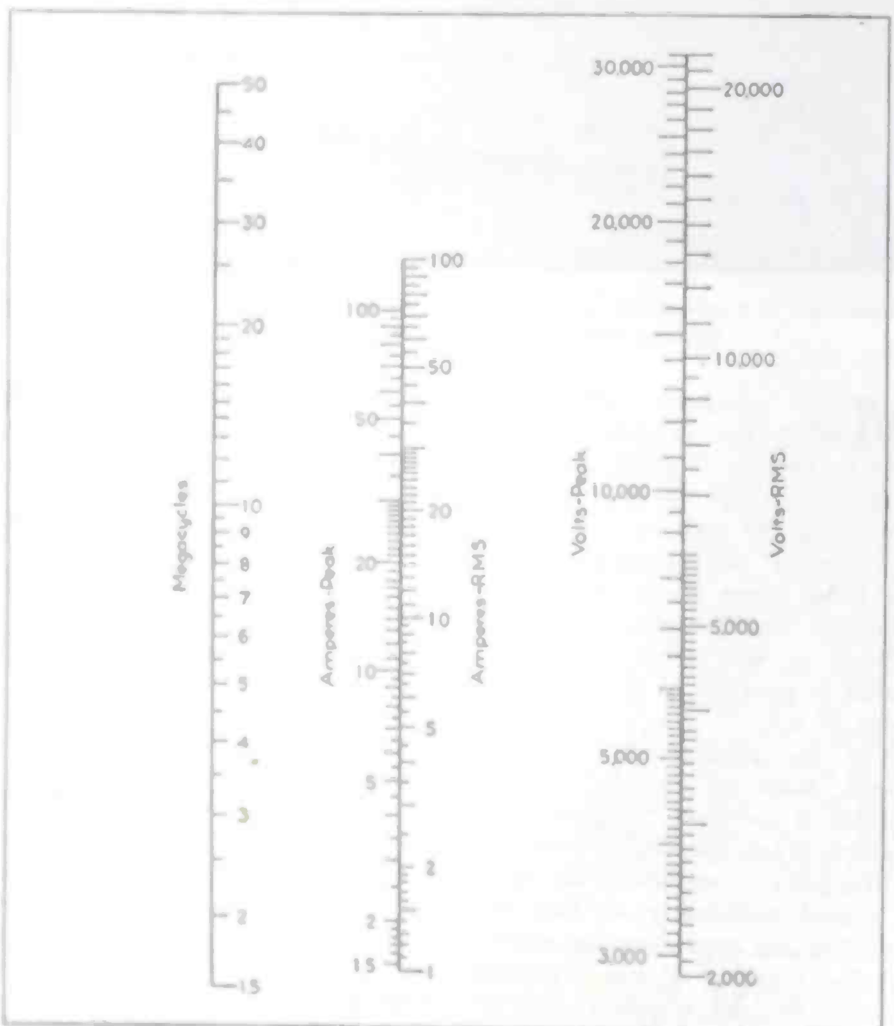
Certain types of vacuum capacitors are designed so that thermal expansion of the boro-silicate glass is the same as that of the metal end-cups which are iron-nickel-cobalt alloy. This careful matching of temperature coefficients prevents change of capacitance with temperature. Rugged, cylindrical-plate construction also leads to more stable values than those of clamped, parallel-plate, air units. These are usually subject to stresses in the insulating supports due to vibration, aging, or bending of plates.

Geometric capacitance is not identical with effective capacitance—the value actually used in practice. For example, equivalent series capacitance of an air, vacuum, or pressure unit is given by the equation

$$C_e = \frac{C}{1 - LC\,\omega^2} \qquad (1)$$

where C is total geometric capacitance, L is inductance of the plates and leads, and $\omega = 2\pi f$. From this it can be seen that plates and leads of the capacitor cause a rise in effective capacitance with increasing frequency. A good quality variable

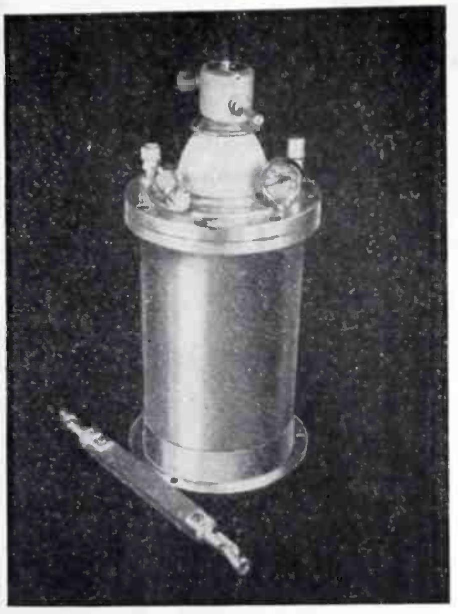
(*Continued on page* 320)



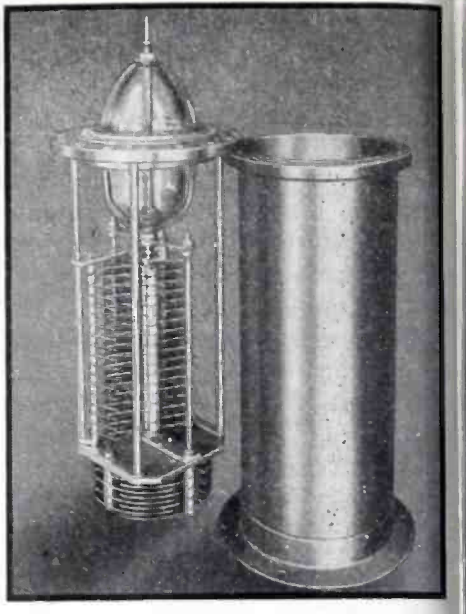
Relationships between current, voltage, and frequency for 50$\mu\mu f$ vacuum capacitors of the types in an accompanying illustration are established for reference on this nomograph. Straight line passing through any two factors reveals the third

aircraft capacitor. Absence of internal corona and stability of voltage ratings make vacuum capacitors well suited to aircraft applications.

Where a capacitor has a solid dielectric such as mica, breakdown potential varies with the frequency of applied voltage, temperature of the material, moisture present, and thickness of dielectric. Somewhat irregular ratings are often the case at higher frequencies because of the difficulty about placing a solid dielectric in perfect contact with the plates—even under great pressure. Where high rf potentials are involved and where a small lumped capacitance is required, the vacuum unit is more satisfactory than most other types because of its smaller size and more stable breakdown rating.



Pressurized, gas-filled capacitors made by E. F. Johnson Co. follow a basic design. Fixed and variable units both have copper-plated, drawn-steel shells in 6-in. diam. Miter-gear drive serves on variable version shown here



Disposition of internal elements is here illustrated for an early Johnson pressure capacitor. This type is described as partially variable. Diameter is 10 in. and the shell is thick-walled, seamless, and heavily copper plated

Power Loss Factors

Dielectric of most capacitors has a dual or multiple nature, and no solid or liquid material is completely free from power loss. For example, in a typical mica capacitor, there is mica between the plates, and there is also some insulator such as a plastic or ceramic material in contact with the leads. The general effect of this outer insulator can usually be disregarded, except at ultrahigh frequencies or in devices of very small capacitance. In vacuum units, the glass envelope acts as an outer dielectric, but the area of contact with the end-cups is so small, and the dielectric path so long, that the effects of the glass are negligible. For all practical purposes, the high vacuum can be considered the sole dielectric, and the capacitor has an exceptionally high Q.

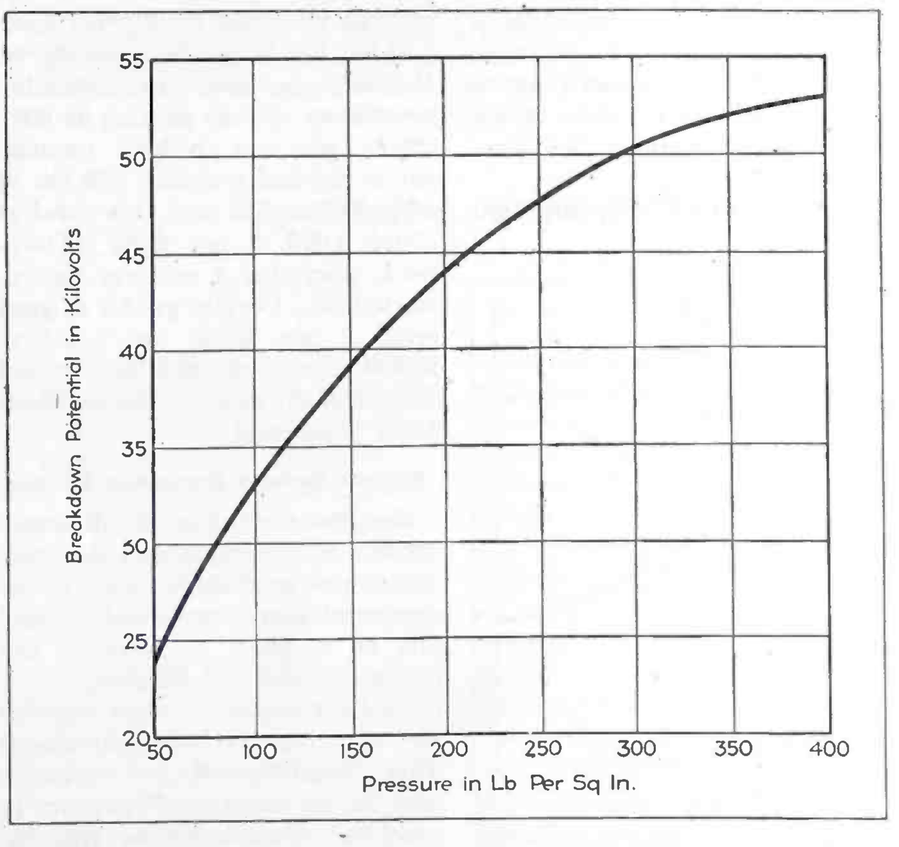


FIG. 3. Rise in breakdown potential with pressure increase in this curve results from greater opportunities for collision between a travelling electron and nitrogen molecules as more of them occupy a given space. This inhibits ionization

Power losses of solid and liquid insulators include those due to insulation resistance, dielectric absorption, and hysteresis. These losses are a function of frequency, rising sharply at very short wavelengths. Loss factor is probably the best criterion of the efficiency of a capacitor, and can be found by multiplying the dielectric constant by the power factor. Phase displacement due to the glass and high vacuum dielectrics of a vacuum capacitor is obviously very slight, resulting in a low loss angle and a correspondingly-low loss factor. Resistance of the plates and leads, skin effect, and eddy currents are other minor sources of power loss, but dielectric absorption and hysteresis losses in this kind of capacitor are approximately nil.

There is, then, an extremely high ratio of susceptance to conductance, because of low dielectric loss. The only other possibility of power loss would be a conduction current of an ionic character through the

wo sizes of Lapp Insulator Co. pres-urized capacitors show aluminum hells, gear head drives, and indicator ressure gages. Also featured are ad-ustable provisions for external flash-over

ices of gas between the plates. is occurs, however, only at dc or v-frequency audio voltages above 00 v. At higher audio frequen-s, this power loss disappears. tal resistance losses in a vacuum pacitor have been found to be gligible up to 50 Mc or more. e unusually high Q of this type kes it useful for tank circuits of liotelephone transmitters, where of the resonant circuit must be ge enough to avoid splatter of the nal due to amplification of stray rmonics.

Frequency Affects Capacitance

At frequencies below about 50 , the capacitance of any unit eglecting edge effects) depends ely upon the type of dielectric, effective surface area of the tes, and the spacing between m. However, the permittivity practically all insulators varies newhat when a voltage of very h frequency is applied. This iation may be the result of a inge in volume of the insulator to electrostriction or electro-tic heating, evaporation of ad-bed moisture, or possibly other tors.[4] The only exceptions are ew types of solid materials, such polymerized styrene, whose di-tric constant is virtually inde-ident of frequency over a wide ge.

Fluctuation of permittivity is not the only cause of frequency variation of capacitance, however. For example, typical variable air capacitors are relatively stable, but their capacitance is likely to be affected somewhat by atmospheric moisture, temperature change, age and vibration. The dielectric constant of dry air at normal pressure is about 1.000558,[6] and that of water, about 85. Thus, a slight increase of humidity will raise the capacitance of such a unit. The dielectric constant of the vacuum capacitor is probably very close to 1, and is materially unaffected by external factors.

Mechanical Structure

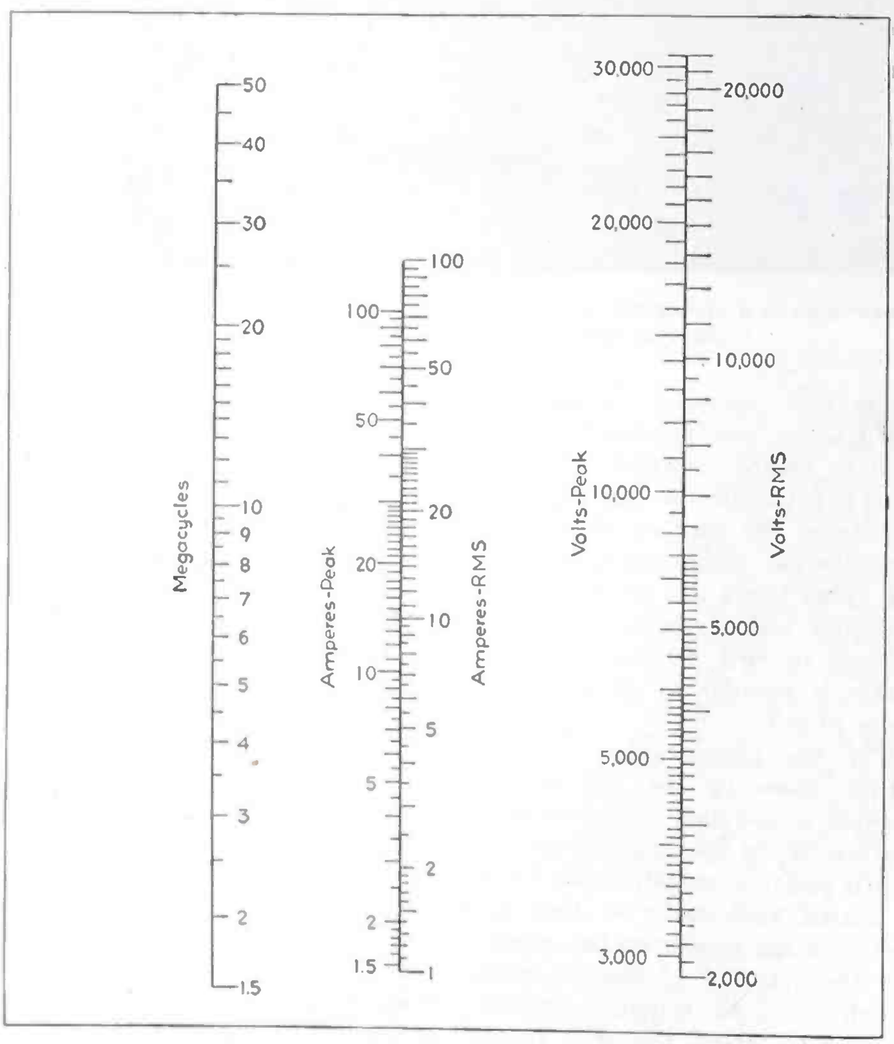
Certain types of vacuum capacitors are designed so that thermal expansion of the boro-silicate glass is the same as that of the metal end-cups which are iron-nickel-cobalt alloy. This careful matching of temperature coefficients prevents change of capacitance with temperature. Rugged, cylindrical-plate construction also leads to more stable values than those of clamped, parallel-plate, air units. These are usually subject to stresses in the insulating supports due to vibration, aging, or bending of plates.

Geometric capacitance is not identical with effective capacitance —the value actually used in practice. For example, equivalent series capacitance of an air, vacuum, or pressure unit is given by the equation

$$C_e = \frac{C}{1 - LC\,\omega^2} \qquad (1)$$

where C is total geometric capacitance, L is inductance of the plates and leads, and $\omega = 2\pi f$. From this it can be seen that plates and leads of the capacitor cause a rise in effective capacitance with increasing frequency. A good quality variable

(*Continued on page* 320)

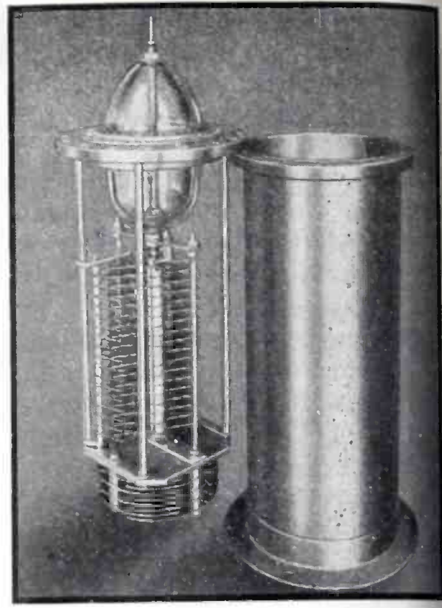


Relationships between current, voltage, and frequency for 50$\mu\mu f$ vacuum capacitors of the types in an accompanying illustration are established for reference on this nomograph. Straight line passing through any two factors reveals the third

aircraft capacitor. Absence of internal corona and stability of voltage ratings make vacuum capacitors well suited to aircraft applications.

Where a capacitor has a solid dielectric such as mica, breakdown potential varies with the frequency of applied voltage, temperature of the material, moisture present, and thickness of dielectric. Somewhat irregular ratings are often the case at higher frequencies because of the difficulty about placing a solid dielectric in perfect contact with the plates—even under great pressure. Where high rf potentials are involved and where a small lumped capacitance is required, the vacuum unit is more satisfactory than most other types because of its smaller size and more stable breakdown rating.

Pressurized, gas-filled capacitors made by E. F. Johnson Co. follow a basic design. Fixed and variable units both have copper-plated, drawn-steel shells in 6-in. diam. Miter-gear drive serves on variable version shown here



Disposition of internal elements is here illustrated for an early Johnson pressure capacitor. This type is described as partially variable. Diameter is 10 in. and the shell is thick-walled, seamless, and heavily copper plated

Power Loss Factors

Dielectric of most capacitors has a dual or multiple nature, and no solid or liquid material is completely free from power loss. For example, in a typical mica capacitor, there is mica between the plates, and there is also some insulator such as a plastic or ceramic material in contact with the leads. The general effect of this outer insulator can usually be disregarded, except at ultrahigh frequencies or in devices of very small capacitance. In vacuum units, the glass envelope acts as an outer dielectric, but the area of contact with the end-cups is so small, and the dielectric path so long, that the effects of the glass are negligible. For all practical purposes, the high vacuum can be considered the sole dielectric, and the capacitor has an exceptionally high Q.

Power losses of solid and liquid insulators include those due to insulation resistance, dielectric absorption, and hysteresis. These losses are a function of frequency, rising sharply at very short wavelengths. Loss factor is probably the best criterion of the efficiency of a capacitor, and can be found by multiplying the dielectric constant by the power factor. Phase displacement due to the glass and high vacuum dielectrics of a vacuum capacitor is obviously very slight, resulting in a low loss angle and a correspondingly-low loss factor. Resistance of the plates and leads, skin effect, and eddy currents are other minor sources of power loss, but dielectric absorption and hysteresis losses in this kind of capacitor are approximately nil.

There is, then, an extremely high ratio of susceptance to conductance, because of low dielectric loss. The only other possibility of power loss would be a conduction current of an ionic character through the

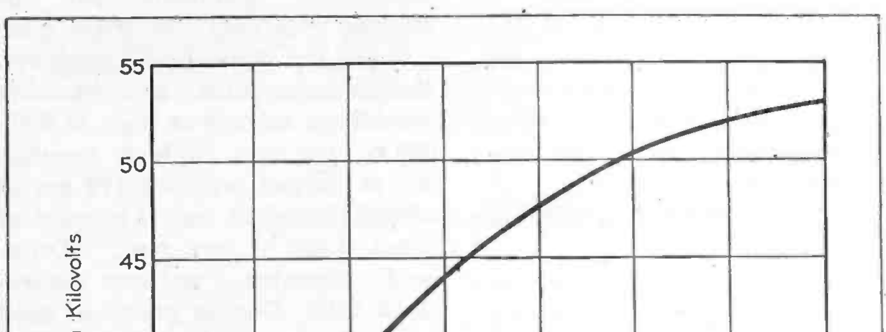


FIG. 3. Rise in breakdown potential with pressure increase in this curve results from greater opportunities for collision between a travelling electron and nitrogen molecules as more of them occupy a given space. This inhibits ionization

...o sizes of Lapp Insulator Co. pres-...ized capacitors show aluminum ...dls, gear head drives, and indicator ...ssure gages. Also featured are ad-...table provisions for external flash-over

...es of gas between the plates. ... occurs, however, only at dc or ...frequency audio voltages above ...0 v. At higher audio frequen-... this power loss disappears. ...d resistance losses in a vacuum ...citor have been found to be ...igible up to 50 Mc or more. ... unusually high Q of this type ...es it useful for tank circuits of ...otelephone transmitters, where ... the resonant circuit must be ... enough to avoid splatter of the ...al due to amplification of stray ...monics.

...requency Affects Capacitance

... frequencies below about 50 ... the capacitance of any unit ...lecting edge effects) depends ...y upon the type of dielectric, ...effective surface area of the ...s, and the spacing between ... However, the permittivity ...ractically all insulators varies ...what when a voltage of very ... frequency is applied. This ...ation may be the result of a ...ge in volume of the insulator ... to electrostriction or electro-...c heating, evaporation of ad-...ed moisture, or possibly other ...rs.[7] The only exceptions are ... types of solid materials, such ...olymerized styrene, whose di-...ric constant is virtually inde-...ent of frequency over a wide ...e.

Fluctuation of permittivity is not the only cause of frequency variation of capacitance, however. For example, typical variable air capacitors are relatively stable, but their capacitance is likely to be affected somewhat by atmospheric moisture, temperature change, age and vibration. The dielectric constant of dry air at normal pressure is about 1.000658,[8] and that of water, about 85. Thus, a slight increase of humidity will raise the capacitance of such a unit. The dielectric constant of the vacuum capacitor is probably very close to 1, and is materially unaffected by external factors.

Mechanical Structure

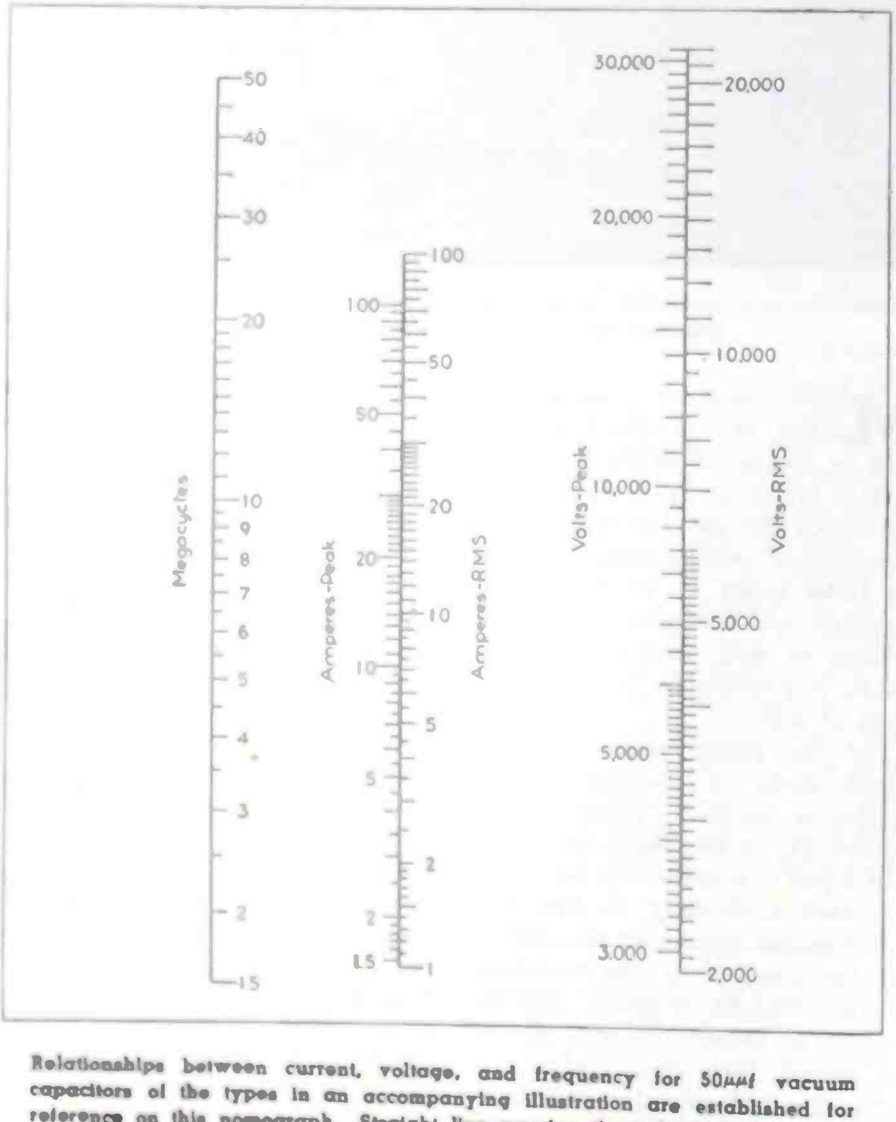
Certain types of vacuum capacitors are designed so that thermal expansion of the boro-silicate glass is the same as that of the metal end-cups which are iron-nickel-cobalt alloy. This careful matching of temperature coefficients prevents change of capacitance with temperature. Rugged, cylindrical-plate construction also leads to more stable values than those of clamped, parallel-plate, air units. These are usually subject to stresses in the insulating supports due to vibration, aging, or bending of plates.

Geometric capacitance is not identical with effective capacitance —the value actually used in practice. For example, equivalent series capacitance of an air, vacuum, or pressure unit is given by the equation

$$C_e = \frac{C}{1 - LC\,\omega^2} \qquad (1)$$

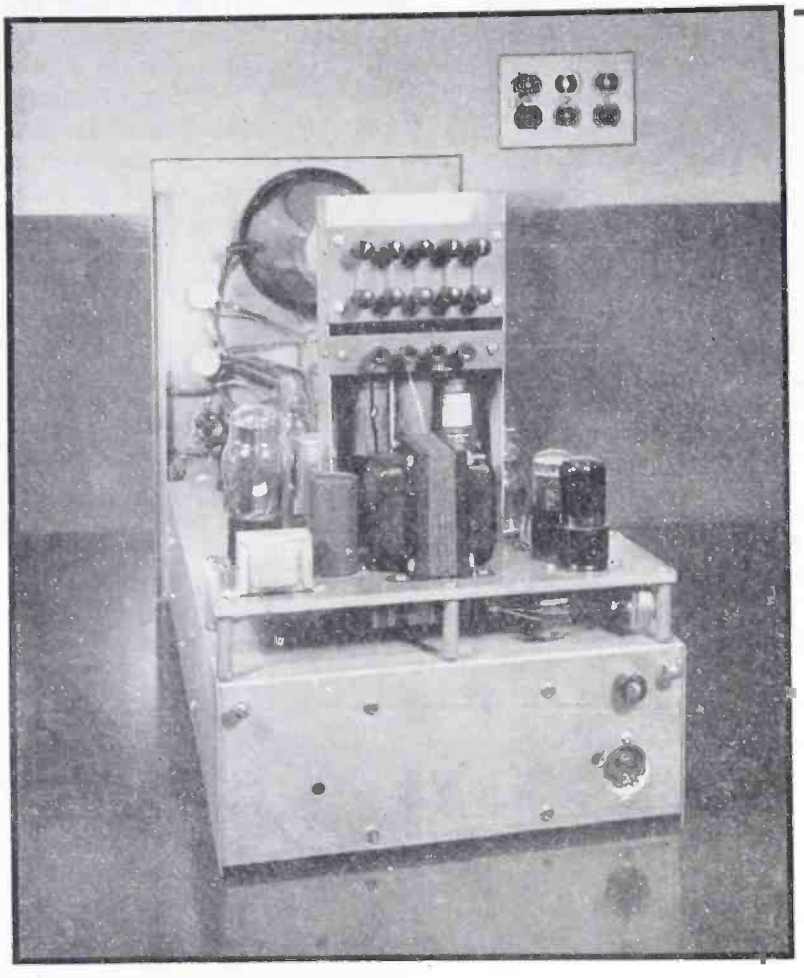
where C is total geometric capacitance, L is inductance of the plates and leads, and $\omega = 2\pi f$. From this it can be seen that plates and leads of the capacitor cause a rise in effective capacitance with increasing frequency. A good quality variable

(*Continued on page* 320)



Relationships between current, voltage, and frequency for 50$\mu\mu f$ vacuum capacitors of the types in an accompanying illustration are established for reference on this nomograph. Straight line passing through any two factors reveals the third

Beam Blanking



Rear view of a commercial cathode-ray oscilloscope in which the beam-blanking circuit has been incorporated

A three-tube electronic unit permits photographing a complete transient trace on a cathode-ray oscilloscope screen with high detail and no fogging. Arrival of transient trips a trigger circuit, releasing the blanked beam, and provides a dotted "Z" timing wave

By WALTHER RICHTER

Allis-Chalmers Manufacturing Co., Milwaukee, Wisc.

MOST modern cathode-ray tubes are provided with a grid by means of which it is possible to interrupt the electron beam producing the spot on the screen. Commercial oscilloscopes containing these tubes are provided with a control which applies a negative voltage to this control grid and makes it possible to interrupt the beam at will.

For the photography of transients, some of the instruments provide a so-called "single-sweep" feature. When the single-sweep circuit is put into operation, the beam is biased sufficiently so that the spot does not appear on the screen, but the starting of the transient or any desired tripping impulse is used to sweep the spot across the screen just once. This is a highly desirable addition, but there are two points which prove to be somewhat undesirable.

First, even with the beam biased so as not to strike the screen, there are scattered electrons striking the screen, leading to a reasonably strong background illumination. If for any reason the camera shutter has to be opened an appreciable time before the expected transient begins, an undesirable amount of fogging of the film takes place.

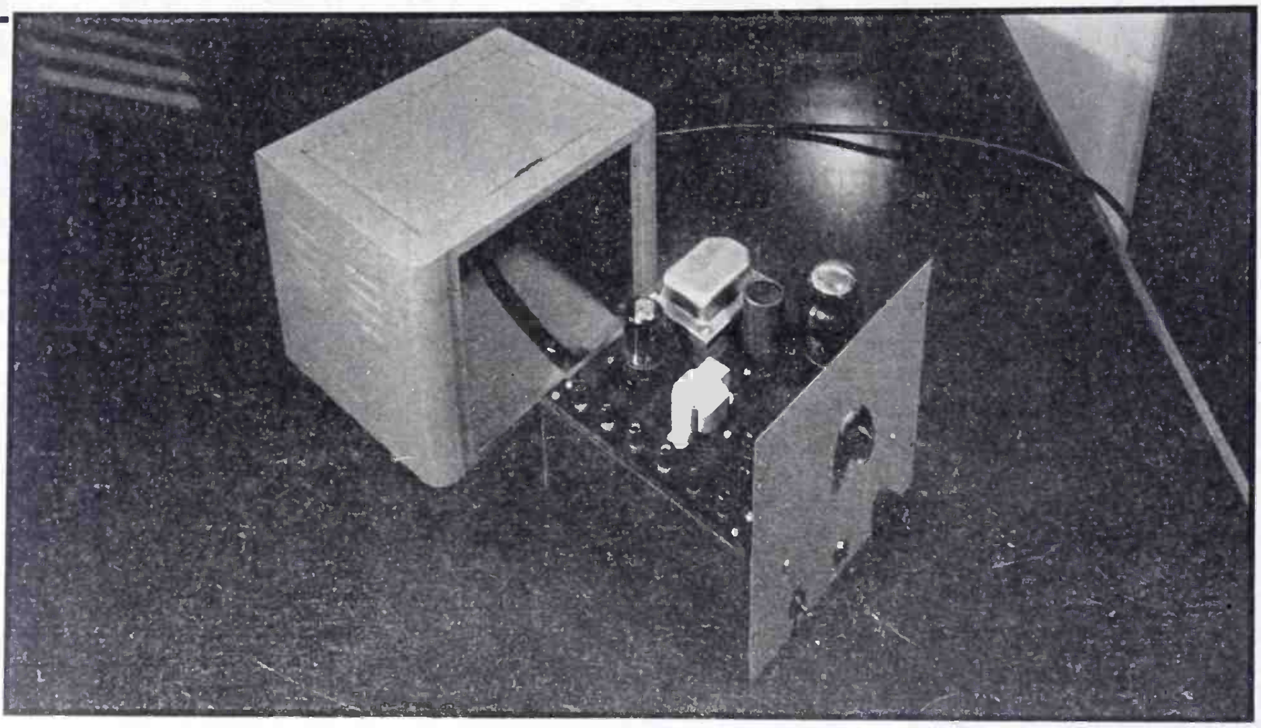
Secondly, if it is desired to obtain a picture of the complete transient, then it is of course necessary to adjust the rate of the single sweep to such a value that the time taken by one sweep is equal to the total time of the transient. The resulting oscillogram can therefore not be any longer than a single sweep. It is quite obvious that considerable detail of the transient may become lost in the picture due to the need of compressing it into a single sweep.

Suppose now that instead of only one, we permit five sweeps, with the rate of sweep adjusted to such a value that one sweep will take place in a time equal to one-fifth of the time of the transient, or in other words, the time of five sweeps will equal the duration of the transient. The oscillogram will then consist of five branches, each one representing one-fifth of the transient.

An example of a transient as it would appear with a single sweep appears in Fig. 1(a), while Fig. 1(b) shows this same transient spread over five sweeps. Corresponding segments in the two traces are similarly marked.

With the number of sweeps limited to a reasonable value, such as 5, there is usually no difficulty in piecing the individual branches properly to each other since the displacement from the zero line and the slope must be the same at the right and left hand edges of the oscillogram. The piecing together of the segments may be further facilitated by having enough brilliancy so that the return sweep produces a faint trace which then connects the proper branches with each other. It is

Circuit for Oscilloscopes



Complete beam-blanking equipment built as a separate unit for use with any oscilloscope

dent that such a picture will eal finer detail of the transient.

Film-Fogging Problem

t is entirely feasible to obtain s result by designing an elec- nic circuit that will make the ep repeat itself for a definite nber of cycles, but this still does remove the possibility of fog- g. Therefore a more desirable ution would be one in which the ep operates continuously, and beam is released only for the ired exposure. In principle, this a rather simple procedure; all has to do is to keep the grid the cathode-ray tube sufficiently ;ative to cause cut-off of the m, and reduce this negative bias the proper value for the time of oosure.

rom a practical point of view, vever, there is a serious handi- standing in the way of an easy ution, due to the following con- ion: when operating a cathode- tube, the average potential the deflection plates should be r the anode potential. This con- ion is ordinarily met by placing anode of the cathode-ray tube or near ground potential, which in turn places the cathode at a negative potential amounting to a thousand volts or more with respect to ground. Since the grid must be made negative with respect to the cathode, this means that the operating potential of the grid is also one to several thousand volts negative with respect to ground.

Insulating Problems

With this in mind, it is clear that the problem of shifting the grid potential with respect to the cathode by 100 volts or so is not too easy. One could install a relay, the coil of which would be insulated sufficiently from the contact structure and by means of which the grid voltage could be shifted from one value to another, but any mechanical device of this nature with its mechanical and electrical inertia and the possibility of bouncing contacts is practically ruled out.

The circuit described in the following paragraphs is nothing but a trigger circuit which can be tripped by an impulse transmitted through a capacitor to the proper point in the circuit. The whole trigger circuit and its power supply is insulated from ground for a voltage equal to the operating voltage of the cathode-ray tube. The components are mounted on an insulating panel or on a steel chassis which in turn is insulated from its housing or from the chassis of the oscilloscope.

The only special component needed is a power transformer for the trigger circuit, the primary winding of which is insulated from the core and the other windings for a voltage equal to the operating voltage of the cathode-ray tube. If such a transformer is not available, a 1:1 insulating transformer may be employed which permits the use of any standard small power transformer for the trigger circuit.

Provisions are also made to apply a dotting or "Z" signal to the grid of the cathode-ray tube. The circuit is so arranged that dotting and tripping do not interfere with each other.

Operation of Trigger Circuit

Figure 2 shows the diagram of the complete circuit. The tripping circuit consists of a double triode, VT_1, which with its associated resistors R_1, R_2, R_3, and R_1', R_2' and R_3' forms a trigger circuit. When one

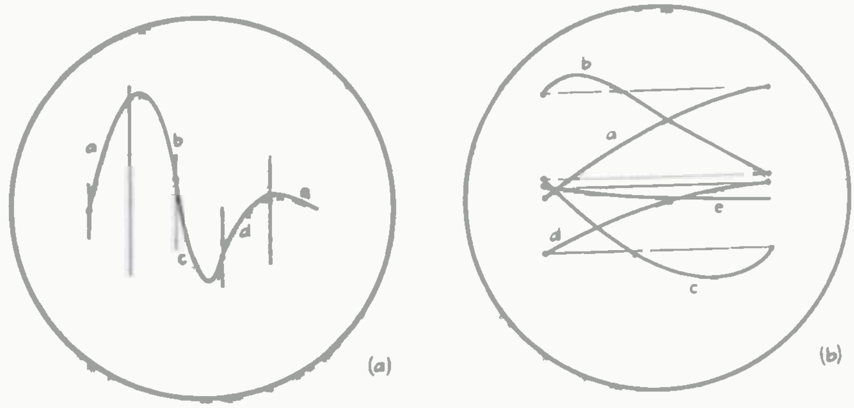


FIG. 1—Conventional single-sweep transient trace (a) and expanded five-sweep trace (b)

section of the tube is conducting, the other section is automatically biased to cut-off. Consequently, either one or the other section is conducting, but never both at the same time. An impulse transmitted to the grid of one section, in such a direction as to change the state in which it is at that instant, will therefore cause the circuit to go from one condition to the other.

One of the sections of VT_1, designated as a, performs the desired control action on the grid of the cathode-ray tube. This is accomplished in the following manner: when left-hand section a is non-conducting, the drop across the plate resistor R_1 is small, since the only current flow through it is due to the current flowing through the high resistances R_2 and R_3. Point A will therefore be only a few volts negative with respect to the positive end of the power supply. The cathode of one section of the double diode VT_2 is connected to point A. The anode of this section is connected through resistor R_4 to point D on potential divider R_5, which is adjusted so that D is negative with respect to point A as long as tube section a is non-conducting. Consequently, no current flows through R_4, and the potential of the grid of the cathode-ray tube with respect to the cathode is simply determined by the position of the arm on R_5. This permits manual adjustment of the grid voltage of the cathode-ray tube to give any desired brilliancy, or to blank the beam if so desired.

If section a of VT_1 is made conducting, however, the plate current will cause a large voltage drop across the plate resistor R_1. This makes point A negative with respect to point D, and consequently there will be a flow of current established through the right-hand section of double diode VT_2. Current flow is in the direction from point D through the diode to point A and is therefore such as to increase the grid bias of the cathode-ray tube over and above any value to which it may have been adjusted by the slider of R_5. Consequently, by triggering the double triode from one condition to the other, a release or blanking of the beam may be obtained. The tripping impulse may be administered to the grid of either section. A negative impulse administered to the grid of section a, or a positive impulse administered to the grid of section b will make section a nonconducting and thus release the beam. Impulses of the opposite polarity will correspondingly blank the beam again.

Production of Dotting Signal

The left-hand section of the double diode is used to provide the "Z" or dotting signal. It is seen that the application of the proper type of signal (preferably of a square-wave shape in order to avoid defocussing during the duration of the dot) through blocking capacitor C_1 causes an alternating current to flow through resistor R_6 which (during its negative half-wave) will cause a current flow through the left-hand section of the double diode, thus periodically biasing the grid of the cathode-ray tube.

It should be noted that blanking and releasing require only an impulse and not the maintaining of a certain voltage during the time that the beam is to be released.

The complete equipment can be made as a separate device which can be used with any oscilloscope on which the cathode and grid terminals have been brought out, or can be permanently incorporated in one of the oscilloscopes available on the market.

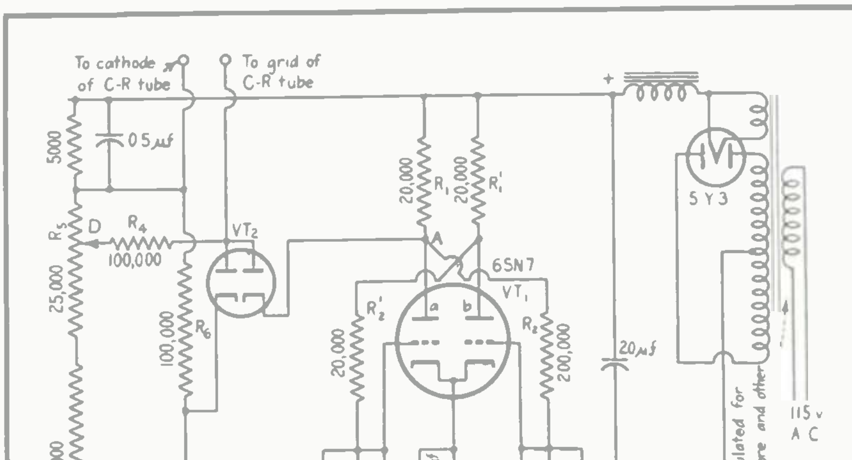


FIG. 2—Complete beam-blanking circuit, with power supply and provisions for applying a dotted "Z" timing voltage to the cathode-ray tube

REMOTE MONITOR

or Directional Broadcasting

Direct measurement of the null point in the radiation pattern from a directional antenna system is accomplished with a modified receiver which gives a continuous microammeter reading at the transmitter

By M. A. O'BRADOVICK *Transmitter Supervisor Station KMPC North Hollywood, Calif.*

REATER USE of directional antenna systems by broadcast tions has increased the importance of means for measuring and eping a check on the radiation tterns.

nstruments for indicating asing in the several elements of ectional arrays have been spelly devised for the purpose and ilt in as permanent parts of ne transmitters. This measures means by which the desired ult is produced, but is not a ect check on the radiation patn itself, or what is of most importance, the strength of the signal radiated in the minimum signal or null-point direction.

A means of checking signal intensity directly provides an indication of the signal radiated toward the channel-sharing station with which interference must be avoided.

Unit in Continuous Service

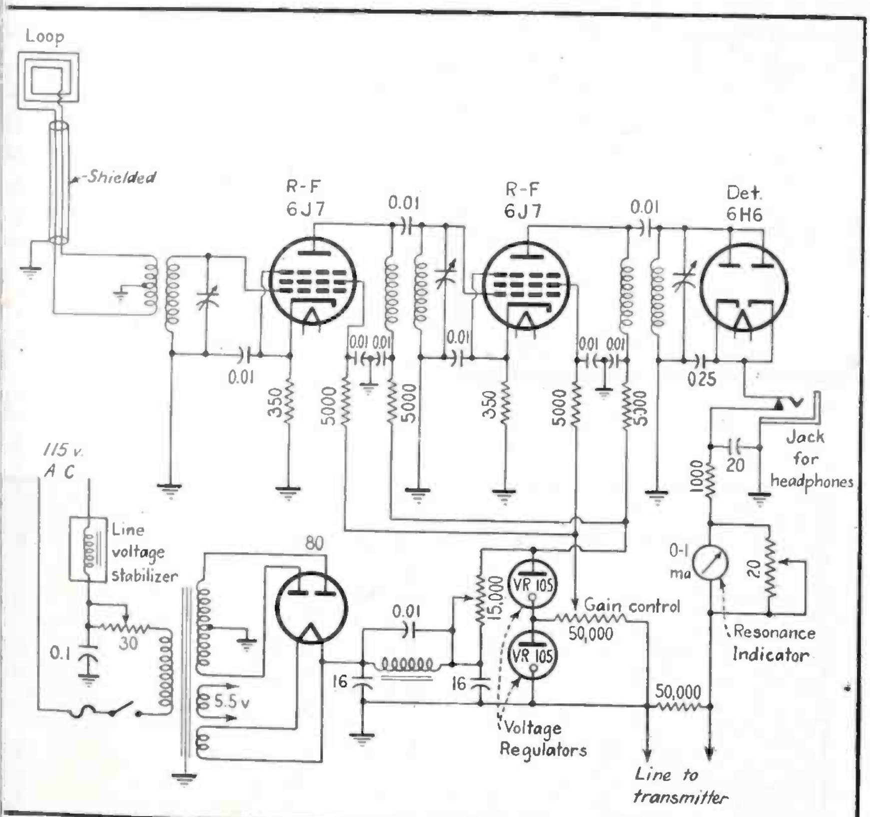
Among the first examples of a signal-monitoring system of this type is one installed for the 10 kw transmitter of KMPC, North Hollywood, Calif, the last of this power to be installed before the war. Operating on 710 kc, KMPC shares the channel with KIRO, Seattle, Wash., 960 miles away.

Mounted on a pole, the remote monitoring unit receives a signal from the antenna array to the right of the pole in the background and 1½ miles away. Receiver diode current goes back to the transmitter by phone line

At a distance of 1½ miles from the three 300 ft towers which make up the directional array, a simple type of monitoring receiver is installed on a 25 ft pole, surmounted by a loop antenna. The receiver operates continuously, energized from a 115-v line on the pole. The dc developed in the diode detector of the receiver is sent over a telephone line back to the transmitter, where it actuates a microammeter on the operator's console.

Steady deflection of this meter affords a constant and directly

(Continued on page 270)



Circuit of the remote monitor. The 30-ohm rheostat in the power-transformer primary circuit reduces the line voltage to extend service life

SINGLE-INDUCTO

Advantages over tuned interstage transformers in wide-band r-f and video amplifiers are discussed, performance is analyzed, expressions are set up for total voltage gain, bandwidth and skirt steepness ratio, and design curves are given for band widths up to 5 Mc

By C. T. McCOMB and A. P. GREEN

Naval Research Laboratory
Washington, D. C.

OF THE MANY METHODS of coupling between stages of tuned amplifiers, probably the simplest is the common single-inductor coupling network. While the single inductor does not possess the versatility of the tuned transformer or of other more elaborate coupling networks, neither does it entail the complexity of design, manufacture, and alignment of other types of coupling.

Consideration of the characteristics of the single-inductor coupling network is made under conditions where the center frequency and bandwidth requirements are such that the single inductor exhibits its most useful features. The scope of application for this treatment of the single inductor is limited by only a few basic restrictions. In Fig. 1 is shown a schematic circuit for use of the single inductor in a coupling network. Variations of this circuit are of course possible, but they will not change the basic behavior of the network.

Figure 2 gives the fundamental equivalent network involving the inductor. The output capacitance of the preceding tube, the input capacitance of the following tube, and the distributed capacitance of the inductor and circuit are considered as a single shunt capacitor with respect to the inductor in the equivalent circuit.

In the analysis of the network, it

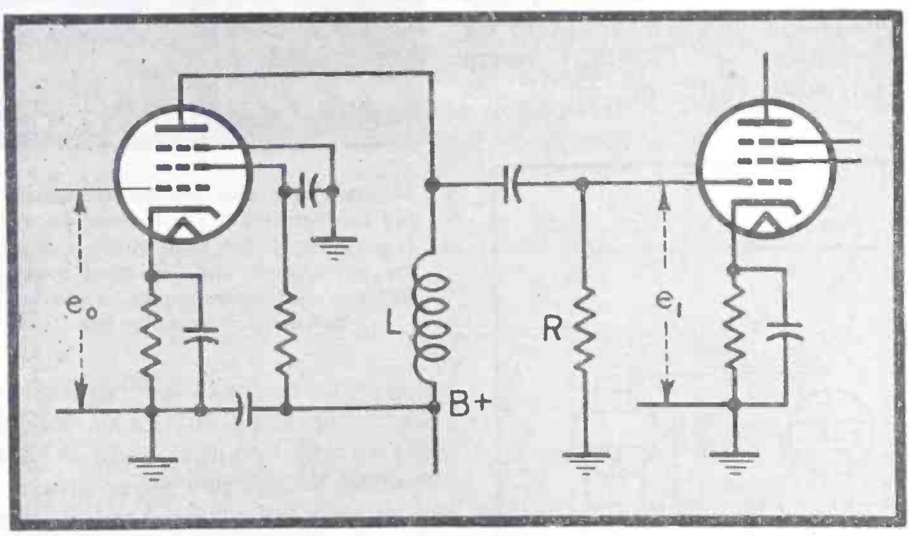


FIG. 1—Circuit using single inductor L in coupling network

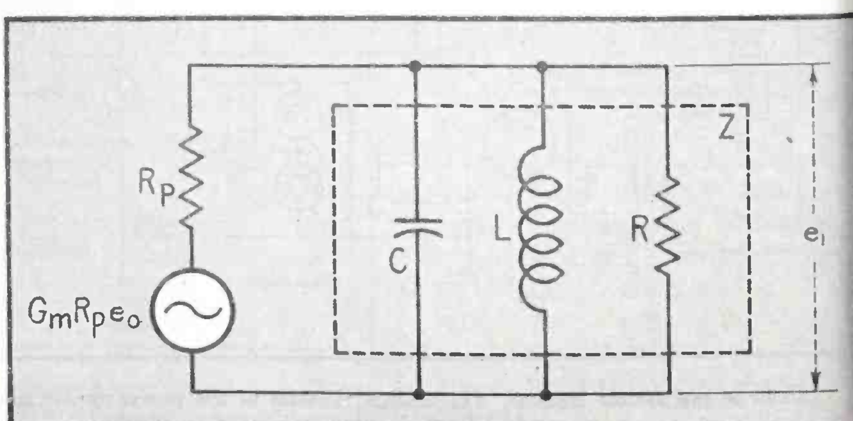


FIG. 2—Equivalent circuit of amplifier stage using a single-inductor coupling network

OUPLING NETWORKS

ıssumed as a first restriction that : inductor has a sufficiently high ; so that its effective inherent ınt resistance is large compared the size of the damping resistor ıd in the coupling network. As second restriction, the plate re- ıtance of the preceding tube is o considered to be very large npared to the damping resistor. e first restriction is merely for purpose of analysis so that the nping action in the network can considered as being due solely to umped shunt resistor. The sec- ı restriction limits the use of s analysis to those applications ere the bandwidth requirements such that the necessary damp- resistor will be small compared the effective plate resistance of tube. This last condition does place a severe limitation on usefulness of this work, be- ıse the great majority of all eo modulation applications will within this range.

otal Voltage Gain for *N* Stages

ın examination of the equivalent work of Fig. 2 shows that the tage gain for a single stage is en by the expression

$$V.G. = \frac{e_1}{e_0} = \frac{g_m R_P Z}{R_P + Z} \qquad (1.10)$$

th the above-discussed second triction that R is small compared to R_P, and since Z can never be greater than R, then for this treatment Z will be small compared to R_P and we will have for one stage of amplification

$$V.G. = e_1/e_0 = g_m Z \qquad (1.11)$$

For N identical stages, as in Fig. 3, the total gain at any frequency, Γ_f, will be

$$\Gamma_f = (g_m Z)^N \qquad (1.20)$$

From the equivalent circuit, Z can be expressed by

$$Z = \frac{1}{\frac{1}{R} + j\left(\omega C - \frac{1}{\omega L}\right)} \qquad (1.30)$$

It is apparent that Z is a maximum and equals R when $\omega C = 1/\omega L$. If we let $\omega = \omega_o$ when $Z = R$ (at resonance), then $\omega_o C = 1/\omega_o L$ or $L = 1/\omega_o^2 C$, we have

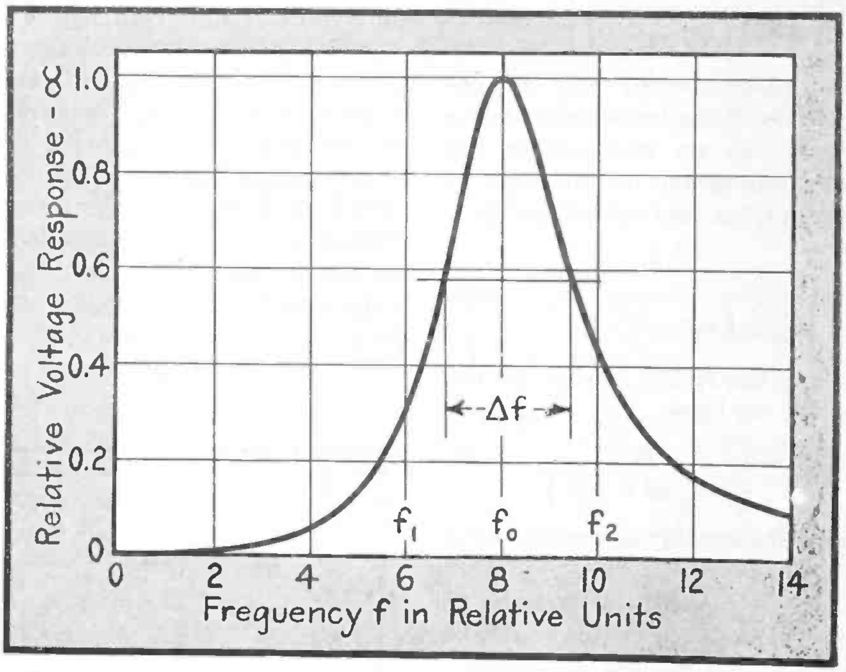
$$Z = \frac{1}{\frac{1}{R} + j\left(\omega C - \frac{\omega_0^2 C}{\omega}\right)} \qquad (1.31)$$

and the total gain will be

$$\Gamma_f = (g_m Z)^N = g_m^N \left[\frac{1}{\frac{1}{R} + j\left(\omega C - \frac{\omega_0^2 C}{\omega}\right)}\right]^N \qquad (1.21)$$

At resonance,

$$\Gamma_{fo} = (g_m R)^N \qquad (1.22)$$



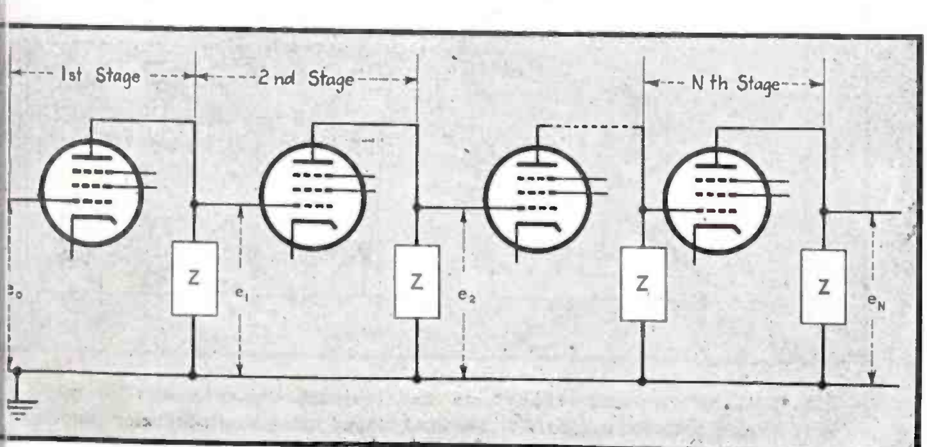


FIG. 3—Use of single-inductor coupling networks (represented by equivalent impedance Z) in N identical stages

FIG. 4—Voltage response characteristic of an amplifier stage using a single-inductor coupling network, showing significance of band width for any specific value of relative voltage response off the resonant frequency

We can now advantageously express the total voltage gain at any frequency as a fraction, α, of the total voltage gain at resonance, thus:

$$\Gamma_f = \alpha \Gamma_{fo} = \alpha (g_m R)^N \qquad (1.23)$$

With this expression for the total voltage gain at any frequency expressed as a function of some of the known constants of the network and the determinable factor, α, we have a useful means for predicting the behavior of any single-inductor type tuned amplifier.

General Bandwidth for N Stages

Since the total gain and the bandwidth are the two basic requirements for any tuned amplifier, it is necessary that an expression be obtained relating these quantities to the known constants of the network.

From Eq. (1.21) and (1.23) for total voltage gain,

$$\Gamma_f = \alpha\,(g_m R)^N$$
$$= g_m{}^N \left[\frac{1}{\dfrac{1}{R} + j\left(\omega C - \dfrac{\omega_0{}^2 C}{\omega}\right)} \right]^N \qquad (2.10)$$

We are interested only in the magnitude of the impedance at any frequency so we may reduce the complex expression on the right to a real number and cancel out $g_m{}^N$, thus

$$\alpha R^N = \left[\frac{1}{\dfrac{1}{R^2} + \left(\omega C - \dfrac{\omega_0{}^2 C}{\omega}\right)^2} \right]^{N/2} \qquad (2.20)$$

Taking the $N/2$th root of the expression, we have

$$\alpha^{2/N} R^2 = \frac{1}{\dfrac{1}{R^2} + \left(\omega C = \dfrac{\omega_0{}^2 C}{\omega}\right)^2} \qquad (2.21)$$

Rearranging terms results in the relation

$$(\omega^2 - \omega_0{}^2)^2 = \frac{\omega^2 (1 - \alpha^{2/N})}{\alpha^{2/N} R^2 C^2} \qquad (2.22)$$

and since $\omega = 2\pi f$ we can write

$$(f^2 - f_0{}^2)^2 = \frac{f^2 (1 - \alpha^{2/N})}{4\pi^2 \alpha^{2/N} R^2 C^2} \qquad (2.23)$$

then

$$f^2 - f_0{}^2 = \pm \frac{f\sqrt{1 - \alpha^{2/N}}}{2\pi\alpha^{1/N} RC} \qquad (2.24)$$

From Fig. 4 it is seen that for any relative voltage response, α, there are two values of f. These frequencies will be designated f_1 and f_2; since they must be positive real numbers, we have for the solutions of Eq. (2.24)

$$f_2{}^2 - f_0{}^2 = \frac{f_2\sqrt{1 - \alpha^{2/N}}}{2\pi\alpha^{1/N} RC} \qquad (2.25)$$

and

$$f_1{}^2 - f_0{}^2 = \frac{-f_1\sqrt{1 - \alpha^{2/N}}}{2\pi\alpha^{1/N} RC} \qquad (2.26)$$

Eliminating f_0 from the above equations and using the notation for general bandwidth, $\Delta f = f_2 - f_1$, we have

$$f_2{}^2 - f_1{}^2 = (f_2 + f_1)\frac{\sqrt{1 - \alpha^{2/N}}}{2\pi\alpha^{1/N} RC} \qquad (2.27)$$

Then, since $f_2{}^2 - f_1{}^2 = (f_2 + f_1)(f_2 - f_1)$,

$$\Delta f = \frac{\sqrt{1 - \alpha^{2/N}}}{2\pi\,\alpha^{1/N} RC} \qquad (2.30)$$

For convenience of analysis, this expression for general bandwidth can be given most simply as

$$\Delta f = \frac{\sqrt{\dfrac{1}{\alpha^{2/N}} - 1}}{2\pi RC} \qquad (2.31)$$

This relationship shows the functional variation of the bandwidth of the amplifier with respect to the circuit constants and the relative voltage response ratio at which the bandwidth is considered. It shows that if R and C are fixed, both the bandwidth at any given relative response, α, and the total voltage gain (since $\Gamma_f = \alpha(g_m R)^N$) will remain constant regardless of the value of the inductance, L, employed. Thus it is seen that any inductance variation will change only the resonant frequency and will have no effect on the bandwidth or total gain.

An important relationship exists between the high and low frequencies, f_2 and f_1, for any relative response, α, and the resonant frequency, f_0, of the coupling network. Dividing Eq. (2.25) by (2.26), we obtain

$$\frac{f_2{}^2 - f_0{}^2}{f_1{}^2 - f_0{}^2} = -\frac{f_2}{f_1} \qquad (3.10)$$

Solving this for $f_0{}^2$ gives

$$f_0{}^2 = f_1 f_2 \qquad (3.11)$$

This establishes the well-known formulation that the resonant frequency is the geometric mean of the high and low response frequencies at any relative response of the amplifier. It follows that the response of an amplifier is thus geometric with respect to its resonant frequency, and a linear frequency plot of the amplifier characteristic will appear asymmetrical. For this reason a logarithmic frequency scale is usually employed so that the characteristic will appear symmetrical.

Skirt Steepness Ratio

An interesting characteristic of the behavior of N stages of a single-inductor coupling network can be drawn from a consideration of the expression in Eq. (2.31) for Δf. The quality of an amplifier is partially determined by its response to near signals relative to its desired bandwidth response. This characteristic is important in the signal-to-noise ratio of the amplifier since the total area under the response curve contributes to noise energy,

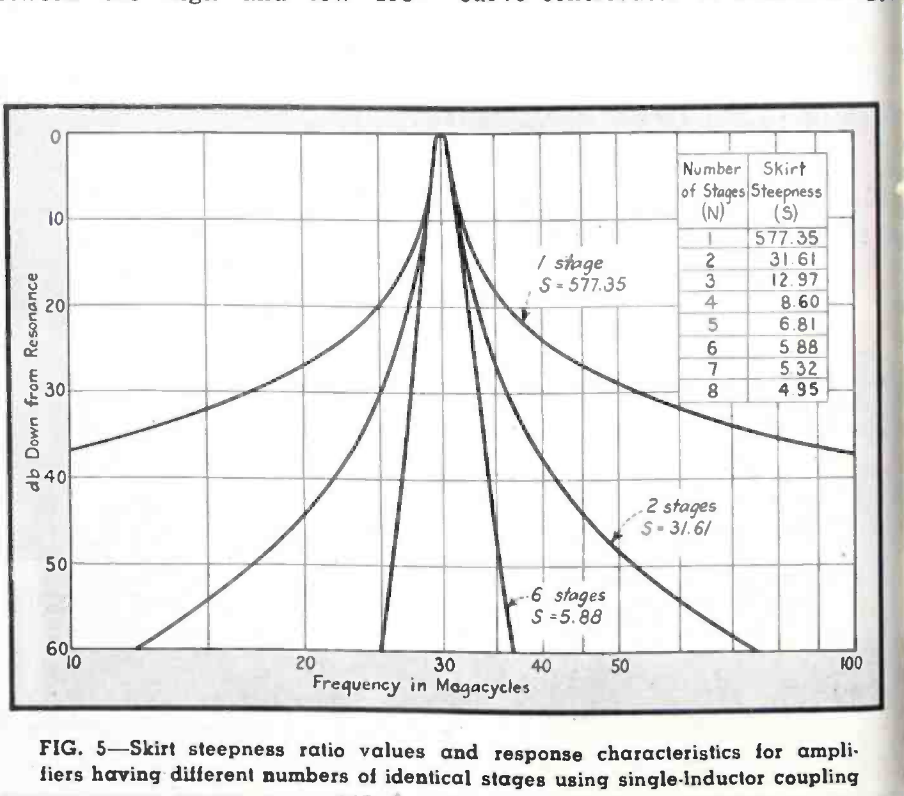


FIG. 5—Skirt steepness ratio values and response characteristics for amplifiers having different numbers of identical stages using single-inductor coupling

ile only an area proportional to t signal bandwidth contributes to t signal energy. This degree of lity is expressed as a factor, t steepness S, which is defined the ratio of the bandwidth at 0 db response to the bandwidth -6 db response. This ratio is n to be an inverse index of the lity of rejection of the ampli- in that as the ratio becomes ller, the response to near sig- will be less. From Eq. 2.31 for and since for -60 db response 0.001 and for -6 db response 0.5, we have

$$= \frac{\Delta f_{-60db}}{\Delta f_{-6db}} = \frac{\sqrt{\frac{1}{(0.001)^{2/N}} - 1}}{\sqrt{\frac{1}{(0.5)^{2/N}} - 1}} \qquad (4.10)$$

t is seen from this expression t the skirt steepness is depend- only upon the number of stages not upon any of the other char- ristics of the amplifier. The o, S, for amplifiers of from one ough eight stages is given in . 5, along with representative ponse characteristics of ampli- s with different numbers of ges. A logarithmic frequency e is used as discussed above in r to obtain symmetrical curves. three response characteristics sented are all down 6 db at a dwidth of 2 Mc with a center uency of 30 Mc. The difference ween the characteristics is due he number of stages used in .

t is seen that a very great im- vement in skirt steepness is ob- ed in going from one stage to greater number of stages. The h more desirable characteristic e of the response of six stages pared to that of two stages is evident from the curves. This ded increase in the rejection of signals is so pronounced that many applications the use of ad- onal stages will be justified even gh the required total gain could btained with a fewer number of ges.

fective Bandwidth for N Stages

he effective bandwidth of a re- nt response characteristic is ned as the bandwidth of an as- ed rectangular response of ht equal to the response of the icular network at resonance and of area equal to its total integrated power response. In order to apply this definition it is necessary to treat the power gain of N stages. This is proportional to the square of the total voltage gain. From Eq. (1.22) for Γ_{f_0} we can write for the power gain at resonance:

$$\text{Total power gain at } f_0 = P_{f_0} = K\Gamma_{f_0}{}^2 = K\,(g_mR)^{2N} \qquad (5.10)$$

where K is the impedance proportionality constant for the particular general circuit under consideration. From this we have, in a manner similar to Eq. (1.23),

$$\text{Total power gain at } f = P_f = \beta P_{f_0} = K\,\beta(g_mR)^{2N} \qquad (5.11)$$

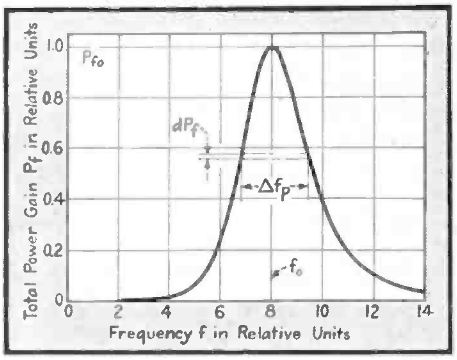


FIG. 6—Example of power response characteristic, the area of which is utilized in determining the effective bandwidth of a stage using a single-inductor coupling network

where β is the fractional power response factor of the total power gain at resonance. It is seen that β is the factor corresponding to α in Eq. (1.23) for voltage response.

Since we are interested in obtaining a relationship in terms of the maximum power response and the bandwidth, we can write

$$K\beta(g_mR)^{2N} = Kg_m{}^{2N}\left[\frac{1}{\frac{1}{R} + j\left(\omega C - \frac{\omega_0{}^2C}{\omega}\right)}\right]^{2N} \qquad (5.20)$$

This becomes

$$\beta R^{2N} = \left[\frac{1}{\frac{1}{R} + j\left(\omega C - \frac{\omega_0{}^2C}{\omega}\right)}\right]^{2N} \qquad (5.21)$$

Reducing the right side of the expression to a real number, since we are interested only in the absolute magnitude, and taking the square root of both sides of the equation gives

$$\beta^{1/2}R^N = \left[\frac{1}{\frac{1}{R^2} + \left(\omega C - \frac{\omega_0{}^2C}{\omega}\right)^2}\right]^{N/2} \qquad (5.22)$$

Comparison of this form of the equation with the similar form obtained in the consideration of general bandwidth in Eq. (2.20), gives us immediately the form of the solution. We see that α in Eq. (2.20) will be replaced by $\beta^{1/2}$. Using the notation Δf_P to indicate the bandwidth with respect to the power response curve, we have

$$\Delta f_P = \frac{\sqrt{\frac{1}{\beta^{1/N}} - 1}}{2\pi RC} \qquad (5.30)$$

This equation now gives the necessary expression for completing the evaluation of the defined effective bandwidth. We may now write the defining integral for the total area under the power response curve. We shall take the equation for Δf_P, which is the expressed bandwidth at any relative response P_f, and integrate with respect to dP_f over the range of zero to P_{f_0} which is the maximum power response. This will give the total area under the curve, an example of which is given in Fig. 6.

$$\text{Area under power curve} = \int_0^{P_{f_0}} \Delta f_P dP_f \qquad (5.40)$$

Applying the definition for effective bandwidth and noting it as Δ_{f_e}, we can write

$$\Delta f_e = \frac{\int_0^{P_{f_0}} \Delta f_P\, dP_f}{P_{f_0}} \qquad (5.50)$$

Using Eq. (5.10), (5.11), and (5.30), we can substitute in Eq. (5.50) as follows:

$$\Delta f_e = \frac{\int_0^{P_{f_0}} \frac{\sqrt{\frac{1}{\beta^{1/N}} - 1}}{2\pi RC}\, d[K\beta(g_mR)^{2N}]}{K(g_mR)^{2N}} \qquad (5.51)$$

Noting in Eq. (5.51) that the variable of relative response is β, we can perform the indicated differentiation, simplify the expression, and evaluate the new limits of integration for β. This gives

$$\Delta f_e = \frac{1}{2\pi RC}\int_0^1 \sqrt{\frac{1}{\beta^{1/N}} - 1}\; d\beta \qquad (5.52)$$

which is the definite integral expression for the effective bandwidth.

The above equation does not lend itself readily to integration, so we shall use a convenient substitution to reduce the expression to an easily integrated form. Letting $\beta = \cos^{2N}\phi$,

$$d\beta = -\,2N\cos^{2N-1}\phi\,\sin\phi\, d\phi$$

and the equation becomes

TABLE I. AMPLIFIER DATA		
Number of Stages (N)	A_e	A_g
1	0.25000	0.15915
2	0.12500	0.10243
3	0.09375	0.08114
4	0.07813	0.06923
5	0.06836	0.06137
6	0.06152	0.05570
7	0.05640	0.05135
8	0.05236	0.04788

$$\Delta f_e = \frac{-N}{\pi RC} \int_{\pi/2}^{0} \sin^2\phi \cos^{2(N-1)}\phi\, d\phi \quad (5.53)$$

The solution of this integral is direct, but for ease of general expression it is necessary to exclude the case of the single-stage amplifier. For this case $N = 1$ and the integral becomes

$$\Delta f_e = \frac{-1}{\pi RC} \int_{\pi/2}^{0} \sin^2\phi\, d\phi \quad (5.54)$$

The solution to this is immediate and for one stage we have

$$\Delta f_e = 1/4RC \quad (5.55)$$

For more than one stage, the solution of the expression is obtained in the form of a series product. This is because the integration of the Nth power of a trigonometric function is a repeated integral of reduced power. The general solution for the effective bandwidth for more than one stage is

$$\Delta f_e = \frac{N}{16\,RC} \prod_{a=4}^{a=2(N-1)} \left(\frac{a-1}{a+2}\right) \quad (5.56)$$

The above expression is seen to give the effective bandwidth of the amplifier in terms of the number of stages and the circuit constants R and C. The equation can be written

$$\Delta f_e = A_e/RC \quad (5.57)$$

where

$$A_e = \frac{N}{16} \prod_{a=4}^{a=2(N-1)} \left(\frac{a-1}{a+2}\right) \quad (5.60)$$

Now we can evaluate A_e for any number of stages and tabulate it. Then for a particular amplifier, C will be fixed by the circuit layout and type of tube used, but R must be chosen to satisfy the bandwidth requirement.

Table I gives the value of A_e for amplifiers of from one to eight stages. This is seen to be extremely useful for the above-discussed application. Also tabulated in Table I are the values of A_g, which is the constant of bandwidth from Eq. (2.31) for general bandwidth, in which bandwidth is taken as the −3 db response width. For this case we have

$$\Delta f = A_g/RC \quad (5.70)$$

where

$$A_g = \frac{\sqrt{\frac{1}{\alpha^{2/N}} - 1}}{2\pi} \quad (5.71)$$

These values were computed directly by setting $\alpha = 0.707$ and evaluating A_g for values of N from one through eight.

An examination of the two columns in Table I shows that as the number of stages increases, the constants become more nearly equal. This consideration leads to a desirable fact concerning the db down from maximum response at the effective bandwidth of a curve.

Letting Δf_e equal Δf_P we can solve for the relative power response β at the effective bandwidth for any value of N. From Eq. (5.30) and (5.57) we have

TABLE II. AMPLIFIER RESPONSE	
Number of Stages (N)	DB down at Δf_e
1	5.399
2	4.163
3	3.886
4	3.757
5	3.683
6	3.633
7	3.605
8	3.570

$$\frac{A_e}{RC} = \frac{\sqrt{\frac{1}{\beta^{1/N}} - 1}}{2\pi RC}$$

The general expression for β in terms of A_e becomes

$$\beta = \left[\frac{1}{1 + (2\pi A_e)^2}\right]^N \quad (5.80)$$

The db down at the effective bandwidth, in terms of A_e for N stages, is then

$$\text{db} = 10N \log_{10}[1 + (2\pi A_e)^2] \quad (5.90)$$

Table II gives the db down response of the amplifier characteristic at the effective bandwidth for one through eight stages. These values are in the anticipated agreement deduced from the values of Table I; that is, as the number of stages increases, the values of effective bandwidth and the 3 db down characteristic become more nearly equal.

The above-considered characteristics of the behavior of the single-inductor coupling network all give valuable yet simple equations for obtaining the design constants of an amplifier for a given set of conditions.

Composite Total Voltage Gain and Effective Bandwidth Behavior for N Stages

A composite relationship can be obtained for the complete behavior of N stages of single-inductor networks in which the total voltage gain, Γ_{fe}, is functional with respect to the effective bandwidth, Δf_e, and the element constants of the networks. This relationship gives the complete design requirements for any amplifier using the two fundamental requirements of total voltage gain and effective bandwidth desired.

From Eq. (1.22) for total gain and Eq. (5.57) for effective bandwidth, we have

$$\Gamma_{fe} = \left(\frac{g_m A_e}{\Delta f_e C}\right)^N \quad (6.10)$$

We see that Γ_{fe} is expressed in terms of the effective bandwidth desired, Δf_e, the effective bandwidth constant A_e (which is known and constant for any number of stages), the g_m of the tube, and the capacitance of the circuit. Thus for some independently chosen value of g_m, and with C fixed by the circuit layout and type of tube used, we have Γ_{fe} expressible in terms of the bandwidth desired and the number of stages.

For purposes of generalization in order to compute the desired family of curves we will arbitrarily assign reasonable values to g_m and C. Letting g_m + 5000 μmhos and C = 25 μμf, we have

$$\Gamma'_{fe} = \left(\frac{200\,A_e}{\Delta f_e}\right)^N \quad (6.11)$$

where Δf_e is expressed in megacycles. Figure 7 is a plot of this equation over the entire practical range of application, with Δf_e covering from 0.5 to 5.0 megacycles and from one through eight stages considered. With this figure one can obtain immediately the number of stages required for a particular set of design requirements.

For any other values of g_m and C in an amplifier the total gain that will be obtained is

$$\Gamma_x = \Gamma'_{fe}\left(\frac{g_{mx}}{5000}\Big/\frac{C_x}{25}\right)^N \quad (6.20)$$

here

$$\Gamma_e = (g_{me}R_e)^n \quad (6.21)$$

Thus the family of curves given n Fig. 7 is perfectly general with ne above equation.

With the desired total gain fixed n an amplifier and with the value f g_{me} established to obtain that ain with the determined number f stages, the necessary value of unt resistance R_e is obtained from q. (6.21) for Γ_e thus

$$R_e = \frac{\Gamma_e^{1/n}}{g_{me}} \quad (6.20)$$

Example of Use of Design Curves

In order to demonstrate the extreme simplicity of application of ne design curves given in Fig. 7 n example will be presented.

Assume that an amplifier is de- red to have a total voltage gain of),000 and an effective bandwidth ' 2.0 Mc. The resonant fre- uency is not involved in the deter- ination of either the number of ages or the shunt resistor R_e as as discussed above. First, obser- ation of Fig. 7 shows that for the nditions required the amplifier ill have either 4 or 5 stages, with riations in C and g_m fixing the tal choice. Four stages gives in- ficient gain for the operational nditions of $C = 25$ $\mu\mu$f and $g_m =$ 00 μmhos that were chosen for g. 7, while five stages gives too uch gain for these conditions. ow assuming that the circuit lay- t is such that we will have 22 $\mu\mu$f pacitance instead of 25 $\mu\mu$f ed in Fig. 7, we see from the uation for Γ_e that this will raise e total gain.

Let us take the two cases of 4 d 5 stages and compute what the erating g_{me} and the required unt resistor R_e will be for our oblem. For 4 stages, from Fig. we have

$$\Gamma_e = 10{,}000 = 3720\left(\frac{g_{me}}{5000}\Big/\frac{22}{25}\right)^4$$

lving, we have

$$= 5000 \times \frac{22}{25}\left(\frac{10{,}000}{3720}\right)^{1/4} = 5640 \ \mu\text{mhos}$$

erefore,

$$= \frac{(10{,}000)^{1/4}}{5640 \times 10^{-6}} = \frac{10}{0.00564} = 1773 \text{ ohms.}$$

We see that to get exactly the nditions set down for the ampli- of the problem when four stages are used, the operating g_m of the tubes would be raised slightly above the value used in Fig. 7. Finding this value, we can compute the value of R_e.

Now taking our amplifier to have five stages, we obtain from Fig. 7

$$\Gamma_e = 10{,}000 = 15{,}100\left(\frac{g_{me}}{5000}\Big/\frac{22}{25}\right)^5$$

Solving, we have

$$g_{me} = 5000 \times \frac{22}{25}\left(\frac{10{,}000}{15{,}100}\right)^{1/5} = 4055 \ \mu\text{mhos}$$

therefore,

$$R_e = \frac{(10{,}000)^{1/5}}{4055 \times 10^{-6}} = \frac{6.3095}{0.004055} = 1554 \text{ ohms.}$$

For five stages we see that the operating g_m of the tubes is reduced below that assumed for Fig. 7. R_e is then computed as in the previous case using the new g_{me}.

From the above solution to the problem we see that the curves of Fig. 7 are completely definitive of the behavior of the general single-inductor coupling network and that for any particular amplifier the consideration of only the capacitance C that will be involved in the circuit need be determined. Then the operating g_m for the tubes and the required value of R_e can be determined directly.

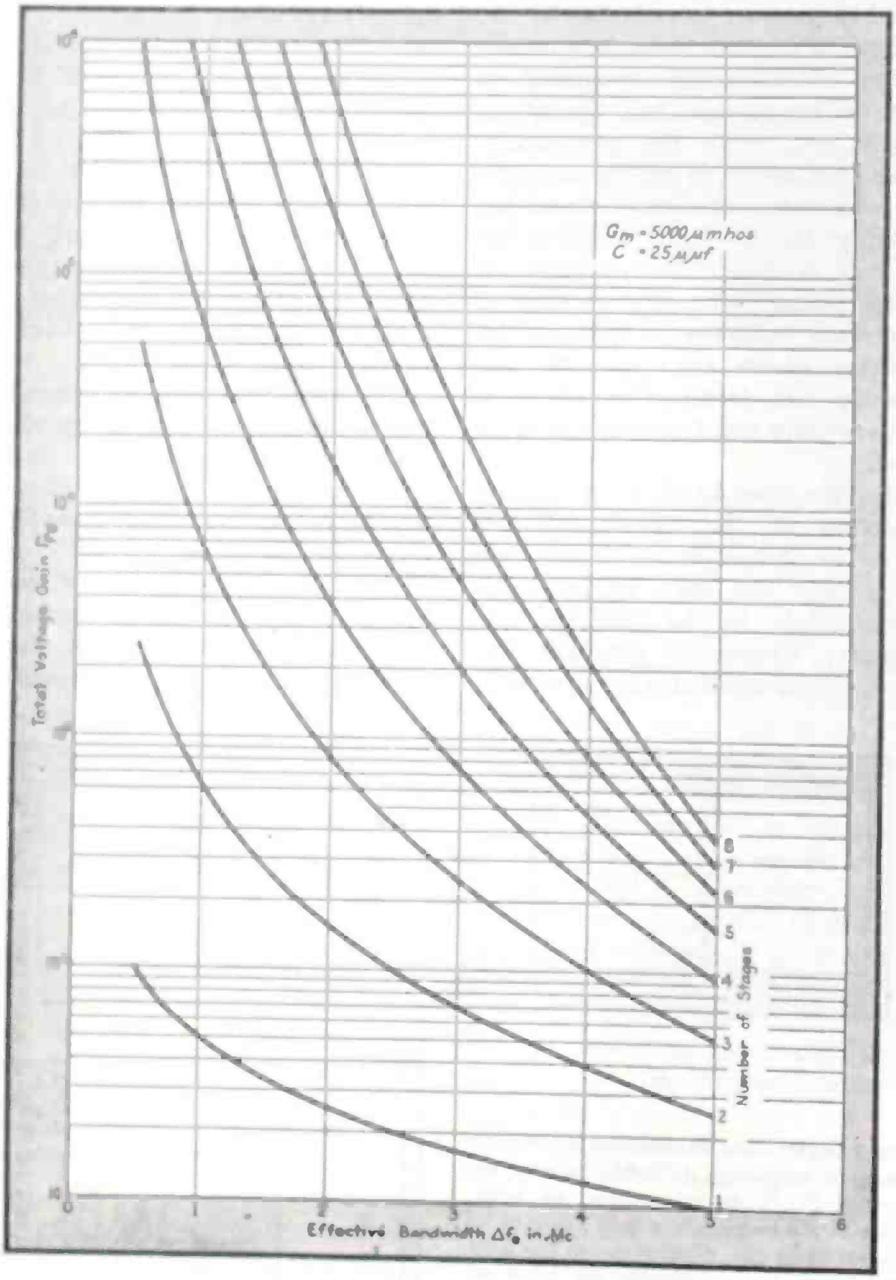


FIG. 7—Design curves for determining the number of amplifier stages required to meet a particular set of design requirements when using single-inductor coupling networks in wide-band amplifiers

Impedance Measurements

This discussion describes the test equipment and procedures for determining capacitance and inductance, as well as the natural frequency, distributed capacitance, resistance, and Q of inductors, by oscilloscopic observation of square-wave decay rates. Results of actual measurements are given, showing accuracy

By FRANK ROCKETT
New York, N. Y.

INTEREST in square waves has centered around their utility in indicating the transient reaction and wide-band response of circuits. In addition, square waves can be used to measure impedances by the following method. It employs a minimum of calibrated equipment, is simple in circuit and operation, rapid and, with the precautions described below, is highly accurate.

Advantages of square waves for testing lie in their multiple-frequency content. For example, in determining resonant frequency of a circuit, square-wave response indicates where the resonant frequency lies irrespective of what square-wave test frequency is being used.

On the other hand, the sine-wave response of the circuit will not give an indication until the test frequency has been adjusted approximately to the resonant frequency. Where the resonant frequency is altogether unknown, positive indication obtained from a square wave of any frequency eliminates the time-consuming necessity of hunting for the unknown frequency as in sine-wave testing.[1]

Apparatus Requirements

Equipment needed for square-wave impedance measurements includes a square-wave generator of known frequency, a calibrated or standard impedance, and a cathode-ray oscilloscope. Either the square-wave frequency or the calibrated impedance must be variable (preferably the frequency if it must be one and not the other), but the range over which measurements can be made is greatly extended if both are made variable. Output impedance of the square-wave generator should be at most one-tenth the smallest impedance to be measured. If it is not low enough a cathode follower[3] can be added, as in Fig. 1. The input impedance of the oscilloscope should be at least ten times larger than the largest impedance to be measured. As will be shown, this impedance can be as high as the grid input of a vacuum tube. If inductance or capacitance is to be measured, the calibrated impedance is a resistance. To measure resistance a calibrated capacitor is the more useful although an inductor can be used if necessary.

Consider the circuit of Fig. 2(a). It can be shown by operational analysis that if the generator provides a square wave of frequency $F = 1/(2\pi RC)$, the voltage developed across R is of the form in Fig. 2(b). This voltage across R decays during a half cycle to 0.043 of its initial value. An oscilloscope across R is used to observe this decay of resistor voltage.

When the square-wave frequency

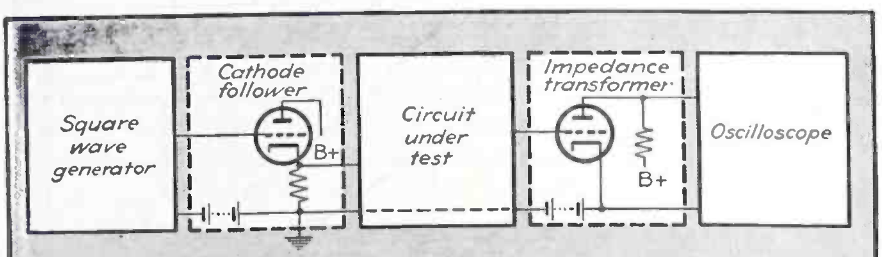


FIG. 1 (left)—Cathode follower decreases output impedance of generator while impedance transformer increases input impedance of oscilloscope in the general set-up of equipment used for square-wave testing

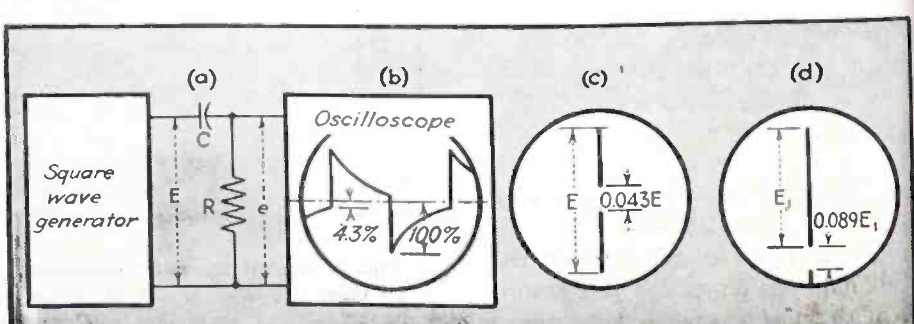
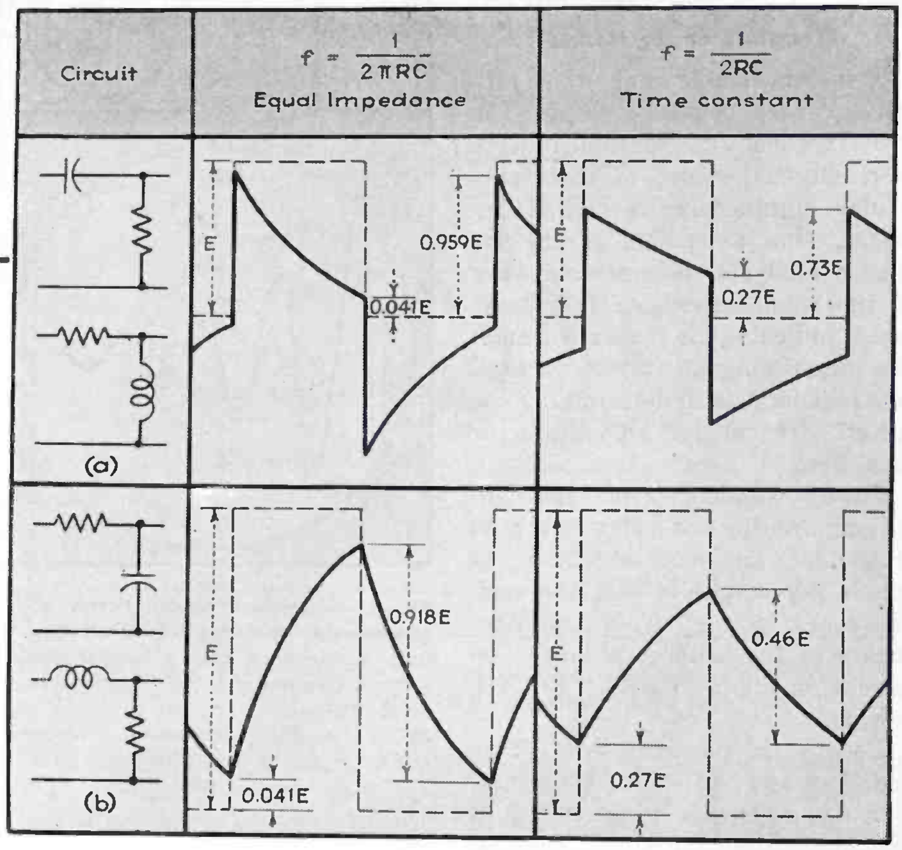


FIG. 2 (right)—Circuit response to a square wave of frequency $1/(2\pi RC)$ follows the law $e = E\epsilon^{t/RC}$ decaying from an initial value of 100 percent to a final value of 4.3 percent as at (b). Without sweep the trace appears as in (c). Moving the trace off center (d) increases the accuracy

With Square Waves



G. 3—High-pass (a) and low-pass (b) cuit outputs and inputs are compared r square-wave frequencies of equal impedance and time-constant conditions

the resistance, as the case may has been adjusted so that the tput voltage decays to 4.3 percent its maximum value, the imdance X_c equals the resistance R, $C = 1/(2\pi fR)$. If the squareive frequency is that frequency at ich information is required, the asurement directly gives $X_c = R$. cause of this relation, the techque is referred to as equal-impedce measurement.

That the specified condition has n reached can readily be obved from the scale on the face of oscilloscope. If the time base the oscilloscope is used and it is frequency which is being varied, is necessary simultaneously to adjust the sweep rate of the oscilcope. The oscilloscope trace will as shown in Fig. 2(b). However, no sweep is used—just vertical flection—the trace will be as own in Fig. 2(c). In addition, trace can be located on the oscilcope screen by means of the rtical centering control so as to minate most of the lower half the trace, thereby taking full adntage of the screen size as illusted in Fig. 2(d).

If resistance is to be measured, calibrated capacitor is inserted C and the unknown resistor for Resistance is given by $R =$ $(2\pi fC)$.

If inductance is to be measured, procedure is the same except it the voltage developed across inductor is applied to the oscilcope. To make use of the voltage veloped across the resistor in asuring inductance, it is necesy to compare it with the applied are-wave voltage in order to obve the equal-impedance condin of Fig. 3(b). This procedure quires an arrangement such as electronic switch. It has given less reliable results than the preceding method—doubtless because of this added complication. Inductance is given by $L = R/(2\pi f)$.

Time Constant Method

An alternative to the preceding is to use a square wave with a repetition period of $2T$ where T is the time constant of the RL or RC circuit under study. That is, the period of a half cycle of the square wave is adjusted to equal the time constant of the circuit, with the result that by the end of each half cycle the output wave has fallen to 36.8 percent of its initial value. See Fig. 3(a). Capacitance is given by $C = 1/(2\pi fR)$, and inductance by $L = R/(2f)$.

This choice of repetition rate has the advantage of interrupting the decay voltage at a point of greater slope than in the equal-impedance method. Dimensions of the image on the oscilloscope are more sensitive to changes in circuit parameters and hence, as a measuring method, the time-constant repetition rate has an advantage. However, the amplitude of the initial output voltage, as well as the final decay value, changes rapidly with circuit changes—which is not the case if frequencies near the equal-impedance frequency are in use.

Aside from being a source of annoyance during adjustments—it can be compensated for by continuous manipulation of the oscilloscope gain—this is no drawback. As a matter of technique the equal-impedance method may be preferred; it is quicker. But for higher accuracy, justifiable only if the precautions described previously are observed, the time constant method is superior.

With a particular set of equipment, the two methods can be used interchangeably to extend the range over which measurements can be made. For example, if the high-frequency response of the equipment is limited and the calibrated resistance fixed, use of the time constant method will permit measuring capacitors π times as large as could be measured by the equal-impedance rate.

Extensions of the Method

It is conceivable that other repetition rates could be used. The two frequencies mentioned have been chosen because of their particular significance in circuit analysis. One extension of the response analysis to a square wave of the equal-impedance frequency, which indicates the reason for making measurements at this particular frequency, is in determining the cut-off frequencies of filters or amplifiers.

Cut-off frequencies of communication circuits are often taken in sinusoidal analysis as those at which the output is half the mid-frequency power. This condition occurs at the equal-impedance frequency in simple *RL* and *RC* networks.

Because of the cascading of impedances and the use of compensation networks, the decay curves of communication circuits will no longer be simple exponentials, as in Fig. 3. However, the square-wave frequency at which the output decays to 4.3 percent of its initial value can still be taken as the low cut-off frequency. Thus the equal-impedance method can be used to measure low cut-off frequencies of complex circuits. A similar extension of the method can be made to measure high cut-off frequencies.

Caution must be used in making this extension because it is the deviation from the exponential curve which reveals most about communication circuits. This method only considers the information obtainable from the end points of the circuit response to square waves. Similar use can, with reservations, be made of the time constant method, and to measure high-frequency cutoff.

Measurement of Q Factor

Inductors, because of their distributed capacitances, have self-resonant frequencies above which they behave as capacitors. In choosing chokes and transformers, it is necessary to know not only their inductances, but also the frequency ranges over which they are inductive. By square-wave measurement, the self-resonant frequency of an inductor and its resonant *Q* can be determined.

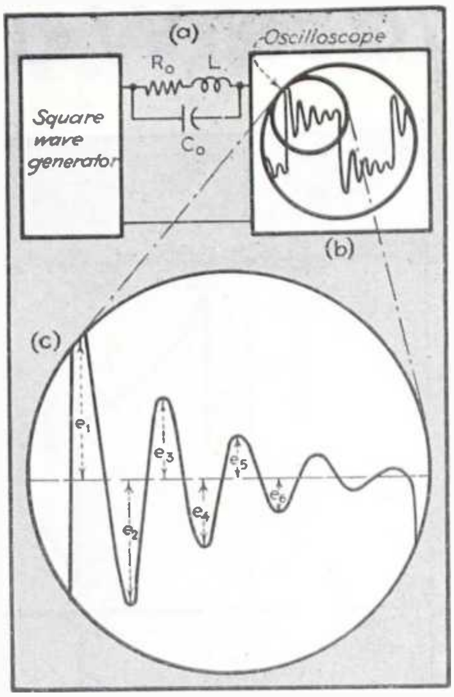


FIG. 4—Equivalent inductor circuit (a) and square-wave response (b) enlarged in (c) from which come values for determining: Natural frequency $f_0 = nF$, where n is the number of cycles per cycle of square wave and F is the square-wave frequency: $R_0 = 2Lf_0 \log_\epsilon (e_3/e_5)$; $C_0 = 1/[(2\pi f_0)^2 L]$; and $O_0 = \pi/\log_\epsilon (e_3/e_5)$

The reactance of the inductor is measured by the previous technique. The inductor is then connected between the high sides of the square-wave generator and the oscilloscope; the low sides of the instruments are directly connected as in Fig. 4(a).

When excited by the multiple-frequency transient of the square wave, the inductor oscillates at its natural period with the result that there is a damped sine wave superimposed on the square wave which is being applied to the oscilloscope through the inductor, Fig. 4(b). The number of oscillations per cycle of the square wave, times the square-wave frequency, gives the natural frequency (f_0) of the inductor.

The square-wave frequency should be adjusted so that a whole number of cycles appears on each cycle of the square wave because counting fractions is difficult. Also, the square-wave frequency should be considerably lower (one-tenth is a convenient ratio) than the natural frequency of the inductor. This is partly because, as the square-wave frequency approaches the self-resonant frequency of the inductor, it forces the oscillations to the extent of changing their frequency, and partly because, with but a few cycles of oscillation per cycle of square wave, errors in estimating fractions or in observing when there are none, increase.

There is no gain in using a square-wave frequency lower than one-twentieth f_0 because of the large number of cycles-per-square-wave which must then be counted. The half period of the lowest square wave that can be used must be no longer than the oscillation decay time of the self-resonant inductor.

The rate of decay of the oscillation is used to measure the a-c resistance of the inductor at its natural frequency. Because the impedance of the inductor at its resonant frequency is more dependent upon the *Q* of the inductor in this range than it is upon the simple inductance, the coil resistance at the natural frequency (R_0) is of greater significance at the upper frequency limit of usability.

This method is illustrated in Fig. 4(c). Transformers can be treated as combinations of self and mutual inductances, each having its own natural frequency and apparent a-c resistance. Critical damping can be quickly determined by this same method. Resonant circuits of all types can likewise be measured.

Neutralizing Impedance Effects

The input impedance of the oscilloscope reduces the shunt-arm impedance while the output impedance of the square-wave generator increases the series-arm impedance of the test circuit. Rather than attempt to correct analytically for these impedances, which can well be complex, it is better to remove their effect, especially since to do so is easy.

Reducing the output impedance of the square-wave generator by means of a cathode follower has been discussed. If the output impedance of the square-wave generator has a d-c path, as it will if a cathode follower is used, all the foregoing circuits provide d-c grid returns. Therefore, an impedance

(*Continued on page 336*)

Microsecond PULSE GENERATOR

ɩesults of investigation to educe deionization time of hyratrons used in a circuit providing pulse-type ignals of variable duration at high repetition rates

By E. F. KIERNAN
*. S. Navy Radio and Sound Laboratory
San Diego, Calif.*

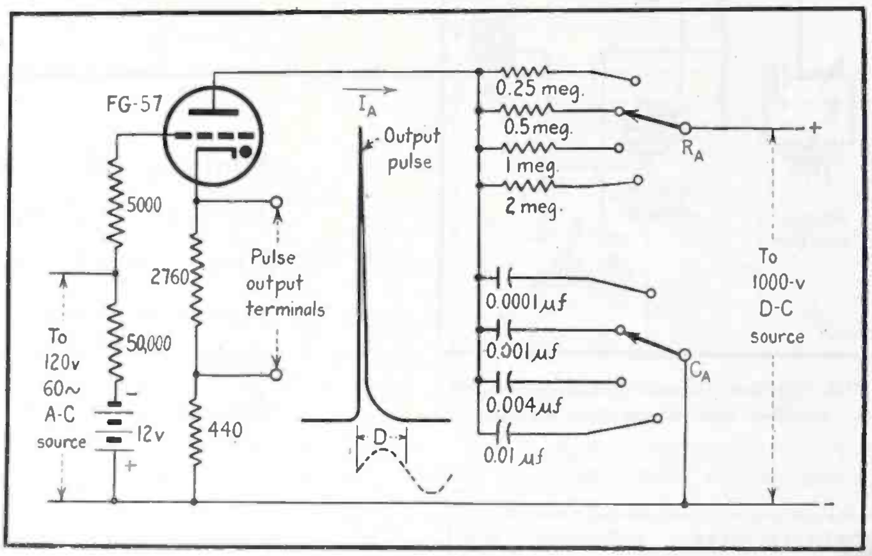


FIG. 1—Circuit used to generate pulses at high repetition rates (up to 400 per sec.), with waveform of output pulse. Performance data is in Table I

ALTHOUGH THE thyratron gas tube has been in common use ɩr some time as a switching or eying device, it has generally een assumed that its repetition ite had definite limitations due the deionization time of the ıs. Several investigators, how-er, have noted that deioniza-on time does not necessarily nit the operational frequency nder all circumstances and odes of operation.

In the course of some develop-ent work, a source of pulse-type gnals of variable duration and riable repetition rate was re-uired. Manufacturer's data indi-ted that the ionization time for typical thyratrons varied between 1 and 50 microseconds, and the deionization time did not exceed 1000 microseconds. Since the break-down or ionization time was well within the requirements, it appeared as though the deionization time would be the pertinent factor. One reference stated that this time varied directly with the gas pressure, inversely as the 3/2 power of the grid voltage, and directly as the 0.7 power of the anode current. It was also stated that as a grid-controlled rectifier the device could not be operated above 5000 cycles.

Obviously, little can be done about the gas pressure, which is fixed at the time of manufacture. The other two factors indicate that large grid voltages and low anode currents should be used to get short deionization times.

The basic test circuit arrangement utilized a thyratron to discharge a capacitor which was recharged from a d-c source through a limiting resistor, as in Fig. 1.

Results for an FG-57 thyratron with 60-cps excitation on the grid are given in Table 1, and show that the duration of the pulse is determined solely by the capacitance of the discharging capacitor. After the capacitor value has been lowered to a point where the capacitor can charge to the applied direct voltage, the amplitude of the pulse is proportional to the size of the capacitor.

The pulses were viewed on the screen of a cathode-ray oscilloscope with a super-imposed transparent reference lattice. Pulse duration was evaluated, with any given setting of the sweep, by means of a sine wave of known frequency from an R-C oscillator. The frequency was adjusted until a half sine wave occupied the same number of divisions on the horizontal scale as did the pulse. Knowing the frequency, the time duration of a half cycle could be readily found.

The values for pulse duration in Table 1 include the points from which the pulse trace leaves the horizontal axis and returns to it. In the case of the 9.4-microsecond pulse the 63 percent and 37 percent points were less than 1 microsecond apart.

Repetition rates between 60 and 400 per second were found practical with smaller tubes such as the 884. Adequate shielding from stray fields and from light is recommended for the gas tubes, especially the more sensitive types such as the 2050, 2051 and 2D21.

TABLE I. TEST DATA

C_A in μf	R_A in meg.	I_A(d-c) in ma.	Pulse Duration in μsec	Pulse Peak Voltage in Volts
0.01	0.25	2.3	130.	751
0.01	0.5	1.6	130.	676
0.01	1	0.9	130.	525
0.01	2	0.05	130.	375
0.004	0.25	2.2	97.5	751
0.004	0.5	1.5	97.5	751
0.004	1	0.8	97.5	638
0.004	2	0.05	97.5	488
0.001	0.25	0.04	18.7	488
0.001	0.5	1.2	18.7	488
0.001	1	0.6	18.7	488
0.001	2	0.3	18.7	488
0.0005	0.25	1.9*	13.1	300
0.0005	0.5	1.2*	13.1	300
0.0005	1	0.5*	13.1	300
0.0005	2	0.3*	13.1	300
0.0001	0.25	2.2*	9.4	150
0.0001	0.5	1.2*	9.4	150
0.0001	1	0.6*	9.4	150
0.0001	2	0.3*	9.4	150

* The a-c grid voltage was changed from 120 115 volts for the last eight sets of readings.

FILTER For Grid-

Analysis of voltage waves in single-phase thyratron rectifier circuits with inductive-input filters, taking into account the variations in harmonic content with conduction angle. Basic equations are developed into a practical design procedure, and examples are given

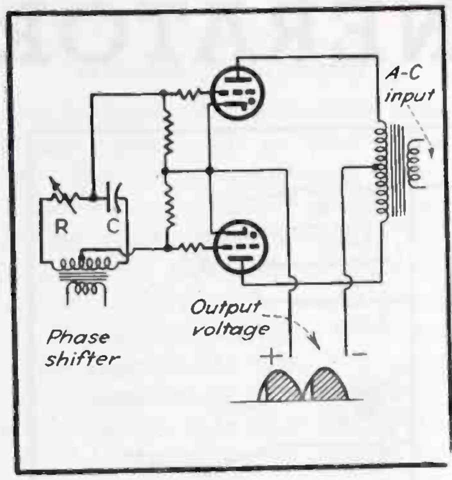


FIG. 1—Basic circuit of grid-controlled rectifier with phase-shift control

SINGLE-PHASE full-wave rectifiers employing gas triodes (thyratrons) have bee nused in numerous applications where accurate and smooth control of the direct-current output is required. In some of these applications adequate filtering is necessary to reduce the output ripple voltage below some specified value. The usual filter design equations used in the case of the high-vacuum or gas-diode rectifiers are not suitable because the magnitudes of the harmonic components to be filtered vary with the conduction angle of the tube.

Grid-controlled gas-tube rectifiers are usually controlled by means of a phase-shifting circuit that controls the point on the anode voltage wave at which the tube starts to conduct.

Rectifier with Resistance Load and No Filter

In Fig. 1 is shown a typical grid-controlled rectifier and phase-shifting circuit for controlling the conduction angle, with an illustration of the type of output voltage wave to be expected for a given angle of delay if the load is pure resistance. The action of the gas triodes and phase shifter circuit will not be discussed further as this is usually dealt with in most texts on electronics, but rather, an analysis of the voltage waves and the design of filters for these waves will be considered in this paper.

In Fig. 2 is shown a typical output voltage wave in which the firing of the tube has been delayed for an angle ϕ and tube conduction takes place through an angle $\theta = \pi - \phi$ if the arc drop is assumed negligible. This recurring wave may be expressed by a Fourier series in the usual manner:

$$e = E_{dc} + \sum_{n=1}^{n=\infty} A_n \cos nx + \sum_{n=1}^{n=\infty} B_n \sin nx \qquad (1)$$

where

$$E_{dc} = \frac{1}{2\pi}\int_0^{2\pi} f(x)\,dx \qquad (2)$$

$$A_n = \frac{1}{\pi}\int_0^{2\pi} f(x) \cos nx\,dx \qquad (3)$$

and

$$B_n = \frac{1}{\pi}\int_0^{2\pi} f(x) \sin nx\,dx \qquad (4)$$

In the case of the wave shown in Fig. 2, $f(x)\Big]_0^{\phi} = 0$ and $f(x)\Big]_{\phi}^{\pi} = E_{max}\sin x$ where $x = \omega t$ and E_{max} is the crest value of the transformer voltage from one end to center tap. In determining the coefficients A_n, B_n and E_{dc} it will be necessary to integrate only through the limits from ϕ to π and multiply the result by two since the half-cycles are identical. Then

$$E_{dc} = \frac{E_{max}}{\pi}\int_{\phi}^{\pi} \sin x\,dx = \frac{E_{max}}{\pi}\left(1 + \cos\phi\right) \qquad (5)$$

The direct current component of the voltage wave thus varies from zero to the value $2E_{max}/\pi$ as the delay angle is varied from π to zero. Figure 3 shows how the ratio E_{dc}/E_{max} varies with ϕ.

Since it is usually necessary to know only the magnitude of the harmonic terms present, a complete Fourier series for the wave is not necessary. Inspection of Eq. (1) will show that the nth harmonic is given by $(A_n \cos nx + B_n \sin nx)$, and therefore the magnitude of the nth harmonic voltage is $E_{n\,max} = A_n + jB_n$. Substituting Eq. (3) and (4) in Eq. (6),

$$E_{n\,max} = \frac{1}{\pi}\int_0^{2\pi} f(x)\,(\cos nx + j\sin nx)\,dx$$

$$= \frac{1}{\pi}\int_0^{2\pi} f(x)\,e^{jnx}dx \qquad (7)$$

Putting in for $f(x)$ its value for the particular wave under study and changing the limits, we get

$$E_{n\,max} = \frac{2\,E_{max}}{\pi}\int_{\phi}^{\pi} \sin x\,e^{jnx}dx$$

$$= \frac{-2\,E_{max}}{\pi}\left[\frac{e^{jnx}\,(\cos x - jn\sin x)}{1 - n^2}\right]_{\phi}^{\pi} \qquad (8)$$

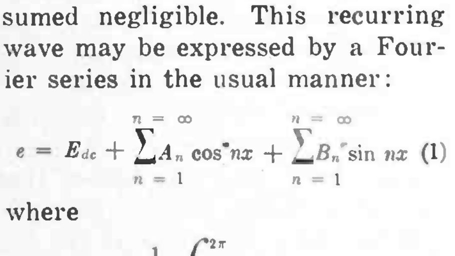


FIG. 2—Wave form for grid-controlled rectifier with no filter

Assoc. Prof. of Electrical Engineering
Texas A. and M. College
By HAROLD A. THOMAS

DESIGN Controlled Rectifiers

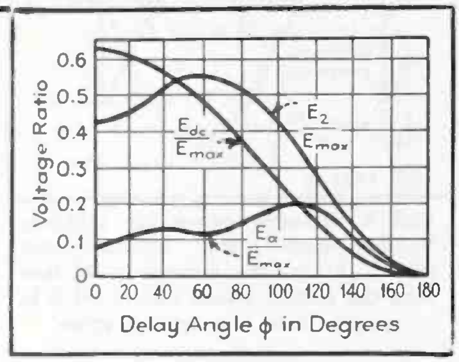


FIG. 3—Output components of a grid-controlled rectifier with no filter

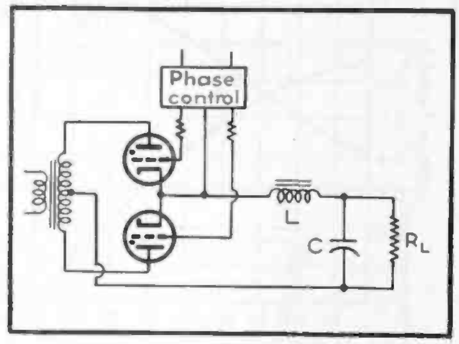


FIG. 4—Grid-controlled rectifier circuit with inductive-input filter

3y applying the principle of symmetry to the wave, it may be seen hat $f(x) = f(\pi + x)$, for which it an be shown that no odd harmonics an exist. If n is given only even alues, the limits substituted and he resulting equation expanded, he following expression for the rest value of the nth harmonic oltage results:

$$E_{n\,max} = \frac{2\,E_{max}}{\pi\,(1 - n^2)} \sqrt{(1 + \cos\phi \cos n\phi + n \sin\phi \sin n\phi)^2 + (n \sin\phi \cos n\phi - \cos\phi \sin n\phi)^2} \quad (9)$$

'igure 3 shows the variation of ne second and fourth harmonic erms with the angle ϕ. It must be tressed that the curve shown in 'ig. 3 can be used only with a nonreactive load as the presence of a lter changes the output voltage rave of the rectifier considerably. his fact is commonly overlooked, s has been pointed out by M. B. tout.[1]

Rectifier with Inductive-Input Filter

It was noticed in Fig. 2 that curent flows for only a portion of each alf-cycle if the load is non-inducve. If a series inductance is dded, the current will tend to flow or a longer period of time but ith a corresponding decrease in ne peak value. If the inductance is nade large enough, current will ow through the load circuit conuously. A critical value of inuctance L_{cr} may be defined as that alue which will just prevent the urrent from dropping to zero at ny portion of the cycle.

If a grid-controlled rectifier with elayed firing angle has an inducve-input filter (Fig. 4) with the alue of the inductance less than ritical, damped oscillatory waves re set up as shown in Fig. 5(a), nd the circuit in general becomes ery unstable. This type of operation is very undesirable and should be avoided by making $L > L_{cr}$ for all values of load current and delay angle.

If $L > L_{cr}$, the tube that is conducting will continue to conduct until the second tube fires, even though the anode potential swings negative with respect to the transformer center-tap over a portion of the cycle as shown in Fig. 5(b). This effect is produced by the induced emf of the input filter choke.

Since for this case the tube drop is constant throughout the whole cycle, it will not enter into the calculation of the harmonic terms and can be subtracted from the direct-current component.

A study of the wave in Fig. 5(b) will show that $f(x) = E_{max} \sin x - E_D \Big]_{\phi}^{\pi+\phi}$ Substituting this in Eq. (2) gives

$$E_{dc} = \frac{E_{max}}{\pi} \int_{\phi}^{\pi+\phi} \sin x\,dx - \frac{E_D}{\pi} \int_{\phi}^{\pi+\phi} dx = \frac{2\,E_{max}}{\pi} \cos\phi - E_D \quad (10)$$

A plot of Eq. (10), neglecting tube drop, is shown in Fig. 6. It is seen that the complete range of output voltage may be covered with only a 90-deg variation of delay angle. Values from this curve should be multiplied by $E_{dc}/(E_D + E_{dc})$ to correct for tube drop.

Substituting $f(x)$ into Eq. (7) gives for the nth harmonic

$$E_{n\,max} = \frac{2\,E_{max}}{\pi} \int_{\phi}^{\pi+\phi} \sin x\, e^{jnx}\, dx \quad (11)$$

which when integrated, limits substituted, and reduced as before (with $n = 2, 4, 6, \ldots\ldots$) gives

$$E_{n\,max} = \frac{4\,E_{max}}{(1 - n^2)} \sqrt{(\cos\phi \cos n\phi + n \sin\phi \sin n\phi)^2 + (\cos\phi \sin n\phi - n \sin\phi \cos n\phi)^2} \quad (12)$$

Since any filter designed to reduce the second harmonic voltage to a specified value will be at least four times more effective for the next higher harmonic, it is necessary to consider only the second harmonic in the design of the filter. Figure 6 shows the variation of the second harmonic voltage at the input to the filter with the delay angle ϕ.

The usual procedure for determining the critical value of inductance required in single-phase full-wave diode rectifier circuits is to neglect all the harmonic terms except the second and solve the resulting equivalent circuit for the direct and alternating components of current through the input choke. The critical value of inductance L_{cr} which will just keep a current flow at all times through the choke can then be determined from the critical condition of $I_{dc} = I_{ac\,max}$. This solution[2] gives $L_{cr} = R_T/1130$ for a 60-cycle impressed voltage, where R_T is the total d-c resistance that the direct component of cur-

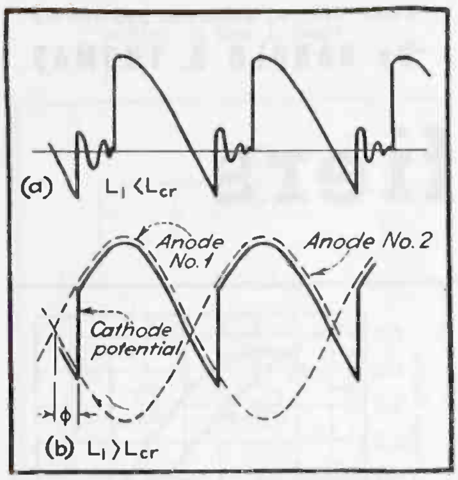


FIG. 5—Voltage waves for grid-controlled rectifier with inductive-input filter. At (a) the inductance is less than the critical value, and at (b) it is greater than the critical value

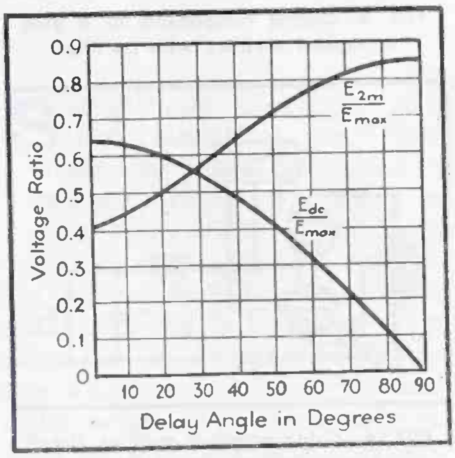


FIG. 6—Output components of grid-controlled rectifier with inductive-input filter

rent must flow through. This equation is correct within about 10 percent for the diode rectifiers except when operating at low voltages, but will give an error of from 25 to 50 percent, depending on the delay angle, for the grid-controlled rectifier. The correct value of critical inductance for grid-controlled rectifiers for different firing angles has been determined in an analysis by Overbeck.[3] The results of this investigation are shown in the curve of L_{cr}/R_T versus ϕ in Fig. 7. The values of L_{cr}/R_T should be multiplied by $(E_D/E_{do}) + 1$ to correct for tube drop.

As mentioned before, the a-c voltages of higher order are not only much smaller initially than the second harmonic but also are attenuated by the filter to a much higher degree, and therefore the percent output ripple voltage of the filter may be defined as the rms value of the second harmonic output voltage expressed as a percentage of the d-c output voltage. Then

$$\%\ \text{Ripple} = 100 \times E_2/E_{dc\ output} \qquad (13)$$

$$E_2 = 4\ E_{max}\ K_\phi\ S/3\pi\sqrt{2} \qquad (14)$$

where

$$K_\phi = \sqrt{(\cos\phi\cos n\phi + n\sin\phi\sin n\phi)^2 + (\cos\phi\sin n\phi - n\sin\phi\cos n\phi)^2}$$

and S, the smoothing factor of the filter, is in accordance with the usual filter design equation

$$S = \frac{1}{(2\omega)^{2a}\,(L_1L_2L_3\ldots L_a)\,(C_1C_2C_3\ldots C_a)} \qquad (15)$$

ω being 2π times the original supply frequency and a the number of sections in the filter.

The direct output voltage is the direct input voltage to the filter minus the voltage drop in the filter:

$$E_{dc\ out} = \left(\frac{2\ E_{max}}{\pi}\cos\phi - E_D\right) - I_{dc}\,R_F \qquad (16)$$

and

$$I_{dc} = \frac{\left(\frac{2E_{max}}{\pi}\cos\phi - E_D\right)}{R_L + R_F} \qquad (17)$$

where R_L is the resistance of the load and R_F is the filter resistance. Substituting Eq. (17) into (16), then substituting the resulting equation along with Eq. (14) into (13) gives

$$\%\ \text{Ripple} = \frac{4\ E_{max}\ K_\phi\ S \times 100}{3\pi\sqrt{2}\left(\frac{2\ E_{max}}{\pi}\cos\phi - E_D\right)\left(1 - \frac{R_F}{R_L + R_F}\right)} \qquad (18)$$

In the case of rectifiers for voltages of the order of a few hundred volts or more and for delay angles up to 60 or 70 deg (larger angles than this are impractical), E_D in Eq. (18) may be neglected. Further, since $R_L >> R_F$, the quantity $1 - R_F/(R_L + R_F)$ of Eq. (18) will be approximately equal to 1 (this approximation can be corrected for later), then Eq. (18) can be reduced to

$$\%\ \text{Ripple} \cong \frac{\sqrt{2}\,K_\phi\,S \times 100}{3\cos\phi} \qquad (19)$$

For a single-section filter at 60 cps, Eq. (19) can be expressed as

$$\%\ \text{Ripple} \times L_1C_1 \times 10^{-2} = 0.831\ K_\phi/\cos\phi \qquad (20)$$

and for a two-section filter

$$\%\ \text{Ripple} \times L_1L_2C_1C_2 \times 10^{-2} = 1.46\ K_\phi/\cos\phi \qquad (21)$$

A plot of Eq. (20) and (21) which may be used for design purposes is shown in Fig. 7. If the d-c resistance R_F of the filter chokes is not small compared to R_L, then the values of percent ripple (L_1C_1) should be multiplied by $(R_L + R_F)/R_L$.

Practical Design Procedure

Ordinarily in the design of rectifier and filter systems the output voltage, current rating, and percent ripple that can be tolerated are specified by the use to which the rectifier is to be put, and it is the problem of the designer to choose circuit elements that will allow the specifications to be met in the most economical way. Unfortunately, when starting with the output or load requirements some cut-and-try calculations may be necessary, though the use of the curves in Fig. 6 and 7 will reduce the amount of work quite appreciably. Also, single-phase rectifiers are used only on relatively low-power installations where high accuracy in the design is not usually necessary.

While the equations predict that the output voltage can be varied from a maximum value down to zero, it is obvious from a study of Fig. 6 and 7 that it would require an infinite filter to do so if low percentage ripple is to be maintained. Practical limits on the maximum delay angle range between 60 to 70 deg. At 70 deg the output voltage will be reduced to about 34 percent of the value with zero delay.

The use of a swinging choke for the input inductance will reduce the cost of the filter considerably. Also, since the percent ripple increases with delay angle, the required LC product should be calculated for the largest delay angle. The following examples illustrate the design procedure for a typical rectifier.

Examples

Assume the load requirements are such that the load voltage is to vary between 500 and 1000 volts with a maximum percent ripple of 0.5 percent, and that the load current is to vary between 100 and 500 milliamperes. Neglecting tube and filter voltage drop as a first approximation, we find from Fig. 6 that $E_{do}/E_{max} = 0.636$ (for $\phi = 0$), or $E_{max} = 1000/0.636 = 1570$ volts. From Eq. (10), $\cos\phi_{max} = 500\pi/2\times1570 = 0.5$, and $\phi_{max} = 60°$.

From Fig. 7, for $\phi = 0$, $(L_{cr}/R_T) \times 10^3 = 0.88$. Since $R_T = 1000/$

$10 \times 10^{-3} = 10{,}000$ ohms, then $L_{cr} = 3.8$ henrys. For $\phi = 60°$, $(L_{cr}/R_T) \times 10^3 = 4.4$. Here $R_T = 500/100 \times 10^{-3} = 5000$ ohms, and $L_{cr} = 5000 \times 4.4 \times 10^{-3} = 22$ henrys. Hence the input inductance should have a minimum inductance of 22 henrys at a current of 100 milliamperes.

The amount of filtering necessary should always be calculated for the maximum delay angle. From Fig. 7, for $\phi = 60°$, percent ripple $\times (L_1L_2C_1C_2) \times 10^{-2} = 5.26$. For 0.5 percent ripple, $(L_1L_2C_1C_2) = 1052$. If L_1 is a swinging choke having 25 henrys at 100 milliamperes and 6 henrys at 500 milliamperes, and if C_1 and C_2 are 4 μf each, then $L_2 = 1052/6 \times 4 \times 4 = 11$ henrys. In this case a single-section filter would have proved impractical because of the large values of L and C required.

Since the inductance values of the chokes are now known, their resistances may be determined from the choke design. Typical values for the above chokes rated at 500 milliamperes would be about 75 ohms each. Hence the voltage drop in the filter would be $2 \times 75 \times 0.5 = 75$ volts. Assuming the tube drop is 10 volts, the actual transformer voltage required would be $(1000 + 75 + 10)/0.636\sqrt{2} = 1205$ volts effective each side of center-tap.

In the above example the effect of ignition voltage on minimum delay-angle and two other corrections mentioned earlier in the discussion were not considered because of their small effect. However, in the case of low-voltage high-current rectifiers, these corrections would have to be made and so for the purpose of illustration they will be calculated for the above rectifier.

It will be noticed from Fig. 5(b) that the cathode-anode potential difference is equal to twice the transformer voltage at the instant of firing, and hence the minimum value of ϕ is the value that will make twice the instantaneous transformer voltage equal to the ignition voltage of the tube. If FG-17 type thyratron tubes are used in the above application, the ignition potential will be approximately 40 volts. Hence $40 = 2E_{max} \sin \phi_{min}$, and also from Eq. (10) (include the filter drop which was determined from the first approximate design), $1000 + 0.5 \times 2 \times 75 = (2E_{max}/\pi)$ $(\cos \phi_{min})$ $- 10$. Therefore $\tan \phi_{min} = 40/1085\pi = 0.00172$, or $\phi_{min} = 1°$ and $E_{max} = 1085\pi/2 \cos 1° = 1705$ volts. Also, $E = 1705/\sqrt{2} = 1205$ volts, which is the full-load voltage rating of the transformer secondary from end to center-tap.

To calculate ϕ_{max} from Eq. (10), $500 + 0.5 \times 2 \times 75 + 10 = (2 \times 1705/\pi) \cos \phi_{max}$, from which $\phi_{max} = 57.2°$. Then from Fig. 7, applying corrections, $(L_{cr}/R_T) \times 10^3 = 4.24$ $(1 + 10/500) = 4.33$, and $R_T = (500/100 \times 10^{-3}) + 150 = 5150$ ohms. Therefore $L_{cr} = 4.33 \times 10^{-3} \times 5150 = 22.3$ henrys. Also from Fig. 7 for $\phi_{max} = 57.2°$, percent ripple $\times$ $(L_1L_2C_1C_2)$ $\times$ $10^{-2} = 4.7$ $(R_L + R_F)/R_L$, and $(R_L + R_F)/R_L = (1000 + 150)/1000$ since this correction should be calculated for the lowest load resistance possible for ϕ_{max}, i.e., for $R_L = 500/0.5 = 1000$ ohms. Then $L_1L_2C_1C_2 = 1080$ for 0.5 percent ripple.

As before, if L_1 is a 25-6 henry swinging choke and C_1 and C_2 are each 4 μf, then $L_2 = 1080/6 \times 4 \times 4 = 11.25$ henrys.

It can be seen that in this example the more exact calculation gave practically the same solution as the approximate design based upon the curves with no corrections except that for the transformer voltage. In low-voltage power supplies, however, it would be well to make an approximate solution from the curves, find the approximate value of R_F and then recalculate the values as was done above.

The curves and design procedure have been checked experimentally and were found to be correct within the limits of experimental error.

References

(1) Stout, M. B., Wave Forms for Half-Wave Rectifiers, Electronics, Sept. 1939.

(2) Eastman, "Fundamentals of Vacuum Tubes," McGraw-Hill Book Co., New York, p. 187.

(3) Overbeck, W. P., Critical-Inductance and Control Rectifiers, *Proc. I.R.E.*, 27, p. 655.

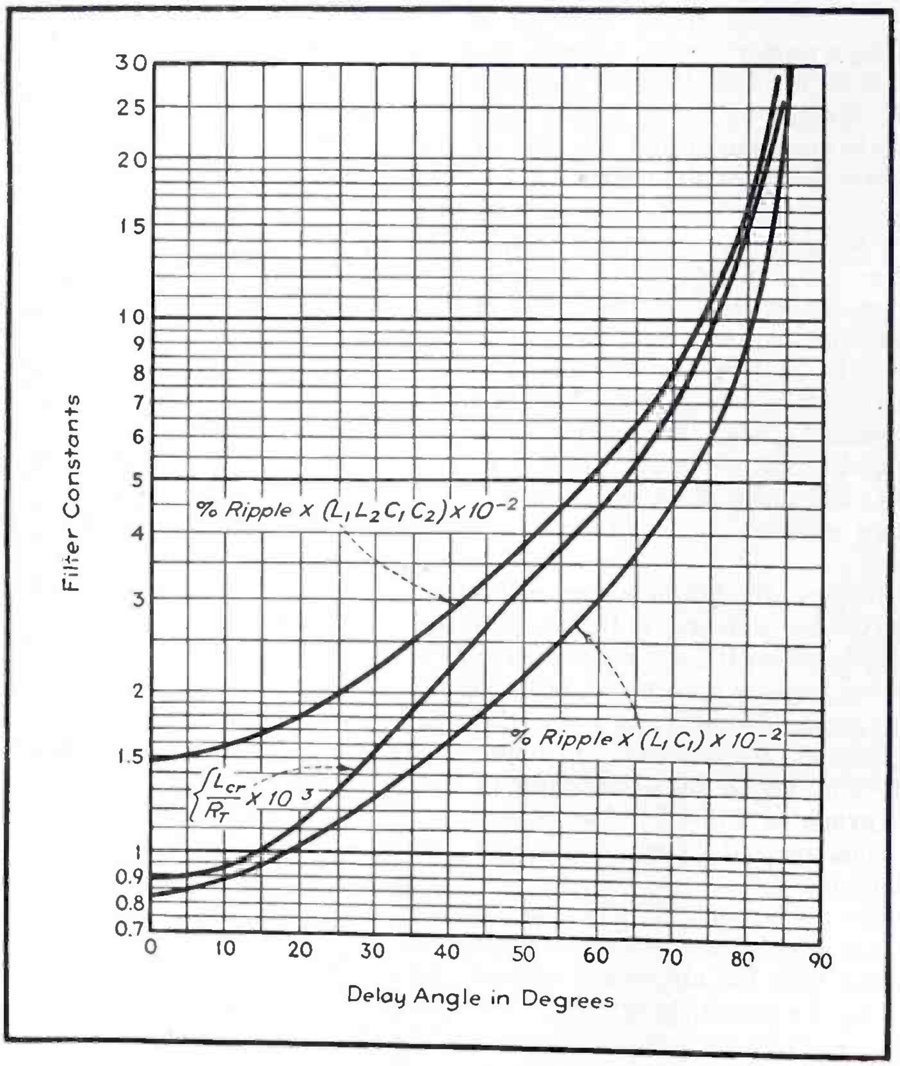
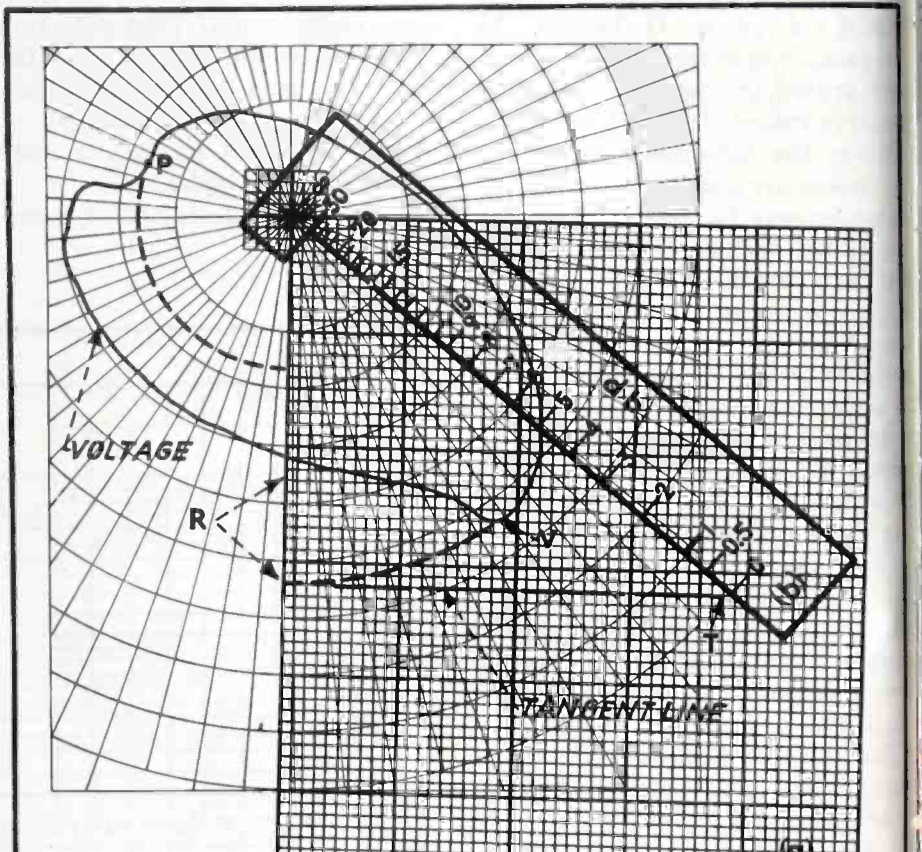


FIG. 7—Curves for determining filter constants for grid-controlled rectifiers

Voltage/db CONVERSION DEVICE

Linear polar-coordinate graphs are readily interpreted. Plotted data need not be normalized and the size of the time-saver is flexible. An antenna radiation problem is worked out as an example

By EDWIN DYKE
Lear Avia, Inc.
Grand Rapids, Mich.



POLAR-COORDINATE GRAPHS following any fixed E^n law may be readily interpreted in terms of db by means of the two-piece transparent plastic conversion device illustrated.

The function of piece (a) is to set up a proportionality between the db scale of piece (b) and the plotted graph. Thus the graph need not be normalized and the size of the two parts of the conversion device is immaterial so long as they are large enough to fit the graph. Piece (a) can be made up readily by ruling squares (any convenient size) on a transparent sheet. For piece (b), the scale shown here can be transferred to a strip of similar material. Two successive photographic negatives of an ink drawing will yield an excellent transparency, often called an "Ozalid transparency.

Suppose, for example, that a linear-voltage antenna radiation pattern (such as the one shown here) drawn to polar coordinates is to be converted. Piece (a) of the device is oriented by centering its upper left-hand corner over the center of the graph with the aid of a pin, and is then rotated to any convenient position.

The vector of maximum amplitude is selected as a reference point V and, with the aid of the nearest arc on the graph, is traced to one edge of piece (a) as shown at R. This edge of piece (a) is now a fixed reference line. At the reference line the arc is tangent to a horizontal line on piece (a).

With piece (a) held in position as described above, piece (b) is oriented by centering its infinity calibration (∞) over the center of the graph, again with the aid of the pin, and then rotating piece (b) until 0 db intersects the tangent line at point T.

The db equivalent of any voltage point on the graph may now be read on the db scale of piece (b). As shown here, for instance, the db equivalent of point P is determined by following an arc to the vertical reference line R, following a horizontal tangent line from that point to the calibrated edge of piece (b) and reading -7.5 db. The same curve plotted in power would yield for the point P, -3.75 db, obtained by dividing the answer by 2.

Follow through!

Follow through! In our business too, we plan and develop an idea, our engineers and laboratories make it practical and economical, production puts it over. But that's not all, field engineers contribute their share of "CINCH FOLLOW THROUGH", right down to the basic mechanical and electrical applications of metal plastic assemblies for the ectronic Industry. Cinch is never satisfied, we constantly improvise, experiment, pioneer, mindful that leadership and follow through must still please you.

CINCH MANUFACTURING CORPORATION
2335 West Van Buren Street, Chicago, Illinois
SUBSIDIARY OF UNITED-CARR FASTENER CORPORATION, CAMBRIDGE, MASS.

INDUSTRIAL CONTROL

Dielectric Heating of Tire Cord Sets Twist

TWIST-SETTING of textile yarns with electronic heating is being accomplished by Industrial Rayon Corp. in a new process invented by the company's technical staff.

The twist of the rayon tire cord is set by submitting packages of the cord to dielectric heating. Heat generated in the cord is distributed so uniformly that spools or cones containing 18 pounds or more of rayon tire cord may be effectively treated. Such giant cones are used in the weftless method of tire construction.

The process is completed in a matter of minutes and results in the production of a cord in which the twist is uniformly set. Control of the moisture content of the cord may be facilitated by wrapping the cones of cord in moistureproof paper before processing.

The equipment originally installed for this process has been in operation at Industrial Rayon's Cleveland plant for more than eight months and includes high frequency power generating units having outputs of approximately 22,500 BTU per hour each. They were furnished by the Girdler Corp., through its Thermex Division, and each unit is capable of handling several thousand pounds of packaged tire cord in a 24 hour period. Additional high-frequency twist-setting units are to be installed in two other plants.

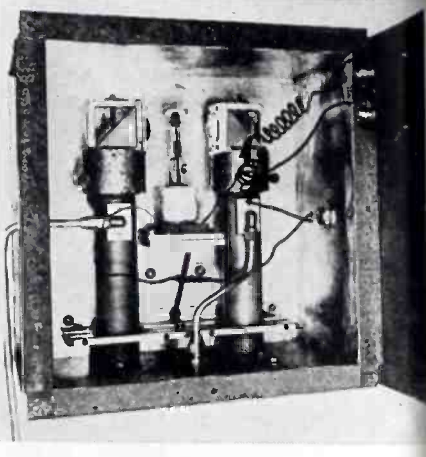
Patent applications covering the use of high-frequency heating for twist-setting of textile products generally, including tire cord, have been assigned to Industrial Rayon. The new process is also being used by The B. F. Goodrich Company, under license from Industrial Rayon, in connection with production of rayon tire cord. Radio Corporation of America supplied the high frequency power units used by Goodrich.

Factory layout of dielectric heating equipment used for setting the twist of rayon tire cord. The 18-lb spools of cord are wrapped in moistureproof paper for control of moisture. The operator at the right is removing plywood covers that were placed over the spools during passage through the heating chambers

Rapid Gas Analysis for Vapor Control

MANY INDUSTRIES are concerned with the problem of controlling contaminated atmospheres. Elaborate air-conditioning systems, special section hoods, etc., are employed in plants to draw off vapors and gases and in many instances workers wear gas masks during certain operations. In spite of these precautions, it is usually necessary to make periodic checks of the air in various parts of the plant to determine whether the concentration of the volatile substance is being held within the safety level.

Most gas analyzers require 15 minutes or more to take an air sample and show only the average concentration of the gas during that period of time. With this technique, momentary high peaks escape observation. An electronic instrument developed at E. I. du Pont de Nemours can run continuous samples and give direct and instantaneous readings. This permits accurate second-by-second observation of the vapor level in each step of a manufacturing process.

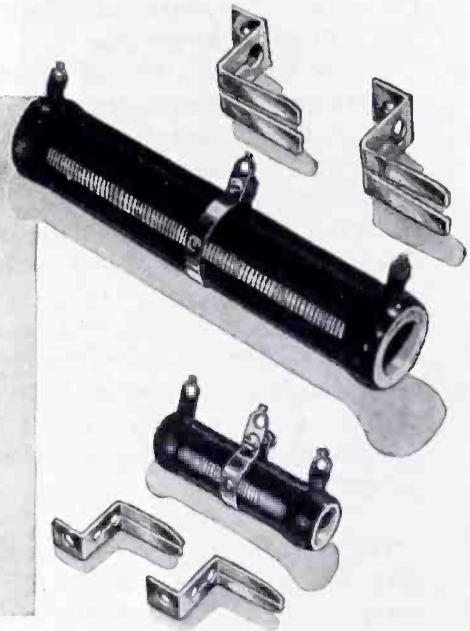


The carbon disulfide analyzer contains a mercury lamp with glass envelope removed and mounted so that its radiation is reflected down absorption tubes to photocells. The contaminated air is also supplied to one tube, then passed through activated charcoal and fed to the second tube for comparison

V. F. Hanson, of the Electrochemicals Department of the du Pont Company, designed the original instrument. A modified model, intended particularly for carbon disulfide analysis, has been developed by Dr. Shirleigh Silverman, assisted by Dr. J. W. Ballou and W. H. Warhus, all of the Rayon

MALLORY Wire-Wound RESISTORS

- ★ *Dissipate Heat Rapidly*
- ★ *Withstand Atmospheric Conditions*
- ★ *Prevent Burnouts and Failures*
- ★ *Stay Accurate*
- ★ *Save Time and Trouble*



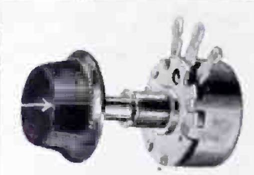
MALLORY resistors are serving today in production, research and actual battle to speed the moment of victory. Every day their usefulness increases as science, widening the field of electrical and electronic development, builds new devices for controlling, counting, measuring, detecting.

You can depend on Mallory resistors to give long, uninterrupted service. The wire-wound units give maximum wattage dissipation and are strongly resistant to humidity. Available in fixed and variable types, they cover every power range from 10 watts to 200 watts. Mallory variable resistors are also stocked in a wide variety of sizes, types and resistance values.

Whatever your needs . . . for original equipment, processing, servicing, experimenting . . . Mallory can help you in your resistor problems. We invite you to send for the latest data.

For standard units consult your nearest Mallory distributor.

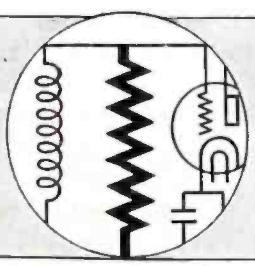
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA



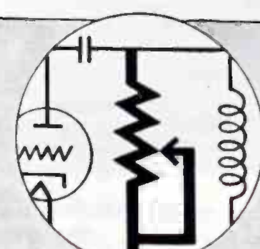
MALLORY TYPE "CA" VARIABLE RESISTOR
Insulated contact arm. Dissipates 2 watts. Total rotation, 280°. Effective electrical rotation, 270°. Diameter, 1⅛ inches.

MALLORY TYPE "E" VARIABLE RESISTOR
Grounded contact arm. Dissipates 9 watts. Total rotation, 310°. Effective electrical rotation, 299°. Diameter, 2$\frac{5}{16}$ inches.

For security— Buy War Bonds



P. R. MALLORY & CO. Inc.
MALLORY
FIXED AND VARIABLE RESISTORS

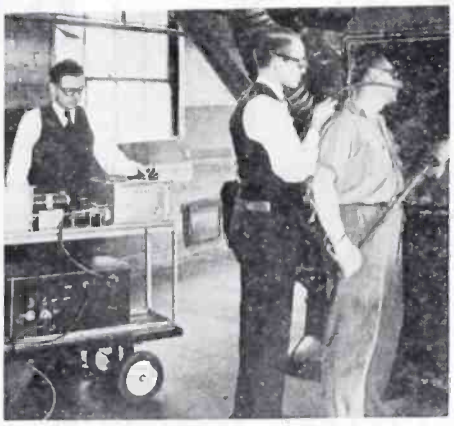


Technical Division of the company. The Mine Safety Appliance Co. is planning to manufacture instruments of this general type.

Operation of the ultraviolet photometer is based on the phenomenon of light absorption by gases. Most gases absorb light of some particular wavelength, in effect casting a shadow where that particular wavelength line would otherwise have fallen. In a spectrum that shadow is known as an absorption line. Carbon disulfide, for example, strongly absorbs light having a wavelength of 3132 Angstrom units, in the ultraviolet range.

Comparison System

The instrument is so constructed that the air to be analyzed is pumped through several small chambers, which filter out dust, oil and moisture, and thence into a pair of parallel tubes, about 31 inches long. The contaminated air runs into the first tube and then through a canister of activated charcoal which removes carbon disulfide, and passes purified air into the second tube. This permits a continuous comparison of the purified with the contaminated air and very minute differences may be detected.



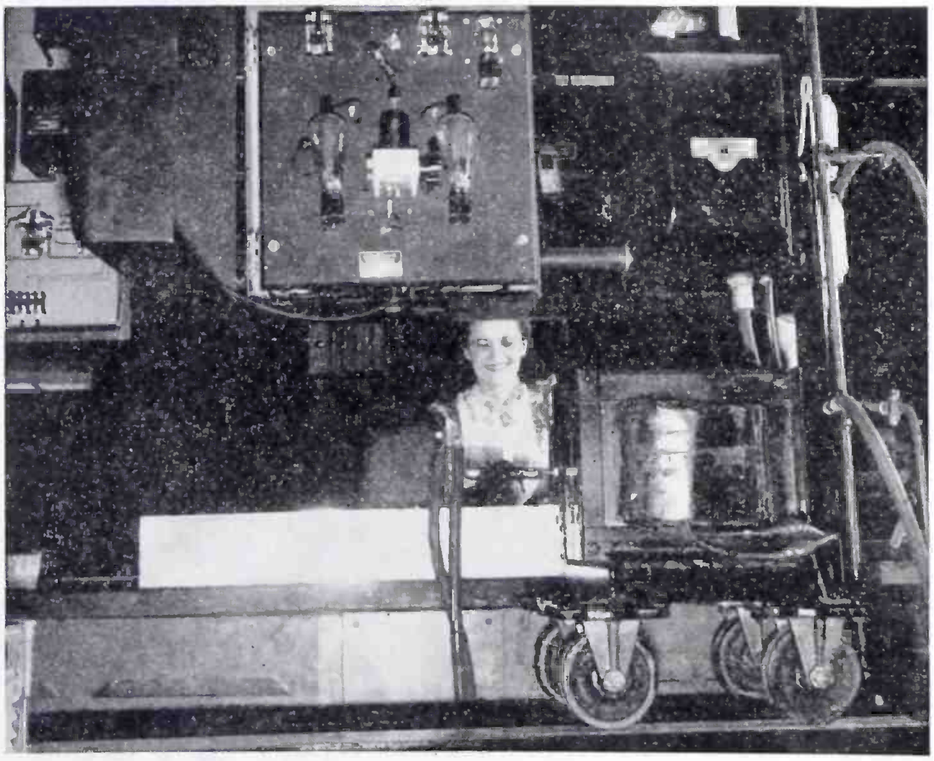
Engineers in the Du Pont plant check on the efficiency of a large suction hose used to draw off fumes during a production process. The intake hose of the analyzer is held at the operator's nose level

Rays of ultraviolet light from a mercury lamp pass through the two tubes and fall upon a sodium phototube mounted at the opposite end of each tube. A vacuum-tube amplifier follows the phototubes and actuates a microammeter for readings.

Filters in the optical system have been so selected that about 60 percent of the photometric response of the cell is due to light of 3132 Angstrom units in wavelength, the light which carbon disulfide absorbs. No other atmospheric element has been found in plants where this instrument is used that absorbs either this band of light or the 3650 Angstrom unit band, which accounts for most of the remainder of the photocell's response. One part of carbon disulfide in a million parts of air will produce an absorption of 0.02 percent.

In one test, 61 readings were made during the nine minutes required to open, dump and clean out a large vessel in which material was treated with carbon disulfide. During most of the operation the concentration of gas remained below 20 parts per million and older methods of analysis, which could give only the average for this entire time interval, would show no danger points. However, the ultraviolet photometer revealed that the concentration rose to 60 parts per million at one moment and to 40 at another. The ventilating equipment was therefore modified in order to eliminate these peaks.

Magnetic Inspection of Bolts and Castings



The tubes on the panel control a current impulse of 40,000 amperes for magnetizing bolts and castings. The transformer is mounted on trucks to permit short lead lengths to the test positions

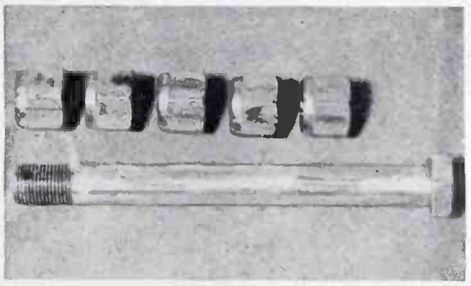
ELECTROMAGNETIC INSPECTION of bolts and other parts made of magnetic material has been made for some time at the Buffalo, N. Y. plant of the Airplane Division of Curtiss-Wright Corp. The equipment used for this purpose shows up flaws and cracks and can handle part sizes ranging from small bolts to reasonably large castings.

When a magnetic substance has electrical current passed through it, a north and a south pole are produced at each crack in the material. When finely divided iron oxide in solution is poured over the material, the oxide particles adhere at the cracks and make them readily visible. The importance of such electromagnetic inspection operations in the production of aircraft has long been considered a vital necessity as a safety measure.

This method of inspection requires a large amount of current and this has been obtained from storage batteries in the past. Main-

tenance cost on the battery equipment has run approximately $3000 yearly. To cut down this expense, A. E. Soderholm, of the company's engineering staff, started work on a method of using electronic equipment to replace the batteries. As a result of his research and study, electronic units were built to specification by General Electric Co.

The electronic equipment shown in the photograph makes available a source of power which is constant, day in and day out, at a fixed



Cracks and flaws in nuts and bolts made visible by the action of heavy current from vacuum-tube rectifiers through the part under test. Iron oxide collects at the crack

amperage. By the use of thyratrons and ignitrons, a current impulse of 40,000 amperes is available which provides deeper penetration and greater concentration of the oxide-iron particles. The estimated yearly maintenance cost of the electronic equipment is $50, principally for replacement of vacuum tubes.

With the vacuum tube power supply as a source of current, the hazard of fire is completely eliminated as there are no electric arcs. Another advantage is the elimina tion of lost motion due to periodi shut downs previously experienc during battery changeover an charging periods.

Flame-Failure Control of Industrial Furnaces

IF THE FLAME FAILS in furnaces fired by pulverized coal, oil or gas, electronic flame-failure safeguards can prevent the development of explosion hazards. In its simplest form, the equipment shuts off the fuel supply and attracts the operator's attention by a signal. Such systems may be modified by the addition of various interlocks, furnace purges, automatic ignition, relights, timers, alarms, and other devices.

Operation of the equipment depends upon detecting a flame's existence by a phototube or an electrode, or both. Furnaces burning pulverized coal or oil, in which flame luminosity is light yellow, or brighter, generally use the phototube detector. Ordinarily a blue flame, such as gas burners make, requires an electrode detector which is a conductor of electricity with a resistance of from 1 to 100 megohms.

At flame failure, the resulting change in the current through the phototube or electrode exposed t the flame is amplified by electroni tubes to the desired value. The cir cuit of one of the simplest forms o flame-failure safeguards is show in Fig. 1. This system, made b Wheelco Instruments Co., is use on an oil-fired furnace with push button opening of the fuel valve an manual lighting of the flame with torch.

Photoelectric System

The diagram shows no-flame co ditions, when, for example, th flameguard has been energized bu the fuel valve is still closed. Th operation of the circuit can b traced by assuming transformer in stantaneous polarity as shown. Sec ondary S_1 supplies current to hea the cathodes of the twin vacuum tube T. Transformer secondaries S_2 and S_3 complete a circuit from cathode C to anode A, secondary S_1 resistor R_1, and secondary S_2. Until there is a flame, phototube P is inactive and there is no potential on

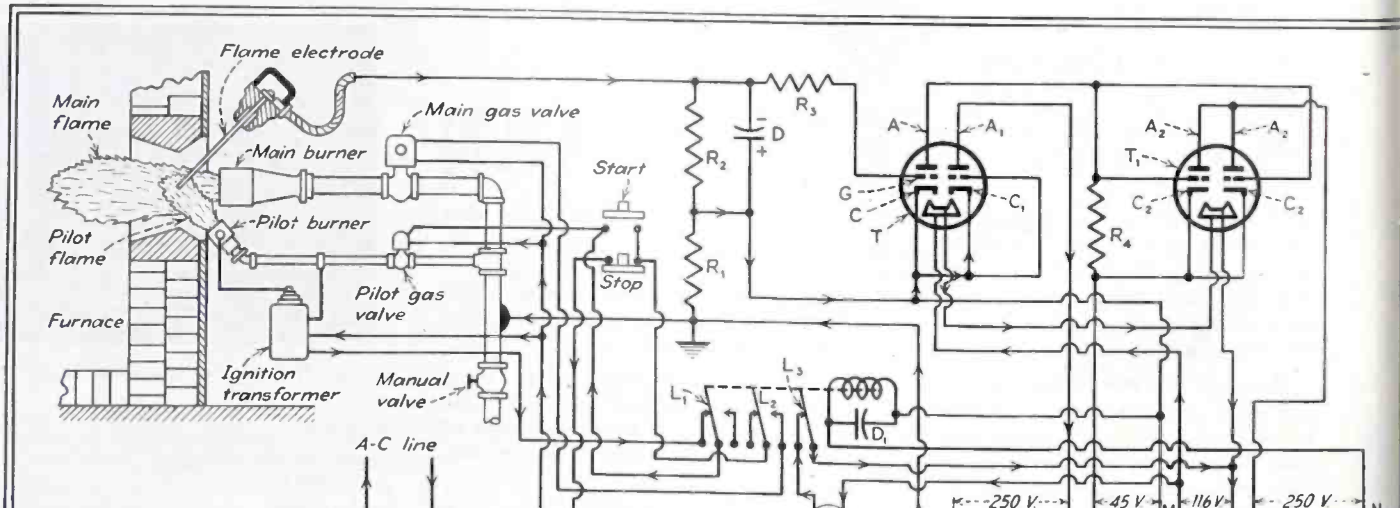
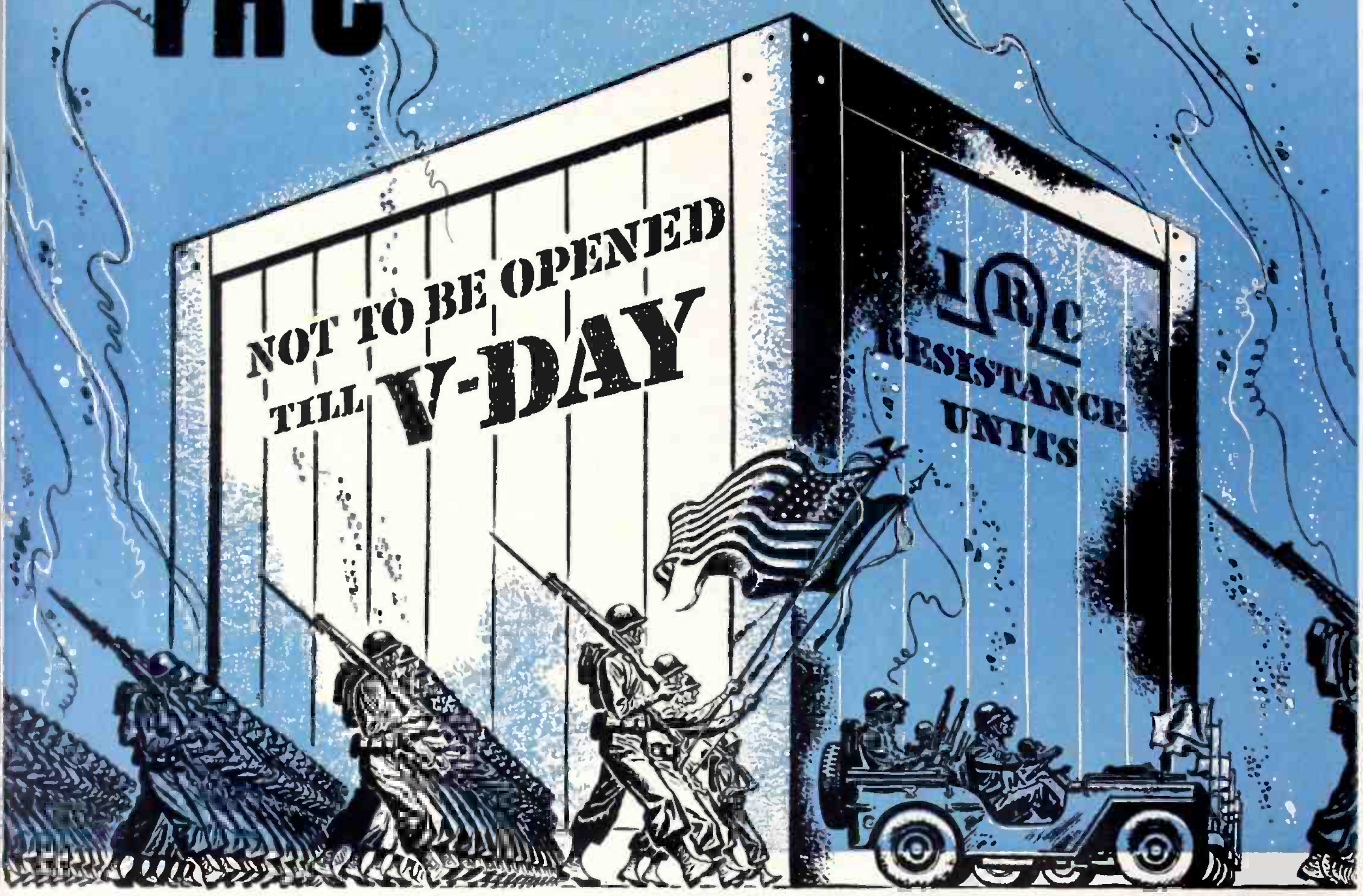


FIG. 2—Circuit of a flame protection system for a gas-fired furnace. Actuated by a flame electrode and electronic amplifier are a solenoid-operated pilot valve, main gas valve, and automatic ignition. The electronic amplifier controls the working units of both the fuel and ignition systems

IRC WILL BE READY



When that Great Day dawns you'll be in the market for new types of components for your electronic devices now in the planning stage. Among your needs will be resistors embodying those characteristics which the new applications demand.

For months, in the midst of war production, the IRC Engineering Staff has been looking ahead—designing, adapting, testing, perfecting—to incorporate in peacetime resistors special features developed for war uses and which will anticipate industry's future requirements.

Yes, "IRC will be ready" to supply resistors of *all types* on a mass production basis. . . . In the meantime and without obligation, our Research Engineering Department invites you to discuss with them (confidentially, of course) any resistor problems connected with your peace-time production.

PREFERRED FOR PERFORMANCE · IRC · FIXED & VARIABLE RESISTORS

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.

grid G, consequently current can flow between cathode C and anode A.

The voltage drop across resistor R_1 puts a negative potential on grid G_1. How this potential is produced can be easily seen by considering secondary S_3 alone. If a connection were made between grid G_1 and cathode C_1, current from S_3 would flow from grid G_1 to cathode C_1, then from C to A, and back to S_3.

In the absence of the connection between G_1 and C_1, there exists a negative potential equal to that of secondary S_3, and this side of the tube cannot conduct. As a result the relay coil remains dead, a circuit for this coil being through secondary S_2, cathode C_1, anode A_1, secondary S_4 and back to the relay, but it is blocked by grid G_1.

Relay contacts, therefore, remain closed in the position shown, and the pilot light is energized through contact L_1 to show a no-flame condition.

Valve Open

Closing the pushbutton connects the fuel-valve-opening coil across the line. This valve opens and when the fuel is burning with sufficient flame the phototube conducts on the reverse transformer polarity from that in the diagram. This circuit is from terminal N of secondary S_2, the relay coil, resistor R_2 to ground through the phototube resistors R_3 and R_4, back to S_2. The anode of the phototube connects between R_3 and R_5, which puts a negative potential on grid G equal to the voltage drop across R_3 and R_4, and charges capacitor D.

When the polarity of the transformer reverses, capacitor D discharges through resistors R_5, R_3 and R_4, and maintains the negative potential on grid G to block the circuit between cathode C and anode A. Blocking the circuit removes the potential on G_1, and the right-hand side of the tube completes the relay-coil circuit.

This circuit is from S_2 through cathode C_1, anode A_1, secondary S_4, the relay coil, and back to S_2. Energizing the relay coil causes it to open contact L_1, to extinguish the pilot light and close contact L, to short-circuit the pushbutton and put the fuel-valve coil circuit directly across the line. When the pilot light goes out the operator knows the burner has been lighted and he releases the pushbutton.

Flame Failure

If for any reason the flame fails, the phototube becomes inoperative and removes the negative potential from grid G. Current can again flow from cathode C to anode A to give grid G_1 a negative potential and block the right-hand side of this tube, as previously explained. Since the circuit is blocked between C_1 and A_1, the relay coil deenergizes, to open contact L and close L_1. The former opens the fuel-valve-coil circuit, and this valve closes to shut

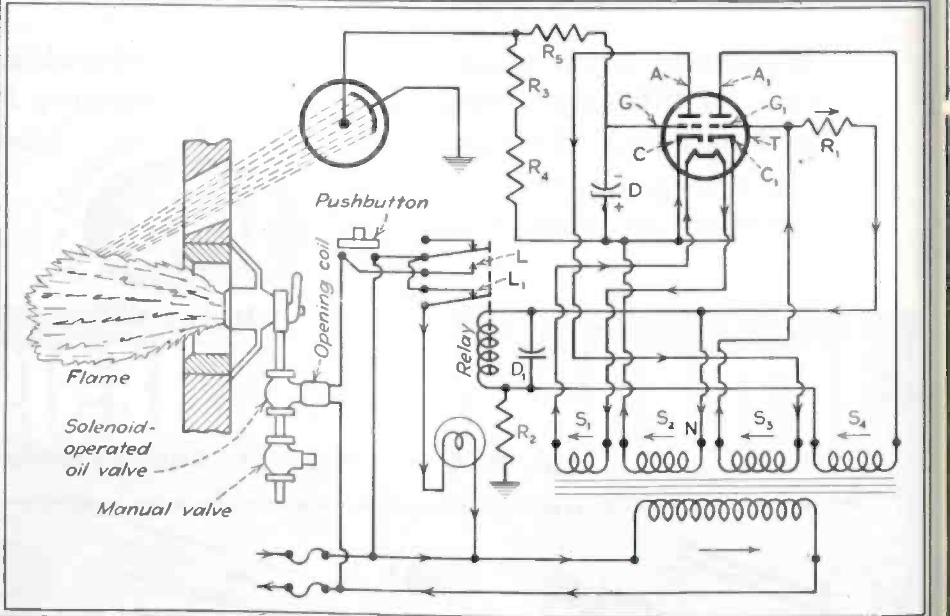
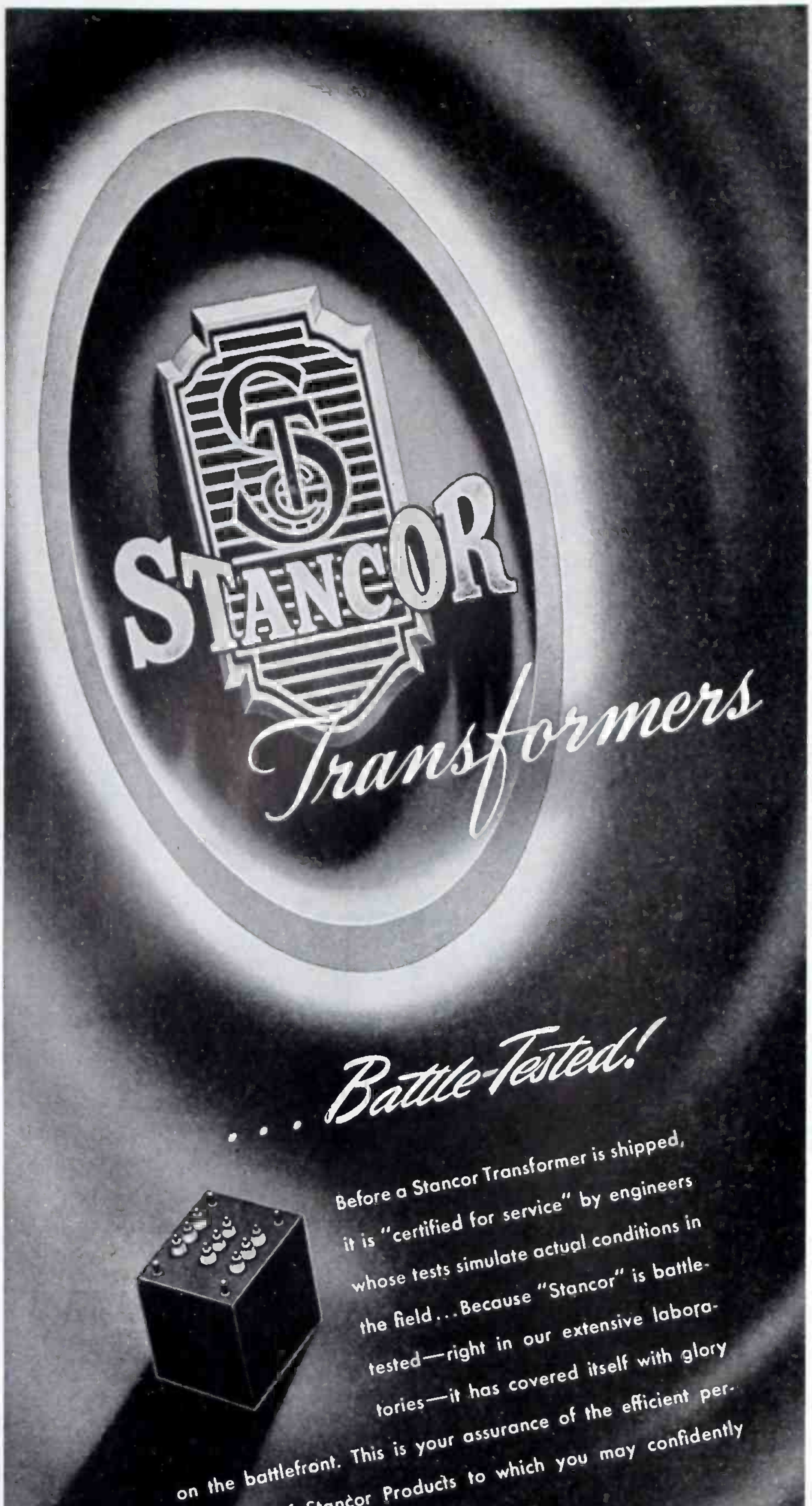


FIG. 1—Simple flame-failure system for an oil-fired furnace. A pushbutton opens a solenoid-operated fuel valve and the flame is lit manually with a torch



off the oil. Closing of contact L_1 lights the pilot lamp to signal the operator that the fire is out.

To prevent the relay dropping out during transient flame disturbances, such as puffs and flickering, that temporarily shut light off from the phototube, a capacitor D_1 connects across the relay coil. Time delay in relay opening after its coil circuit is blocked depends on the size of the capacitor and the charge on it just before flame interruption. This time can be adjusted but if insufficient to overcome effects of transient flame disturbances, it may be lengthened by increasing capacitance.

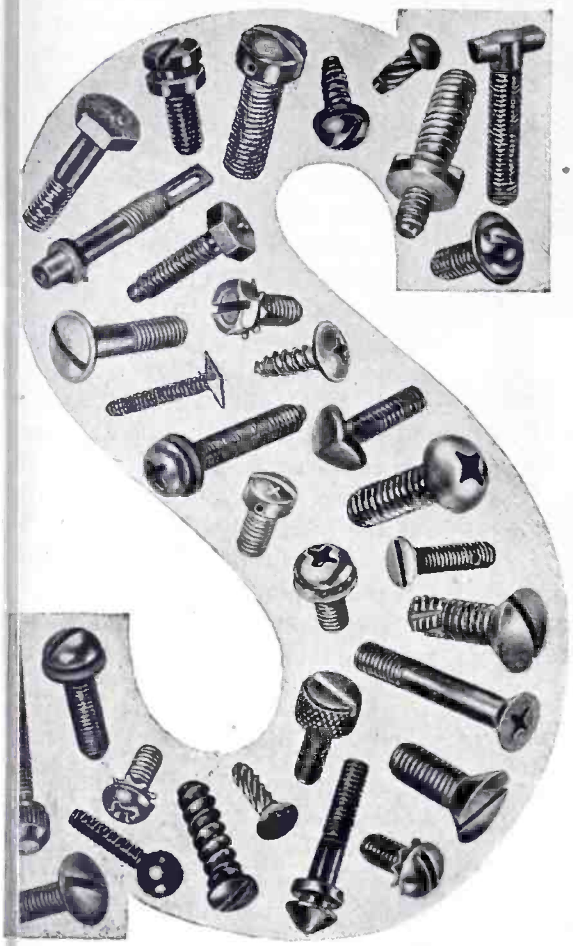
Flame Conduction Type

Figure 2, a gas-burning system developed recently by Brown Instrument Co., includes a flame-electrode, main gas burner, pilot burner and automatic ignition. The control part of the system uses two twin vacuum tubes, T and T_1. Assume no-flame conditions with the line switch closed. The cathodes of the two tubes are heated and the pilot light energized from the transformer secondary S_3, as indicated by the arrowheads. Secondary S_1 completes a circuit through resistor R_1, cathode C_1 and anode A_1 of tube T, back to S_1. Under this condition grid G does not have a negative potential and this side of the tube conducts when the polarity of secondary S_2 is the reverse of that shown. This circuit is from terminal M of secondary S_2 to cathode C, anode A, through resistor R_4, back to S_2. Voltage drop across R_4 puts a negative potential on the grids of tube T_1 to block the relay-coil circuit. This circuit, when not blocked, is from terminal N of secondary S_4 through the relay coil, secondary S_2, cathodes C_2, anodes A_2, back to S_4.

Ignition of Pilot

Closing the start button completes the circuit from the line through the ignition coil, contact L_1, start and stop buttons, back to the line, as indicated. A circuit is also completed through the pilot-valve coil, the start and stop buttons, to the line. The pilot valve opens and the ignition system lights the pilot flame and it contacts the electrode. Then a circuit is completed from secondary S_4 through the flame, the flame electrode, re-

PLAN YOUR FASTENINGS IN THE PRODUCT DESIGN STAGE TO SAVE ASSEMBLY HEADACHES



"Cold-forging"—proof #23
... more each month

The cold-forged part illustrated was designed early in the product design stage, thereby eliminating unnecessary assembly problems. A saving, too, was effected—a saving in money—materials—motions—for the part was cold-forged by Scovill.

Many Scovill customers have profited by planning early and choosing the fastenings—special or standard—that meet their exact requirements. They have called in a Scovill Fastenings expert to help them determine the best kind of fastenings to use—one of our featured standard fastenings, or a part specially designed to fill their specific need.

Each day the practical problems of reconversion and postwar production draw closer—now is the time to let Scovill ingenuity in cold-forging and special design serve you. Call today for a Scovill Fastenings expert to help you decide on the exact modern fastening that will meet your specific need.

3 Standard Fastenings for Production Efficiency

1 Phillips Recessed Head Screws—The modern, effective, time-saving fastening device proven in tens of thousands of assembly lines.

2 Self-Tapping Machine Screws—Eliminate separate tapping operations in making fastenings to castings, heavy gauge sheet metal, and plastics.

3 Washer-Screw Assemblies—Wherever the use of lock washers is indicated, the time-saving of pre-assemblies is obvious.

SCOVILL MANUFACTURING COMPANY
WATERVILLE SCREW PRODUCTS DIVISION

WATERVILLE 48, CONN. TEL. WATERBURY 3-3151

NEW YORK, Chrysler Building • DETROIT, 714 Fisher Building • CHICAGO, 1229 W. Washington Boulevard • PHILADELPHIA, 18 W. Chelten Avenue Building
PITTSBURGH, 2882 W. Liberty Ave. • SYRACUSE, Syracuse-Kemper Insurance Bldg. • LOS ANGELES, 2627 S. Soto St. • SAN FRANCISCO, 434 Brannan St.

sistor R_2, cathode C_1 and anode A_1, back to S_1.

Grid G connects, through resistor R_3, between the electrode and resistor R_2 which puts a negative potential on this grid to block the circuit from cathode C to anode A. Capacitor D is also charged and when the polarity of the transformer reverses, the capacitor discharges through resistor R_3 and maintains a negative potential on grid G to block the circuit through R_4 and S_3.

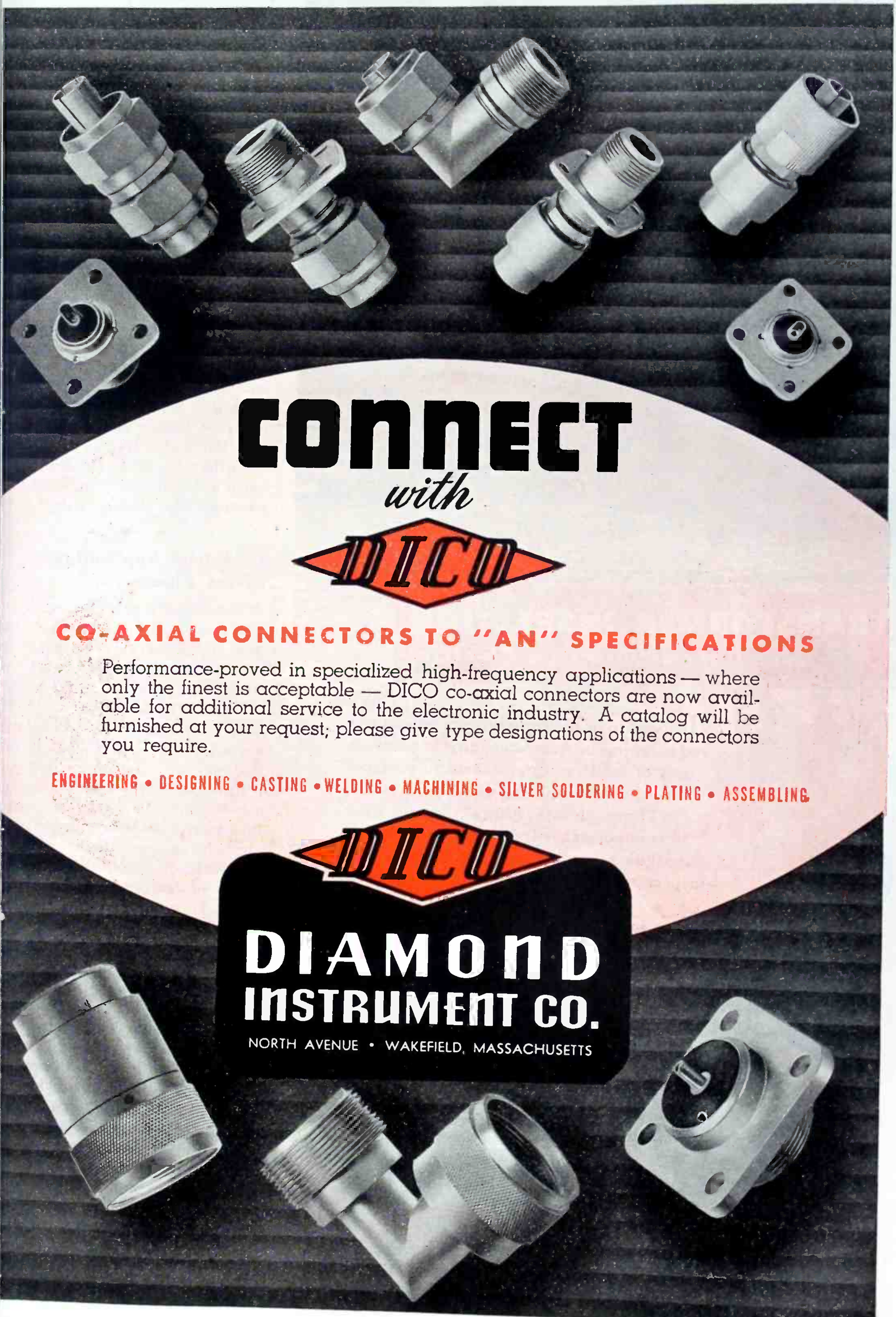
Absence of current through R_4 removes the negative potential from the grids of tube T_1, and the relay coil is energized. The circuit for this coil is through secondary S_2, cathodes C_2, anodes A_2, secondary S_4 and the relay coil. Energizing this coil opens contacts L_1 and L_3 and closes contact L_2. Opening contacts L_1 and L_3 opens the pilot-lamp and ignition-coil circuits, but the pilot valve is held open by the circuit through the pushbutton. When the pilot light goes dark, it denotes that the pilot flame has been established and has contacted the electrode.

Main Flame

Closing contact L_2 completes the main gas-valve coil circuit from the right-hand side of the line, through the main gas-valve coil, contact L_2, the stop button, then to the left-hand side of the line. This valve opens and the operator holds the start button closed, releasing it when the main burner ignites. The main valve circuit remains closed through contact L_2 and the stop button. As long as the flame contacts the electrode, the relay holds its contacts closed to the flame position.

Should the flame fail for any reason, it will remove the negative potential from grid G. This tube will again complete the circuit for secondary S_3 through resistor R_4, to make the grid of T_1 negative and block the relay coil circuit. Its contacts then return to the start position and break the main gas-valve-coil circuit through contact L_2, after which the valve closes. The system then remains in a safe no-flame position until the start button is pressed, when the operations just described repeat.

During normal operation, pressing the stop button opens the main gas-valve coil and this valve closes. The operator holds the button open until


CONNECT
with
DICO
CO-AXIAL CONNECTORS TO "AN" SPECIFICATIONS
Performance-proved in specialized high-frequency applications — where only the finest is acceptable — DICO co-axial connectors are now available for additional service to the electronic industry. A catalog will be furnished at your request; please give type designations of the connectors you require.
ENGINEERING • DESIGNING • CASTING • WELDING • MACHINING • SILVER SOLDERING • PLATING • ASSEMBLING
DICO
DIAMOND INSTRUMENT CO.
NORTH AVENUE • WAKEFIELD, MASSACHUSETTS

he sees the pilot lamp light, when he knows that the equipment has returned to safe no-flame position.

If the electrode were to bend down and touch the gas burner it would form a closed circuit to ground the same as when a flame exists. This danger is provided against because when the electrode grounds, capacitor D discharges so rapidly that the potential on grid G decreases to where its side of the tube conducts and makes tube T_1 grids negative to block this tube. The tube then acts the same as when the flame extinguishes; the relay opens its contact to close the fuel valve and light the pilot light. This system is therefore protected against either breaking or short-circuiting of the electrode. If the electrode breaks and does not contact the flame, it creates no-flame conditions to close the main fuel valve automatically. Grounding the electrode also closes the fuel valve.

• • •

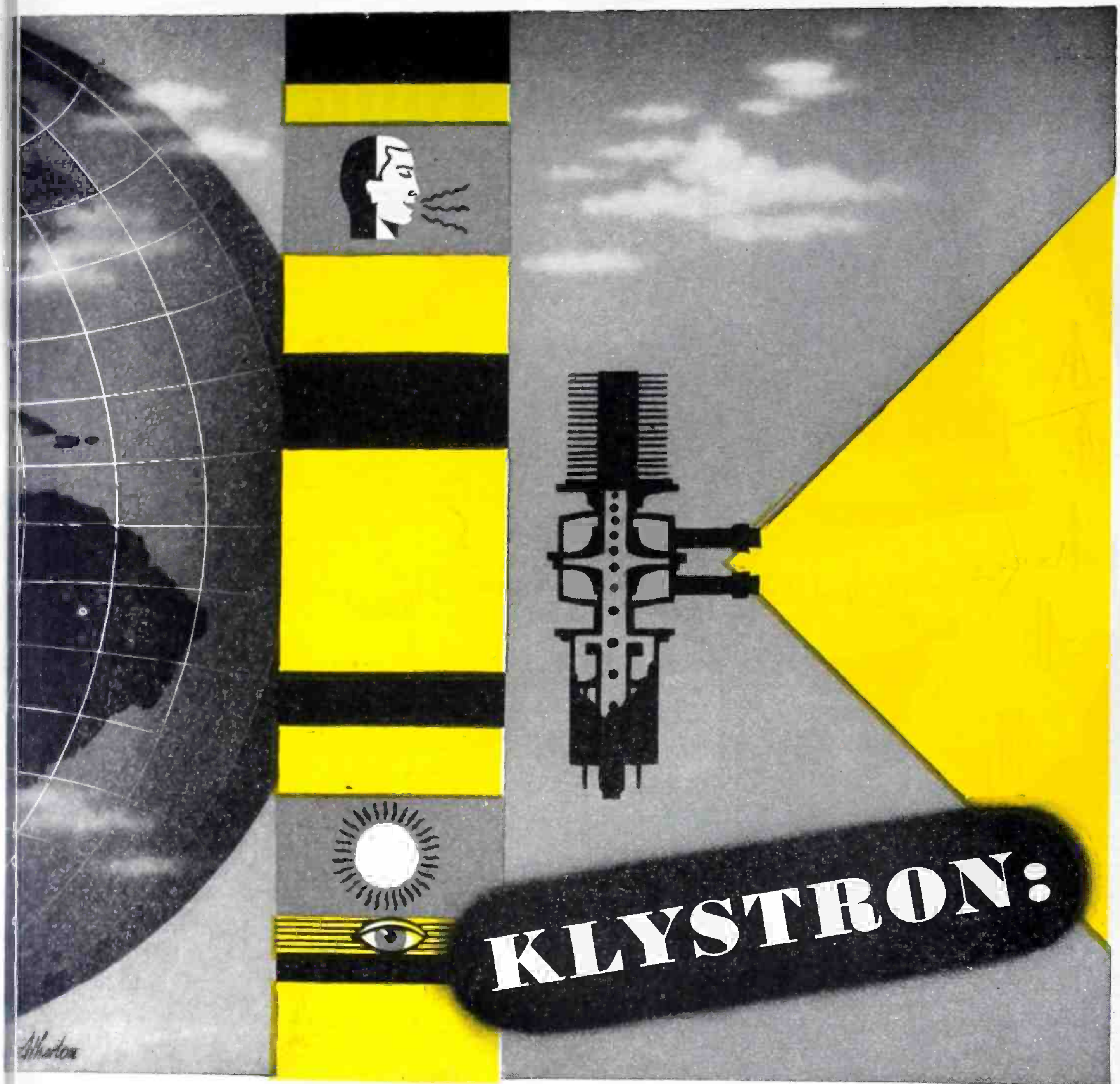
Industrial Applications of the Fluoroscope

A COMPARISON of radiographic and fluoroscopic techniques that have been developed as part of the expansion of industrial x-ray use since the start of the war was made by R. W. Mayer of Kelly-Koett Mfg. Co. in addressing the Pittsburgh section of the American Industrial Radium and X-ray Society. He pointed out that the Government, as a customer, will not be in the picture to require x-ray inspection of airplane castings, tank welds, armor plate, etc., from the sole standpoint of safety—although there might be some government safety regulations calling for x-ray inspection of certain vital parts of airplanes used as public carriers.

"Many industrial x-ray users who started using the equipment originally because of government requirements, have learned the value of inspection beneath the surface for the information it provides, enabling them to improve quality, reduce costs and save labor. It is likely that these users will pass along what they have learned and establish acceptance standards of their own on purchases of castings, welded parts and assembled units.

Equipment

"One contribution to industrial x-ray expansion is the improvement



Makes *vhf* waves behave

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

The ultra-high-frequency waves hus generated are so short that they pproach heat and light waves in the lectro-magnetic spectrum.

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

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

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

• •

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

Sperry Gyroscope Company INC.

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

ROSCOPICS • ELECTRONICS • AUTOMATIC COMPUTATION • SERVO-MECHANISMS


IS YOUR STATION
Illustrations show part of RCA's
complete line of Faradon Condensers,
extensively used in stations everywhere
BUY MORE WAR BONDS

of presently available types of x-ray machines and the creation of new machines and accessory devices as our own knowledge increases. Progress thus far has been much greater along the lines of straight radiography than on fluoroscopy. The reason for this is that x-ray has been, for years, a tool for the medical profession and equipment and medical traditions have been carried over into industry. For example, the standard medical size 14 x 17 in. film is just about right for the human torso, but no engineer would have established such dimensions, although they happen to work out very satisfactorily.

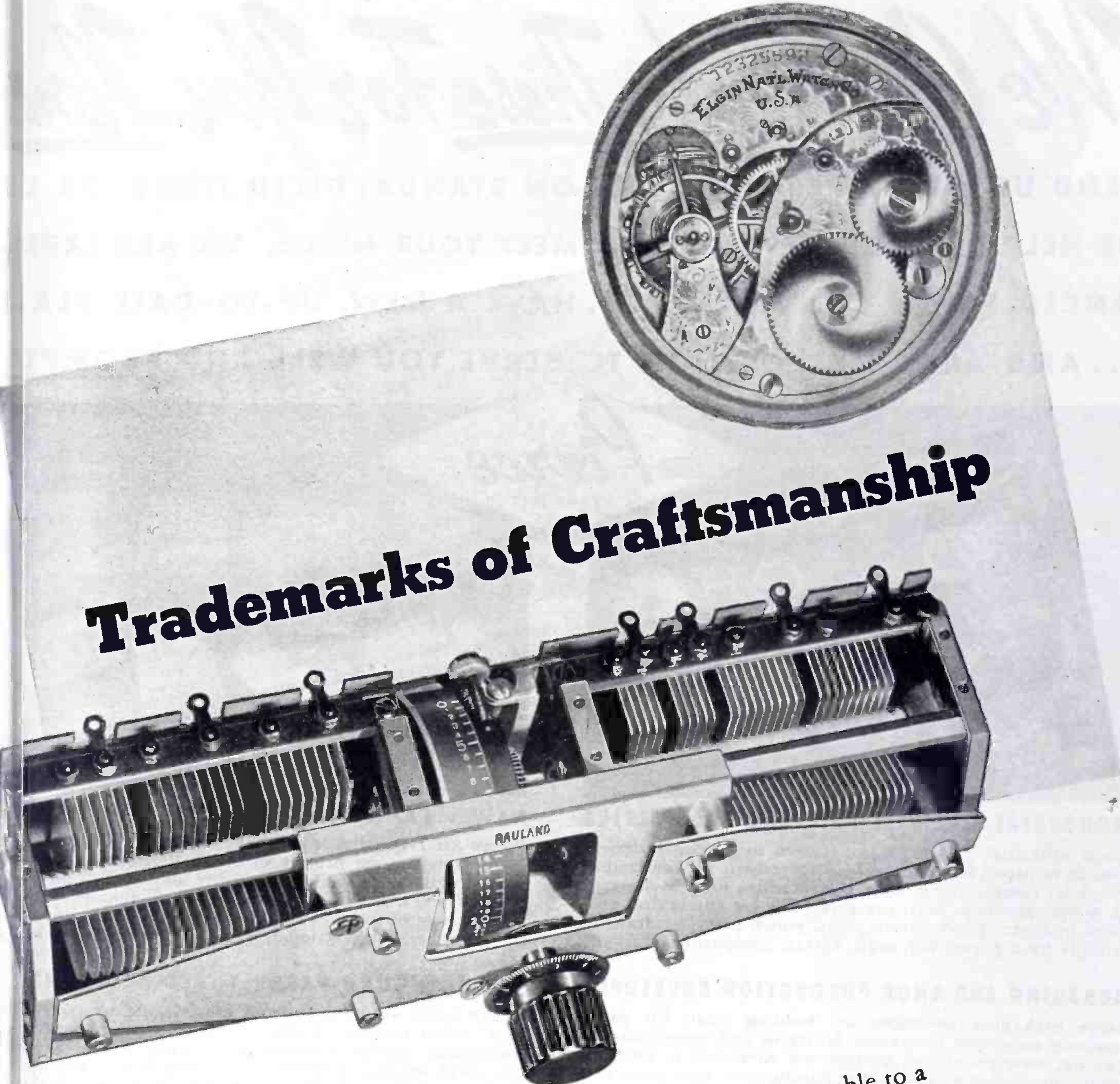
"Medical x-ray equipment for radiography required only minor modification for industry, but the medical fluoroscope is another matter. The principal reason for the slow development of the fluoroscope in medicine is the limit of x-ray that a patient can stand with safety. Medical machines are made to cut back automatically to 5 milliamperes when used for fluoroscopy, and the radiologist is extremely careful to restrict the time that a patient is exposed.

"For some time the fluoroscope has been used to spot the presence of foreign bodies in packaged food, tobacco, soap, cereals, etc. One large manufacturer of chewing tobacco experienced labor troubles and when the strikers left their jobs they tossed nails, hairpins, and other foreign articles into the pile of unpackaged tobacco. That tobacco company now has a fluoroscope, and a girl observes and checks every package. There is no difficulty in detecting such impurities since they are usually metallic or, at least, of a density vastly different from the pure article, and fall under the general heading of gross defects. The only problems on such inspection are those of a mechanical nature.

Improved Sensitivity

"Fluoroscopic inspection permits instant separation of the good from the bad—no waiting for films to be developed and dried, no film at all, no dark room, no delay. Savings mount, costs go down, and for these reasons there have been many attempts to widen the field of application of the fluoroscope, but the stumbling block has always been

Trademarks of Craftsmanship



The RAULAND Tuning Capacitor is a true precision instrument, comparable to a fine watch in craftsmanship quality. But minutely-controlled tuning had to be made battle-worthy. So RAULAND engineers created a special shock-absorbing chassis for this finely adjusted tuning mechanism to insure its complete operating dependability under even the roughest tank battle maneuvers and artillery vibration. A typical example of RAULAND precision craftsmanship and engineering thoroughness.

ADIO . . . SOUND . . . **Rauland** . . . COMMUNICATIONS

Electroneering is our business

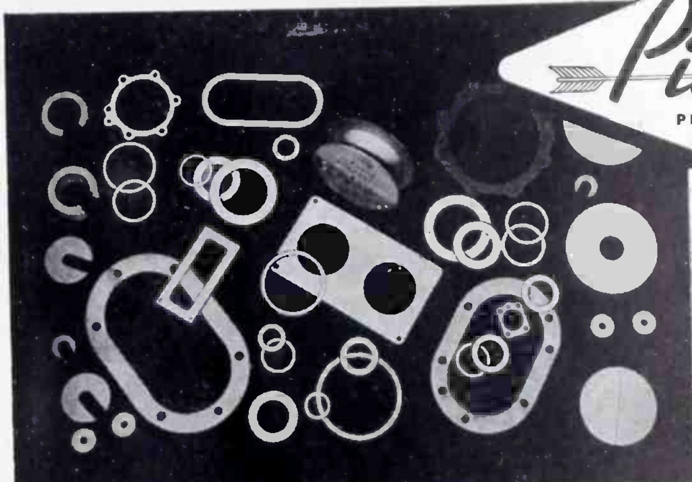
THE RAULAND CORPORATION . . . CHICAGO, ILLINOIS

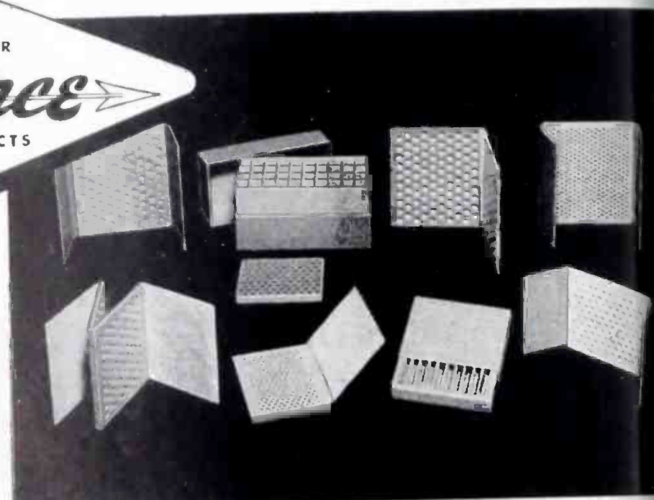
y War Bonds and Stamps! Rauland employees are still investing 10% of their salaries in War Bonds

We Can Make These For You...Now

SEND US YOUR SPECIFICATIONS ON STANDARDIZED ITEMS, OR LET US HELP DEVELOP NEW USES TO MEET YOUR NEEDS. WE ARE EXPERIENCED PAPER CONVERTERS . . . HAVE A NEW, UP-TO-DATE PLANT . . . AND ARE IN A POSITION TO SERVE YOU WELL AND PROMPTLY

PAPER Pierce PRODUCTS





INDUSTRIAL GASKETS; DIE CUT SPECIALTIES

Pierce industrial gaskets: manufactured to precision dimensions from paper, felt, cork, asbestos, synthetic rubber, leather or special compositions; meet specifications for resistence to oil, water, gasoline, heat, pressure. Die-cut specialties: produced by rotary press, platen press, punch press, or drawing methods from paper, felt, cork, special compositions.

PACKAGING AND SHOP PRODUCTION ENVELOPES

Pierce packaging envelopes for holding small flat parts; metal-top envelopes for secure fastening and convenient re-opening; waterproof and greaseproof envelopes to meet all specifications; duplex shop-order envelopes — with protective glassine panels: the modern method of keeping blueprints and production orders together during work in progress.

NEW...SAF-T-PAK BOXES FOR SMALL PARTS

Pierce Saf-T-Pak Boxes: specially designed to individual requirements for the protection of small precision parts and other fragile items easily damaged in shipment. Can be produced from kraft, chipboard, or special compositions in a wide variety of forms with die-cut cells, cushion liners, partitions, other construction features of protective packaging.

SPIRAL-WOUND PAPER TUBES AND CANS

Pierce spiral-wound tubes and cans: in diameters from ½ to 6" — any required length — from waterproof paper, kraft, chipboard, special compositions. Also, Pierce Saf-T-Pak tubes with felt liner for protection of fragile parts in shipment. Pierce protective caps and tubes for male and female threads made in any size, waxed or plain.

PAPER Pierce PRODUCTS

★ **WRITE FOR SAMPLES AND COMPLETE INFORMATION**

Manufactured by **PIERCE PAPER PRODUCTS CO., 2726C AUBURN STREET, ROCKFORD, ILLINOIS**

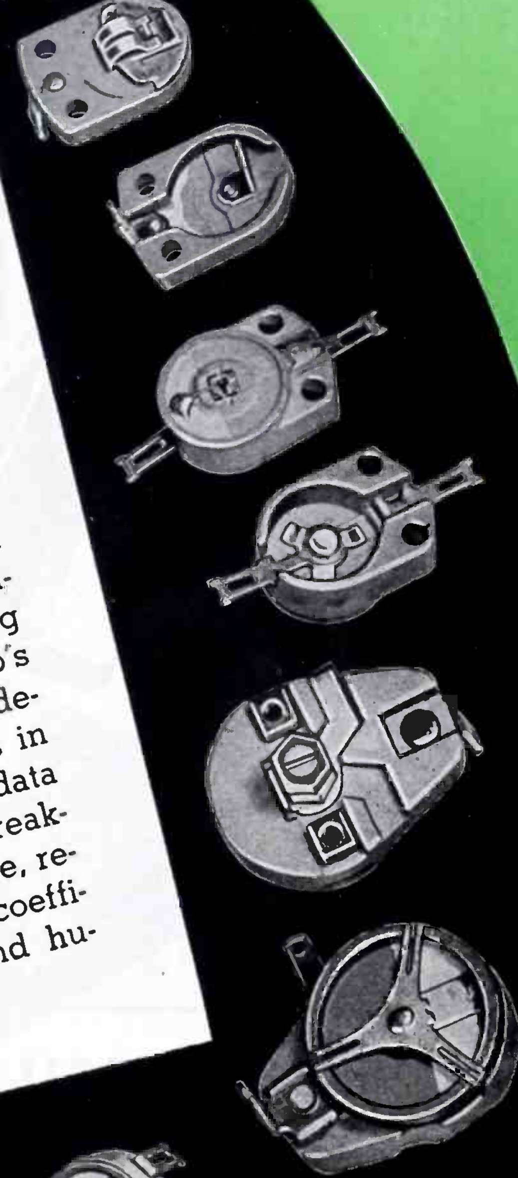
Centralab

CRL

CERAMIC TRIMMERS

Here are trimmer capacitors of compact size . . . full capacity range obtained with 180° rotation, and equal stability . . . maintained at any position from minimum to maximum.

Centralab Ceramic Trimmers are stable under vibration without any special locking device, due to the light weight rotor that is always in balance and under constant heavy spring pressure. Send for Centralab's revised Form 695 which describes the various styles in current production with data on capacity ranges, breakdown, leakage resistance, retracking, temperature coefficient, power factor and humidity characteristics.



CENTRALAB'S CERAMIC TRIMMERS are easily adjusted by means of a screw driver.

ARMY E NAVY

Centralab

CRL

Division of GLOBE-UNION INC., Milwaukee

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

lack of sensitivity. Until very recently, a sensitivity of 15 percent was considered normal, 10 percent good, and under very unusual circumstances, 8 percent might be seen. Today, these limits can be just about cut in half and a sensitivity of 5 percent or better can be counted on as a regular day in and day out production standard.

Limitations

"It is well to recognize some of the inherent limitations of fluoroscopy. In the first place, radiographic technique charts on penetration do not apply. Considerably higher voltages are required on a fluoroscope than on a film. The time factor, which permits the effect of the x-rays to accumulate on film, is totally absent on the fluoroscopic screen. The screen shows only the instantaneous image. True, there is some "after glow", but that is a different phenomenon entirely.

This limitation immediately translates itself into a limit of thickness that can be fluoroscoped because it is not practical to use a unit of more than 220 kv or 250 kv capacity for fluoroscopy. The reason for this limit is principally a matter of safety. As the voltage is increased over these limits, there must be more than a proportionate increase in the thickness of lead and lead glass of the viewing cabinet. Moreover, with fluoroscopy, the x-ray is left turned on for a much longer period of time than is the case with radiography, which increases the importance of providing adequate protection. Our industrial laboratory has found the practical limits to be approximately 2" of aluminum and approximately ½" of steel.

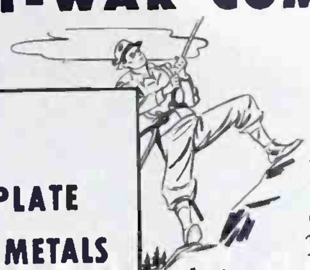
"A second limitation is sensitivity. Radiographic penetrameters are based on 2 percent sensitivity, although on good radiographic work, flaws on the order of 1 percent can be shown. While some excellent sensitivity claims have been made on the part of reliable observers, we prefer to state that the fluoroscope is practical for sensitivities of 5 percent and a little better, at this time.

"Thirdly, the fluoroscopic screen provides no permanent record. The results obtained are in what the observer sees and if a check is re-

GET A

Firm Foothold

ON POST-WAR COMPETITION



USE GENERAL PLATE LAMINATED METALS

NOW!

Establish a firm foothold for your post-war products by incorporating General Plate Laminated Metals in your contemplated peace-time products. These permanently bonded laminations of silver or other precious metals to base metal, or base metal to base metal combinations provide specific performance advantages often not found in solid metals.

Precious metals laminated to base metals provide solid precious metal performance at a fraction of the cost of solid precious metals. They provide high electrical conductivity, corrosion resistance, long life, etc.

Base to base metal combinations give performance requirements not found in solid base metals.

Several new metal combinations . . . developed since the war . . . will also be available for peace products. Get a start on post-war competition, investigate General Plate Laminated Metals, today. Our engineers are available for consultation and recommendations. Write specifying your problems.

General Plate Laminated Metals... are available in sheet, wire and tube . . . inlaid, laminated one or both sides, or as complete fabricated parts. They can be had in combinations of precious to base metal, base to base metal, precious to precious metal.

GENERAL PLATE DIVISION

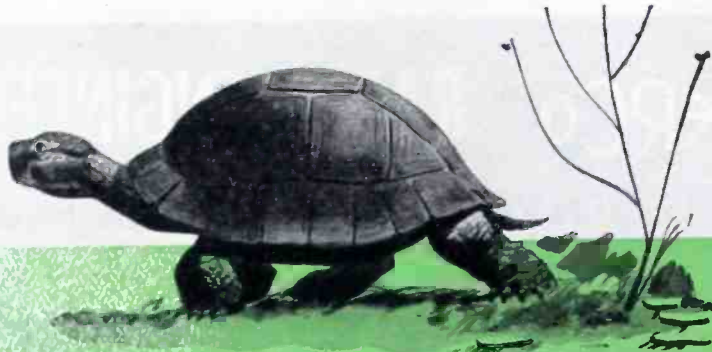
of Metals & Controls Corporation

ATTLEBORO, MASSACHUSETTS

50 Church St., New York, N. Y.; 205 W. Wacker Drive, Chicago, Ill.; 2791 Kensington Place East, Columbus, Ohio; 2635 Page Drive, Altadena, Califor

Metals and Controls Corporation Divisions manufacture the following products: Laminated & Solid Precious Metals, Electrical Conta Solid and Rolled Plated Precious Metals in all forms—Truflex Thermostat Metals.

SLOW AND STEADY



...WITH NO SPEED VARIATIONS

Recently, a manufacturer building secret military apparatus called for a small, compact electric motor that provided unfailing, uniform slow speed. Since standard "off the shelf" gear motors could not meet the strict performance and design specification, the only solution was a special motor.

Holtzer-Cabot motor development engineers tackled the job and designed a special synchronous gear motor that exactly met all the operating conditions... and another military device was on its way to help win the war.

Today, Holtzer-Cabot is designing and building special fractional HP motors for war products, only. However, our motor development engineers, backed by over 50 years of experience in electric motor design will gladly cooperate with you on your motor requirements and problems for post-war products.

SPECIAL MOTORS DESIGNED TO FIT THE APPLICATION

HOLTZER-CABOT

Division of First Industrial Corporation

Designers and Builders of Special Fractional HP Motors and Electrical Apparatus

125 Armory Street, Boston 17, Mass. Chicago, Ill., New York, N. Y., Philadelphia, Pa.

quired, other means must be used.

"Fourthly, the degree of success with fluoroscopy depends on personal factors to a greater degree than is the case with radiography.

Advantages

"These limitations have been listed in order to make it clear that fluoroscopy must not be considered a complete substitution for radiography. In the final analysis, the fluoroscope has definite advantages of time and cost and also has certain exclusive advantages of its own. For example, a radiograph provides a picture in only one plane, but in a fluoroscope the part can be rotated which provides a third dimension to definitely fix the location of the defects. Also, certain types of defects, such as cracks and fissures will only appear on a film if the part is so placed that the plane of the crack lines up with the direction of the x-ray beam. The chances are very slim indeed of being able to place a part on film in exactly such a position, but in a fluoroscope the part can be twisted and turned until—suddenly—there it is.

"On most applications, fluoroscopy will find its greatest value as a supplement to radiography rather than to be used alone. That is, the ultimate in an inspection set up—that lends itself to fluoroscopy at all—is a combination layout arranged to provide ready changeover from one to the other without sacrificing any of the advantages of either.

Needs

"Let us consider what this involves. A fluoroscopic screen is observed through lead glass and the only practical arrangement involves the use of some sort of lead lined cabinet with lead glass viewing window. Since such a cabinet must have all the elements of protection required for radiography, and since the same x-ray generating equipment can be used for both fluoroscopy and radiography, it becomes unnecessary to construct a separate lead lined radiographic room provided, first, that cabinet be designed to be adaptable for either radiography or fluoroscopy; and, second, that the control do double service.

"For the control unit two things

rvington Seamless Bias Varnished Cambric Tape

troduced by Irvington shortly after the turn of e century, the development of Seamless Bias mbric Tape made possible—

. The successful use of bias tape on taping machines

. The production of tight, smooth uniformly protected windings of any contour

. The elimination of air pockets caused by the coning effect of taping a conductor at an angle with straight cut tape

. The saving of time and material by ending cutting waste.

nprovements in manufacturing technique and rnish formulation have earned continuing rec nition of Irvington Seamless Bias Varnished mbric Tape as a leader in its field. Laboratory and field performances repeatedly attest to its uniformity, workability, stable low power factor and resistance to deterioration. Through studied, careful preparation of the base cloth, smooth surfaces, unusual flexibility and tearing strength are assured, without sacrifice of electrical properties. And, although offering ample elongation, Irvington Seamless Bias Varnished Cambric Tape, after stretching, retains 70 percent, or more, of its original high dielectric strength, regardless of thickness, finish, or color.

For detailed technical data, write for catalog "Irvington Varnished Insulation" and supplementary information. Address Dept. 106.

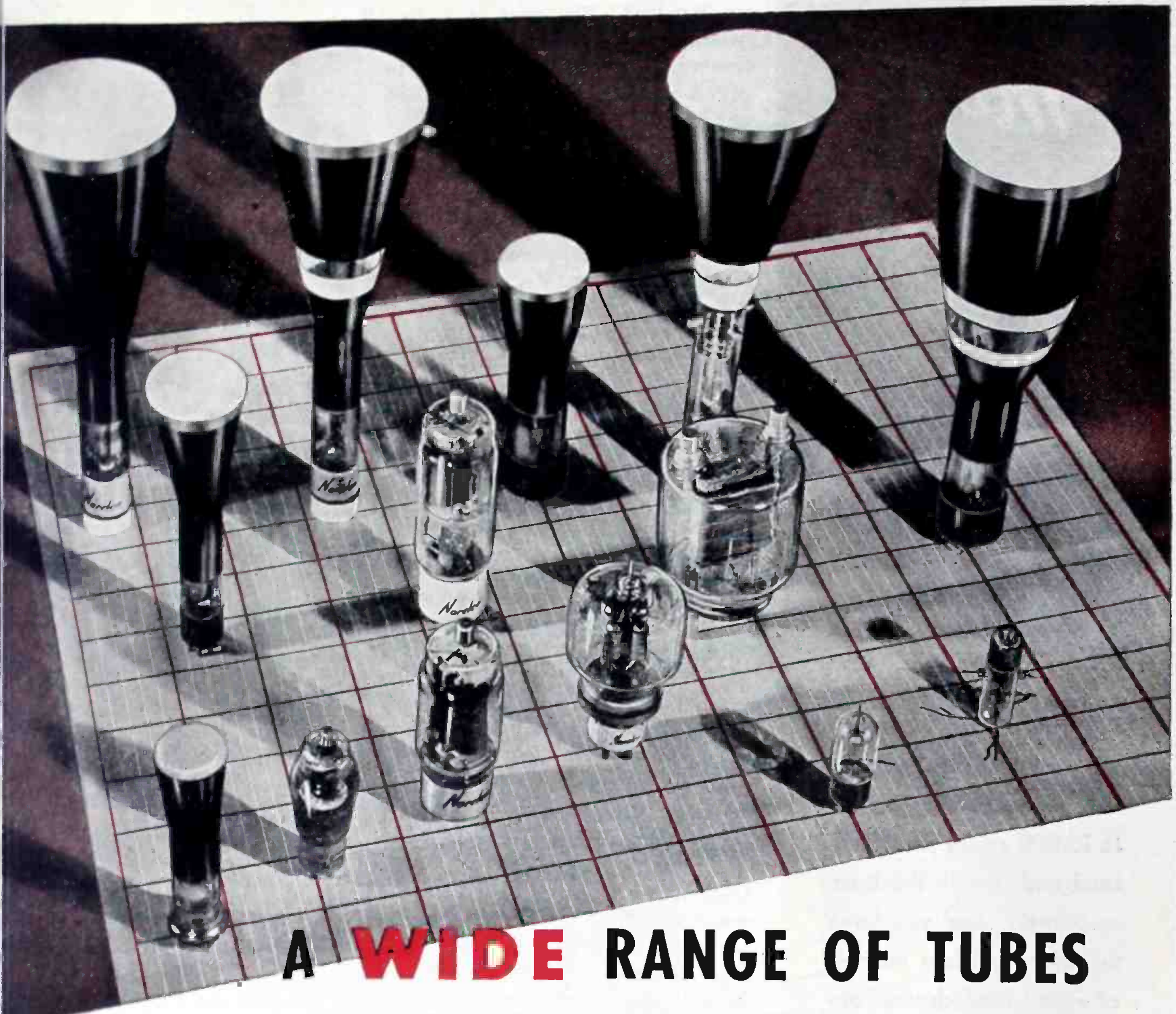
IRVINGTON PRODUCTS: Varnished Fabrics and Papers; Slot Insulation; Flexible Varnished Tubings and Saturated Sleevings; Extruded Plastic Tubings; Harvel and Irvington Insulating Varnishes; Cardolite Resins; Fibron Plastic Tape.

Irvington Varnish & Insulator Company

Irvington 11, New Jersey, U. S. A.

Plants at Irvington, New Jersey, and Hamilton, Ontario, Canada

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



A WIDE RANGE OF TUBES — OF WIDE APPLICATION

THE enviable engineering tradition on which the foundation of the North American Philips Company, Inc., rests, is reflected in the superior quality and performance of electronic tubes bearing the NORELCO stamp. Contributing to the long life and uniform characteristics of these tubes are many exclusive manufacturing techniques and inspection methods developed over a long period.

Among the types we now manufacture — some of which are illustrated — are a number of special-purpose, cathode-ray and transmitting tubes for high and ultra-high frequency applications, r-f and a-f power amplifier tubes, and low- and high-power rectifiers. Although all the tubes we produce now go to the armed forces, we invite inquiries from prospective users. A list of the tube types we are especially equipped to produce will be sent on request.

In the North American Philips Company, there is gathered together a team of outstanding electronic engineers, captained by one of America's leading physicists, and coached by a group with world-wide experience resulting from fifty years of research and development in the electrical field. This new combination of technical talent has at its command many exclusive processes that insure electronic devices of the highest precision and quality. Today, North American Philips works for a United Nations Victory; tomorrow, its aim will be to serve industry.

NORELCO PRODUCTS: In addition to the electronic tubes mentioned above we make Quartz Oscillator Plates; Searchray (X-ray) Apparatus, X-ray Diffraction Apparatus; Medical X-ray Equipment, Tubes and Accessories; Electronic Measuring Instruments; Direct Reading Frequency Meters; High Frequency Heating Equipment; Tungsten and Molybdenum products; Fine Wire; Diamond Dies.

When in New York, be sure to visit our Industrial Electronics Showroom.

Norelco Reg. U. S. Pat. Off. ELECTRONIC PRODUCTS by

NORTH AMERICAN PHILIPS COMPANY, INC.

Dept. C-9, 100 East 42nd Street, New York 17, N. Y.

Factories in Dobbs Ferry, N. Y.; Mount Vernon, N. Y. (Metalix Division); Lewiston, Maine (Elmet Division) are involved. The first is a foot switch control for the fluoroscopic observer, a very simple addition to any x-ray control unit; and the second is to provide stepless control of kilovoltage to permit adjustment, to whatever value is required to penetrate the particular section under observation. Regarding the cabinet, the actual development has been from the radiographic side. For some time, it has been recognized that a cabinet has certain advantages in cost, convenience and flexibility over the construction of a lead lined room."

• • •

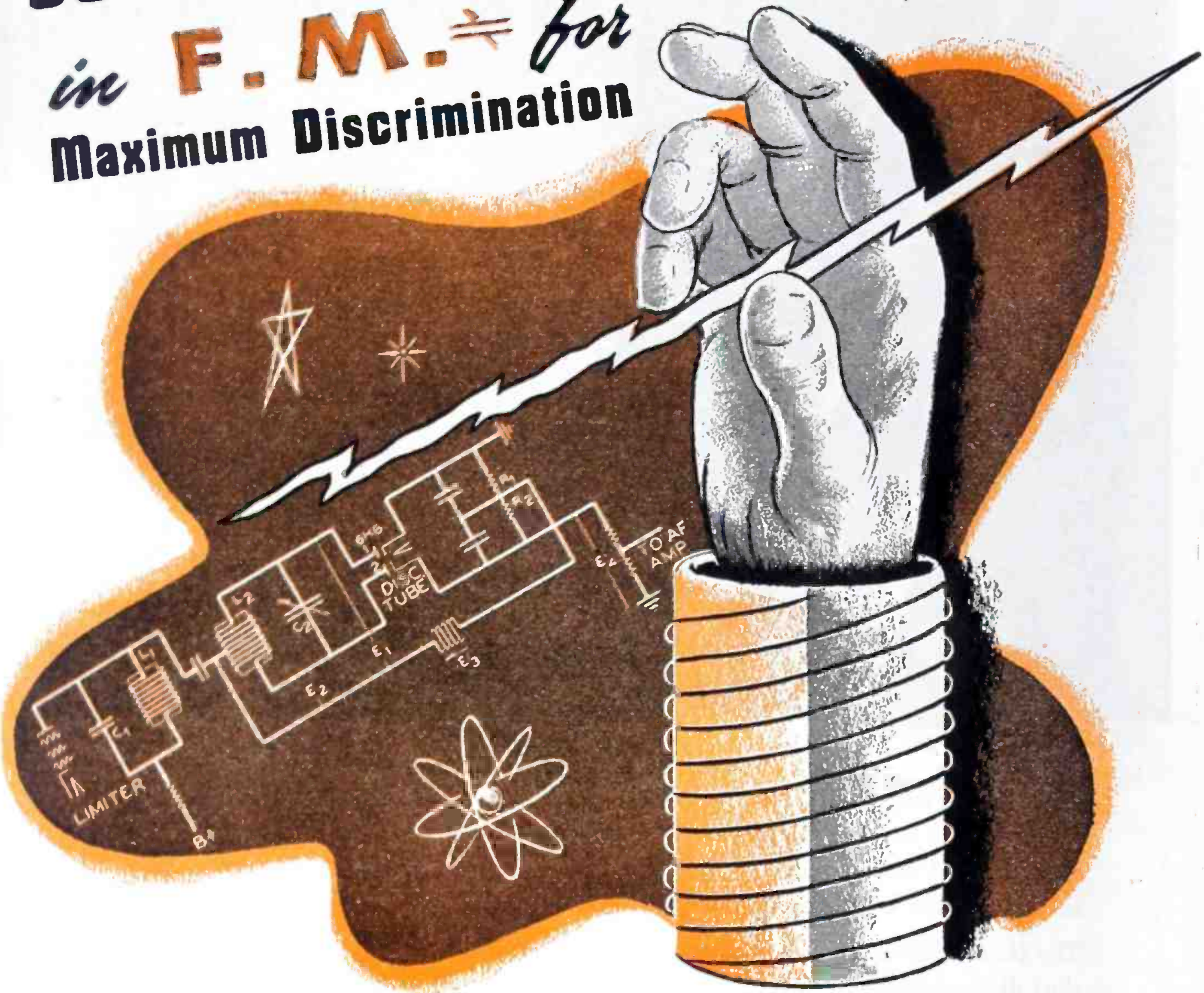
Ultraviolet Radiation Reduces Absenteeism

USE OF ULTRAVIOLET RAYS in business offices to curb epidemics of respiratory diseases responsible for so much absenteeism is demonstrated by the experience of a company in Boston, Mass. The firm employs 70 men and women and protects them from germs with a constant daily radiation barrage from 15 carefully placed irradiators. Graph chart records kept from December 1 to March 1 reveal an average reduction of absenteeism due to illness of over 25 percent, while the decrease effected during the height of the influenza epidemic amounted to 66 percent.

In Boston, Dr. Richard Overholt has carried on extensive research in irradiation, particularly in relation to hospital operating rooms and the prevention of post-operative infection. His own offices have been equipped with air sanitation by engineers of Hanovia Chemical and Manufacturing Co., Dr. Overholt was successful in reducing the overall infection rate by more than 30 percent.

Schirmer-Atherton Co. decided to try out a similar plan to prevent cross-infection in a business office. Twelve ultraviolet irradiators were installed 20 feet apart to protect a total space of approximately 60,000 cubic feet. Three other installations take care of an additional 20,000 cubic feet in separated offices. All irradiators are placed at an approximate height of eight feet from the floor and the rays are thrown upward to protect occupants' eyes from skin or eye redness.

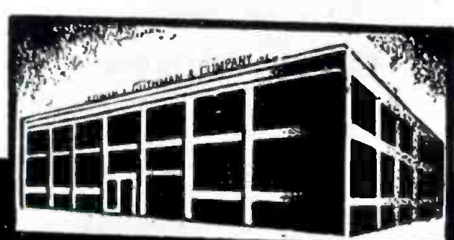
GUTHMAN *Discriminator* COILS in F. M. = for Maximum Discrimination



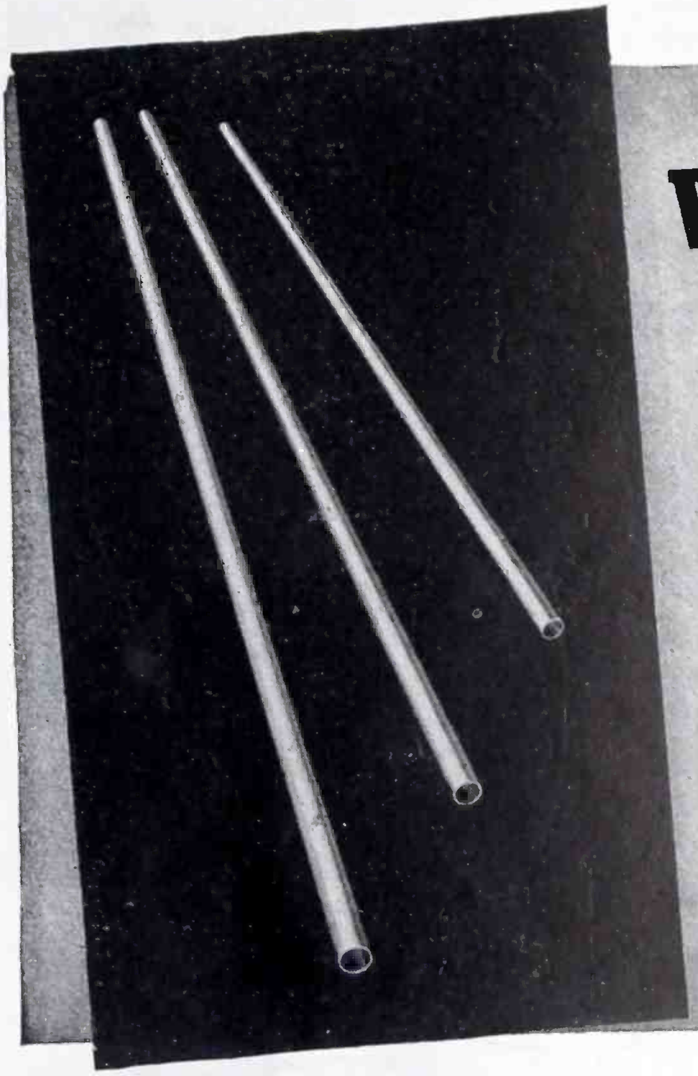
FREQUENCY MODULATION receivers require linear discrimination against undesirable signals. Guthman engineers have developed precise **DISCRIMINATOR COILS** to discriminate equally on both sides of the resonance curve, providing maximum discrimination.

GUTHMAN
Leader in Inductronics

DO YOUR BEST . . .
INVEST IN WAR BONDS!

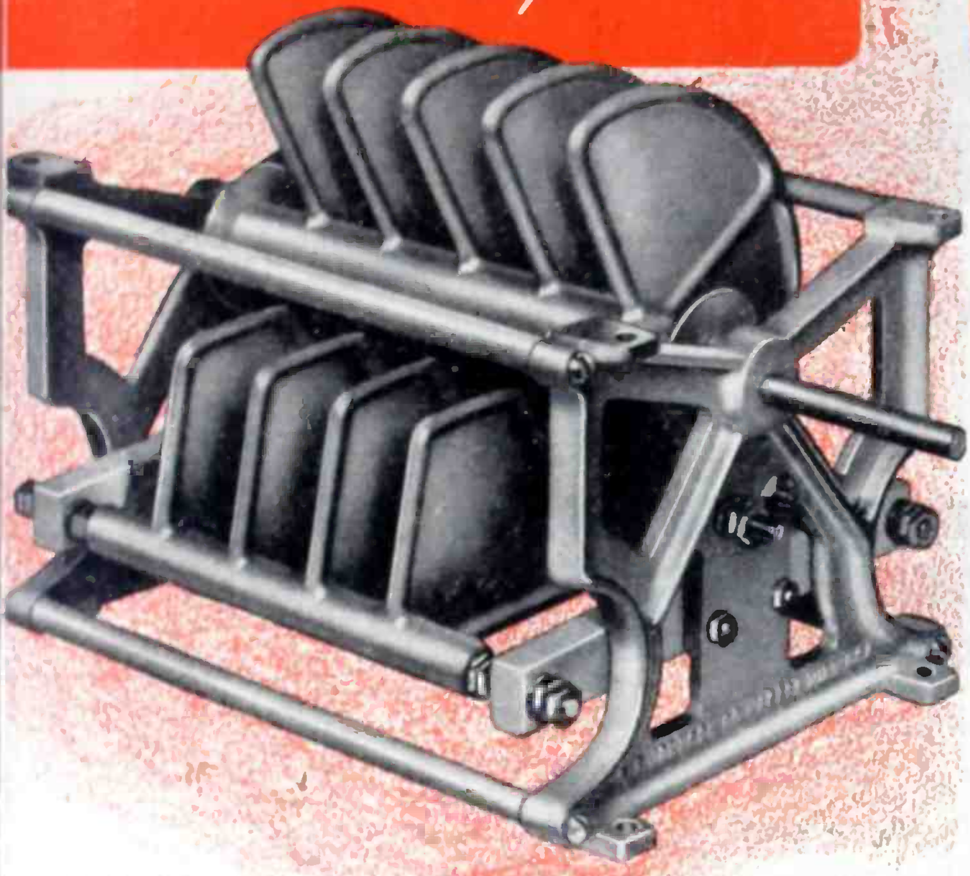


EDWIN I. GUTHMAN & CO. INC.
15 SOUTH THROOP STREET · CHICAGO
PRECISION MANUFACTURERS AND ENGINEERS OF RADIO AND ELECTRICAL EQUIPMENT



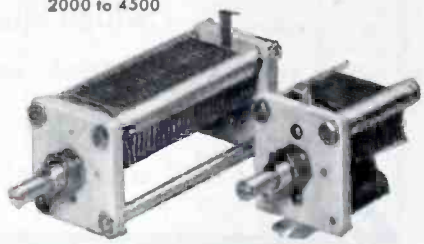
New Development

Decreased Spacing
Shorter Length
Lower Minimum
Less Inductance



Types C and D for peak voltages of 3500 to 13,000

Types E and F for peak voltages of 2000 to 4500



Type H for peak voltages of 1500 to 3000

Type N neutralizing condensers in 5 sizes

Again Johnson scores a first with newly designed thick plates which allow much higher voltages, particularly at high frequencies.

It has long been known that plates with rounded edges have higher breakdown voltages in variable condensers, but it remained for Johnson Engineers to work out ratios of plate thickness, design, voltage, and spacing for maximum advantage.

Greatly decreased length (as much as one-third in some cases) results in lower minimum capacity and lower inductance due to shorter frame rods and other metal parts, which is extremely important at high frequencies.

Corona is noticeably less with the new type plates and corona shields have been added where stator bars enter insulators, resulting in still further improved performance.

Despite these many improvements, in most cases prices are lower because of the saving in material.

Now available in Types A and B, both fixed and variable, this new plate shape and construction will be incorporated in other types as quickly as possible. Write Johnson today for more information and for recommendations on YOUR variable condenser application.

New Catalog 968D now ready.

JOHNSON

a famous name in Radio

E. F. JOHNSON COMPANY • WASECA • MINNESOTA

Secondary Radiation

(*Continued from page* 108)

(22) Seitz, W., *Ann, d. Phys.*, 6, I., 1901.
(23) Tate, J. T., *Phys. Rev.*, 17, p. 394, 1921.
(24) Daene, H., and Schmerwitz, G., *Zeitschr. f. Phys.*, 53, p. 404, 1929.
(25) Farnsworth, H. E., *Phys. Rev.*, 31, p. 414, 1928.
(26) Baeyer, O. v., *Physik, Zeitschr.*, 10, p. 168, 1909.
(27) Baeyer, O. v., *Verh. dtsch. Phys. Ges.*, 10, p. 96, and 935, 1908.
(28) Baeyer, O. v., *Physik. Zeitschr.*, 10, p. 176, 1909.
(29) Campbell, N. R., *Phil. Mag.*, 25, p. 803, 1913.
(30) Gehrts, A., *Ann. d. Phys.*, 36, p. 995, 1911.
(31) Copeland, P. L., Thesis in the Department of Physics, State Univ. of Iowa, July 1931.
(32) Copeland, P. L., *Jour. Frankl. Inst.*, 215, p. 435, 1933.
(33) Copeland, P. L., *Jour. Frankl. Inst.*, 215, p. 593, 1933.
(34) Copeland, P. L., *Phys. Rev.*, 46, p. 167, 1934.
(35) Copeland, P. L., *Phys. Rev.*, 48, p. 96, 1935.
(36) Warnecke, R., *Jour. Phys. Rad.*, 5, p. 267, 1934.
(37) Warnecke, R., *Jour. Phys. Rad.*, 7, p. 270, 1936.
(38) Farnsworth, H. E., *Phys. Rev.*, 20, p. 358, 1922.
(39) Farnsworth, H. E., *Phys. Rev.*, 27, p. 413, 1926.
(40) Kollath, R., *Phys. Zeitschr.*, 38, p. 202–224. 1st Apl., 1937.
(41) Copeland, P. L., *Phys. Rev.*, 35, p. 293, 1930.
(42) Weiss, G., *Fernsehen und Tonfilm* 41, 1936.
(43) Kalckhoff, G., *Zeitschr. f. Phys.*, 80, p. 305, 1933.
(44) Wehnelt, A., *Erg. d. exakt. Naturw.* *Bd.*, IV, p. 417, 1928.
(45) Schmidt, W., *Diss. Berlin*, 1923.
(46) Nickel, G., *Diss. Berlin*, 1922.
(47) Beyschlag, B., *Diss. Berlin*, 1926.
(48) Uredat, E., *Diss. Berlin*, 1930.
(49) Wehnelt, A., *Zeits. f. Phys.*, 48, p. 165, 1928.
(50) Knoll, M., *Zeitschr. f. Techn. Phys.* 16, p. 467, 1935.
(51) Joffé, A., *Zeitschr. f. Phys.*, 48, p. 737, 1928.
(52) Klemperer, O., *Zeitschr. f. Phys.*, 47, p. 417, 1928.
(53) Strübig, H., *Physik. Zeitschr.*, 37, p. 402, 1936.
(54) Bruining, H., *Physica*, 3, p. 1046, 1936.
(55) Müller, H., *Zeitschr. f. Phys.*, in Druck.
(56) Baltruschat, M., and Starke, H.

• • •

FACSIMILE AT SHAEF

Radiotelephoto equipment at SHAEF, Supreme Headquarters of the Allied Ex- peditionary Forces in England, where photos and news of the invasion transmitted to the rest of the world

QUICK-REFERENCE CHART RCA MINIATURE TUBES

BASIC DATA FOR DESIGNERS ON RCA'S WIDE MINIATURE LINE

TYPE NO.	DESCRIPTION	APPLICATION DATA AND SUGGESTED USES	FILAMENT OR HEATER			MAX. RATINGS			TYPICAL PLATE MA.	TRANSCONDUCTANCE at max. plate volts (μmhos)	LIST PRICE
			VOLTS	AMPERES	TYPE	PLATE VOLTS	SCREEN VOLTS	TOT. CATH. MA.			
[illegible]*	H-F DIODE	For discriminator in FM receivers and in measuring equipment. Resonant freq., 1000 Mc.	1.4	0.15	H	330a	—	0.5g	—	—	$1.15
[illegible]*	R-F AMPLIFIER PENTODE	For use where sharp cut-off characteristic is required—no external bulb shield needed.	1.4	0.05	F	110	90	6.5	4.5c	1025c	1.15
[illegible]*	PENTAGRID CONVERTER	Has conversion transconductance of 300 micromhos at 90 volts on plate.	1.4	0.05	F	90	67.5	5.5	1.6	—	1.15
[illegible]	POWER AMPLIFIER PENTODE	Capable of handling audio power output of 270 milliwatts.	1.4	0.10	F	90	67.5	9	7.4	1575	1.15
[illegible]*	DIODE-PENTODE	Combined diode and a-f pentode providing high voltage gain.	1.4	0.05	F	90	90	4.5	1.6	625	0.95
[illegible]*	SUPER-CONTROL R-F AMPLIFIER PENTODE	Useful as r-f or i-f amplifier—no external bulb shield needed.	1.4	0.05	F	90	67.5	5.5	3.5	900	1.15
[illegible]	THYRATRON (Gas-Tetrode)	For relaying. Will operate directly from high-vacuum phototube.	6.3	0.6	H	1300a	—	100d,g	—	—	3.75
[illegible]*	POWER AMPLIFIER PENTODE	Can handle a-f output of 700 milliwatts, or r-f output of 1.2 watts at 10 Mc.	2.8s 1.4p	0.1 0.2	F	150	90	18	13.3	1900	0.75
[illegible]*	H-F TWIN TRIODE	Has Class C output of about 2 watts at 40 megacycles.	2.8s 1.4p	0.11 0.22	F	135	—	5 AF 30 RF	3.7c	1800c	1.30
[illegible]	POWER AMPLIFIER PENTODE	Can handle relatively high audio output of 270 milliwatts.	2.8s 1.4p	0.05 0.10	F	90	90	12	9.5	2150	1.15
[illegible]*	POWER AMPLIFIER PENTODE	Similar to Type 1S4 but has filament arrangement for either series or parallel operation.	2.8s 1.4p	0.05 0.10	F	90	67.5	9	7.4	1575	1.15
[illegible]5*	R-F AMPLIFIER PENTODE	Has sharp cut-off characteristic and high transconductance—useful up to 400 Mc.	6.3	0.3	H	300	150	—	7.0e	5000e	2.15
[illegible]6	POWER AMPLIFIER PENTODE	Can handle a-f power output of 1.1 watts.	6.3	0.15	H	300	250	—	15f	2300f	1.10
[illegible]*	TWIN DIODE	High-perveance detector for wide-band circuits. Tube drop, 10 volts at 60 ma. per diode.	6.3	0.3	H	420a	—	9b,g	—	—	0.75
[illegible]6*	DUPLEX-DIODE HIGH-MU TRIODE	For use as a combined detector, amplifier and avc tube.	6.3	0.15	H	300	—	—	1.0e	1200e	1.50
[illegible]*	H-F POWER TRIODE	Has Class C output of about 5.5 watts at moderate frequencies and 2.5 watts at 150 Mc.	6.3	0.15	H	300	—	25 RF	10.5e AF	2200e	0.90
[illegible]*	U-H-F AMPLIFIER TRIODE	For use primarily as grounded-grid amplifier at frequencies up to about 500 Mc.	6.3	0.4	H	150	—	20	15	12000	8.35
[illegible]*	TWIN TRIODE	Useful as mixer at frequencies up to 600 megacycles. Also useful as oscillator.	6.3	0.45	H	300	—	30 RF	8.5b AF	5300b	1.85
[illegible]*	DETECTOR AMPLIFIER PENTODE	A sharp cut-off pentode for use as an r-f amplifier or detector in u-h-f service.	6.3	0.15	H	250	100	—	2.0	1400	2.50
[illegible]*	DETECTOR AMPLIFIER TRIODE	Has moderately high amplification factor. Useful as u-h-f detector, amplifier, oscillator.	6.3	0.15	H	250	—	—	6.3	2200	2.00
[illegible]*	SUPER-CONTROL R-F AMPLIFIER PENTODE	Remote cut-off pentode useful as mixer or as r-f or i-f amplifier in u-h-f work.	6.3	0.15	H	250	100	—	6.7	1800	2.50
[illegible]	U-H-F DIODE	For u-h-f service as rectifier, detector, or measuring device. Resonant freq., 700 Mc.	6.3	0.15	H	750a	—	5g	—	—	1.50

—Peak inverse volts
—Per unit
c—At 90 volts on plate (and screen)
d—For an averaging period of 30 sec.
e—At 250 volts on plate
f—At 180 volts on plate and screen
g—D-C output Ma.
p—Filaments connected in parallel
s—Filaments connected in series

[illegible]my/Navy Preferred Type.

HERE is a condensed story on the complete line of RCA miniatures. Miniatures—you will recall—were an RCA development back in 1940 when that famous quartet, the 1R5, 1S4, 1S5, and 1T4, put "personal" portables on the map. War demands have speeded the development of miniatures so that today 22 RCA types are available. Note that 18 of the 22 are on the Army/Navy Preferred Type List; of these 22 tubes, 21 were developed by RCA! When you have a tube application problem, turn to RCA engineers. *Remember, the Magic Brain of all electronic equipment is a Tube, and the fountain-head of modern Tube development is RCA.*

Copies of this advertisement for reference are available on request. Write to: RADIO CORPORATION OF AMERICA, 736 South Fifth Street, Harrison, N. J.

BUY MORE WAR BONDS

RCA

RADIO CORPORATION OF AMERICA

RCA VICTOR DIVISION • CAMDEN, N. J.

Steatite Insulators by STUPAKOFF

FOR TRANSMITTING ANTENNA

IN AM, FM and Television broadcasting, Stupakoff low loss steatite insulators have proven their superiority for high frequency installations.

Illustrated are a few styles of precision made lead-in, strain and post insulators by Stupakoff. They provide unfailing service with the ultimate in electrical performance.

Laboratory control—years of engineering experience—modern production facilities—manufacturing skill—combined, enable Stupakoff to produce a complete line of dependable ceramic insulators of unequalled quality for the electronic industry.

Stupakoff engineers, supported by two generations of experience in the manufacture of ceramics, are at your disposal and are ready to assist you in planning projects in the transmitting field.

ARMY E NAVY

"FOR GREAT ACHIEVEMENT"

Do More Than Before—Buy EXTRA War Bonds

STUPAKOFF CERAMIC AND MANUFACTURING CO., LATROBE, PA.

Ceramics for the World of Electronics

Physik. Zeitschr., 23, p. 403, 1922.

(57) Chylinski, S., *Phys. Rev.*, 28, p. 429, 1926.

(58) Chylinski, S., *Phys. Rev.*, 42, p. 393, 1932.

(59) Farnsworth, H. E., *Phys. Rev.*, 31, p. 419, 1928.

(60) Farnsworth, H. E., *Phys. Rev.*, 34, p. 679, 1929.

(61) Hayakawa, K., *Soc. Rep. Tobohu Imp. Univ.*, (1), 22, p. 934, 1933.

(62) Tartakowsky, P., and Kudrjawzewa, W., *Zeits. f. Phys.*, 75, p. 137, 1932.

(63) Rao, S. R., *Proc. Roy. Soc.*, 128, p. 57, 1930.

(64) Ahearn, A. J., *Phys. Rev.*, 38, p. 1858, 1931.

(65) Aldous, W. A., and Campbell, N. R., *Proc. Roy. Soc.*, 151, p. 694, 1935.

(66) Hayner, L. J., *Physics*, 6, p. 328, 1935.

(67) Hayner, L. J., and Hull, A. W., *Phys. Rev.*, 33, p. 281, 1929.

(68) Moullin, E. B., *Proc. Roy. Soc.*, 147, p. 100, 1934.

(69) Penning, F. M., and Kruithof, A. A., *Physica*, 2, p. 793, 1935.

(70) Ziegler, M., *Physica*, 2, p. 415, 1935.

(70-a) Ziegler, M., *Physica*, 3, I, 1936.

(71) Zeigler, M., *Physica*, 3, p. 307, 1936.

(72) Hull, British Patent 1555/1915.

(73) Zworykin & Rejchman, *Proc. I.R.E.*, 27, p. 558 and 566, Sept. 1939.

(74) Iams and Salzberg, *Proc. I.R.E.*, 23, p. 55–64, Jan. 1935.

(75) Thompson, *Proc. I.R.E.*, 29, p. 583–587, Nov. 1941.

(76) Wagner & Ferris, *Proc. I.R.E.*, 29, p. 598–602, Nov. 1941.

(77) Hopkins, U. S. Patent No. 1,920,863 (1932).

(78) Farnsworth, P. T., U. S. Patent No. 2,071,515. U. S. Patent No. 2,174,488.

(79) Hull & Williams, *Phys. Rev.*, 27, p. 423, 1926.

(80) Telleghen, British Patent No. 287,958.

(81) Harries, *Wireless World*, Aug. 2nd, 1935.

(82) Harris, British Patents No. 380,429 and 385, 968, 1931, and *Wireless Engineer*, 13, p. 190–199, April 1936.

(83) Harries, *Wireless Engineer*, 15, p. 212, April 1938.

(84) Harries, ELECTRONICS, May 1936, p. 33–35.

(85) Harries, *Wireless Engineer*, 14, p. 63, Feb. 1937.

(86) Harries, *Electronic Engineering*, p. 586–587, Jan. 1942.

(87) Malter, *Proc. I.R.E.*, 29, p. 587–598; Nov. 1941.

(88) Salzberg & Haeff, *RCA Review*, II, p. 336–374, Jan. 1938.

(89) Dow, "Fundamentals of Engineering Electronics," Chapman and Hall, London.

• • •

COMMUNITY RADIO FOR FRENCH

French villagers, whose radios were confiscated by Germans, listen to BBC news broadcasts from London by means of a traveling radio truck with multiple horn speakers supplied by the Psychological branch of the British Army

M·R

THE LITTLE THINGS ON WHICH SO MUCH DEPENDS!

Friction and Sealing Tapes

M-R FASTHOLD FRICTION TAPE

Double Coated With Rubbery Compounds . . . Tensile Strength more than 44 lbs. — Adhesive Strength more than 5.0 lbs.

In the manufacture of FASTHOLD FRICTION TAPE the best procurable cotton sheeting (long staple 56/60) is first dried to eliminate moisture . . . then the fabric is thoroughly impregnated with a filler coat of insulating, waterproofing and preserving compound . . . after several days of drying a second coat, exceptionally heavy in rubber content, is forced through the fabric by means of enormous rollers . . . then follows another period of drying out before cutting and wrapping in tin foil for protection. The materials used and the precision and control exercised in the manufacture of FASTHOLD FRICTION TAPE enables it to meet all known electrical tests and requirements . . . and to Guarantee it against Unraveling or Drying Out. FASTHOLD FRICTION TAPE is New York warehouse stocked in widths of ⅜—½—¾—1—1½ and 2 inches.

M-R ANHYDROUS SEALING TAPE

IMPROVES WITH AGE AND SERVICE

25.58% Cotton Sheeting · 74.42% M-R Insulating Compounds

Weatherproof . . . Waterproof . . . Acid, Alkali, Oilproof . . . Permanently Flexible . . . Will not Vulcanize or Dry Out . . . Tensile Strength 30 Pounds . . . Dielectric 1,000 volts

ANHYDROUS SEALING TAPE contains nothing which will injure fabrics or metals. It is made of the best procurable cotton sheeting and special M-R Bituminous Compounds. A wrapping of ANHYDROUS TAPE gradually becomes one solid mass (glass hard on the outside and soft inside) that excludes air, moisture, vapors, etc. It can be used to great advantage under conditions which disintegrate ordinary tapes; inside work where acids or alkali fumes or spray prevail; outside for cable joint insulation in conduits transformer connections, extreme high or low temperatures, etc., mines and damp places where atmospheric conditions and constant friction demand maximum wearing qualities.

A joint, properly taped with ANHYDROUS, is absolutely waterproof even after complete submergence for many weeks.

ANHYDROUS SEALING TAPES are New York warehouse stocked in widths of ¾ and 1½ inches . . . other sizes are available, as ordered.

FREE FOR THE ASKING

Write today for samples of M-R Friction and Sealing Tapes . . . also your Free Card of Varnished Tubing with samples ranging from size 0 to 20 to fit wires from .032 to .325 inches . . . other valuable aids, are the M-R Guide Book of Electrical Insulation . . . the Wall Chart with reference tables, electrical symbols, allowable capacities of conductors, dielectric averages, thicknesses of insulating materials and tap drill sizes . . . and the M-R Wax and Compound Guide Book . . . they are full of valuable information . . . write for them on your letterhead.

MITCHELL-RAND *for* **55 YEARS THE ELECTRICAL INSULATION HEADQUARTERS**

MITCHELL-RAND INSULATION COMPANY, INC.

1 MURRAY STREET · COrtlandt 7-9264 · NEW YORK 7, N. Y.

EST. 1889

A PARTIAL LIST OF M-R PRODUCTS

- ...berglas Varnished Tape and Cloth
- ...sulating Papers and Twines
- ...ble Filling and Pothead Compounds
- ...iction Tape and Splice
- ...ansformer Compounds
- Fiberglas Braided Sleeving
- Cotton Tapes, Webbings and Sleevings
- Impregnated Varnish Tubing
- Insulating Varnishes of all types
- Fiberglas Saturated Sleeving and Varnished Tubing
- Asbestos Sleeving and Tape
- Extruded Plastic Tubing
- Varnished Cambric Cloth and Tape
- Mica Plate, Tape, Paper, Cloth and Tubing

TUBES AT WORK

Electronic Tester for Electric Cords and Cables

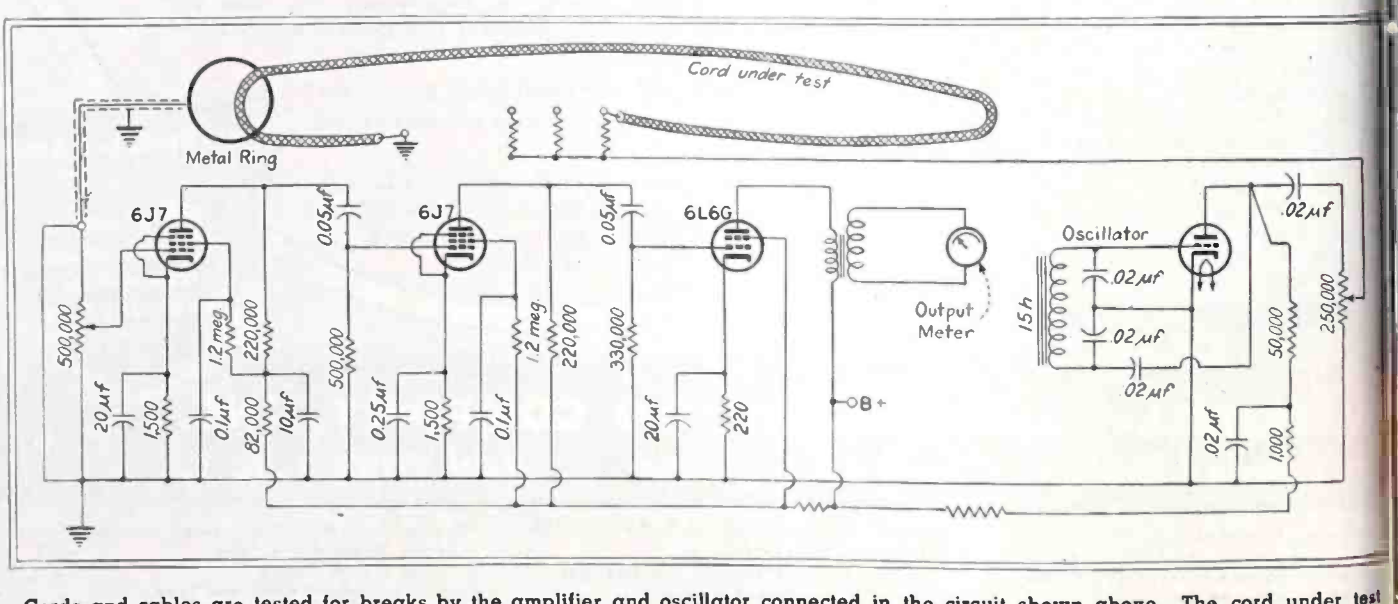
AN ELECTRONIC cable tester, designed and constructed by Consolidated Vultee Aircraft Corp., takes the guesswork out of checking the breaks in electric extension cords and those used on small power-driven tools.

The circuit of the unit is shown in the diagram. One electronic tube is connected as a self-excited oscillator operating on a frequency of about 400 cycles. The output of the oscillator is applied to the cord.

A small amount of the signal energy is picked off the cord by a metal ring through which the cord is passed. Fed to a high-gain amplifier, the signal amplitude is increased sufficiently to operate the output meter shown. When a break in the conductor passes through the ring, a sudden change in the meter deflection occurs and the broken spot can be quickly and accurately ascertained. Thus, the necessity of cutting the cord in more than one place to locate the braek is eliminated.

The metal pickup ring is mounted inside an assembly of fiber insulation material that surrounds the cable during use of the instrument. A short shielded lead is provided for connecting the ring to the amplifier. The ring is mounted on top of the test unit.

Input and output potentiometers are provided to permit adjustment of the circuit so that the meter reading occurs at a convenient portion of the scale when a good cable of the type to be tested is inserted in the ring. Additional provision for this purpose is the use of different values of resistance in the output circuit. Besides the output terminals shown in the diagram, made and female receptacles for the cable plugs used in the Vultee plant are contained in the tester.



Cords and cables are tested for breaks by the amplifier and oscillator connected in the circuit shown above. The cord under test and the metal ring act as the coupling medium between the two units

Multi-Channel Radio Link

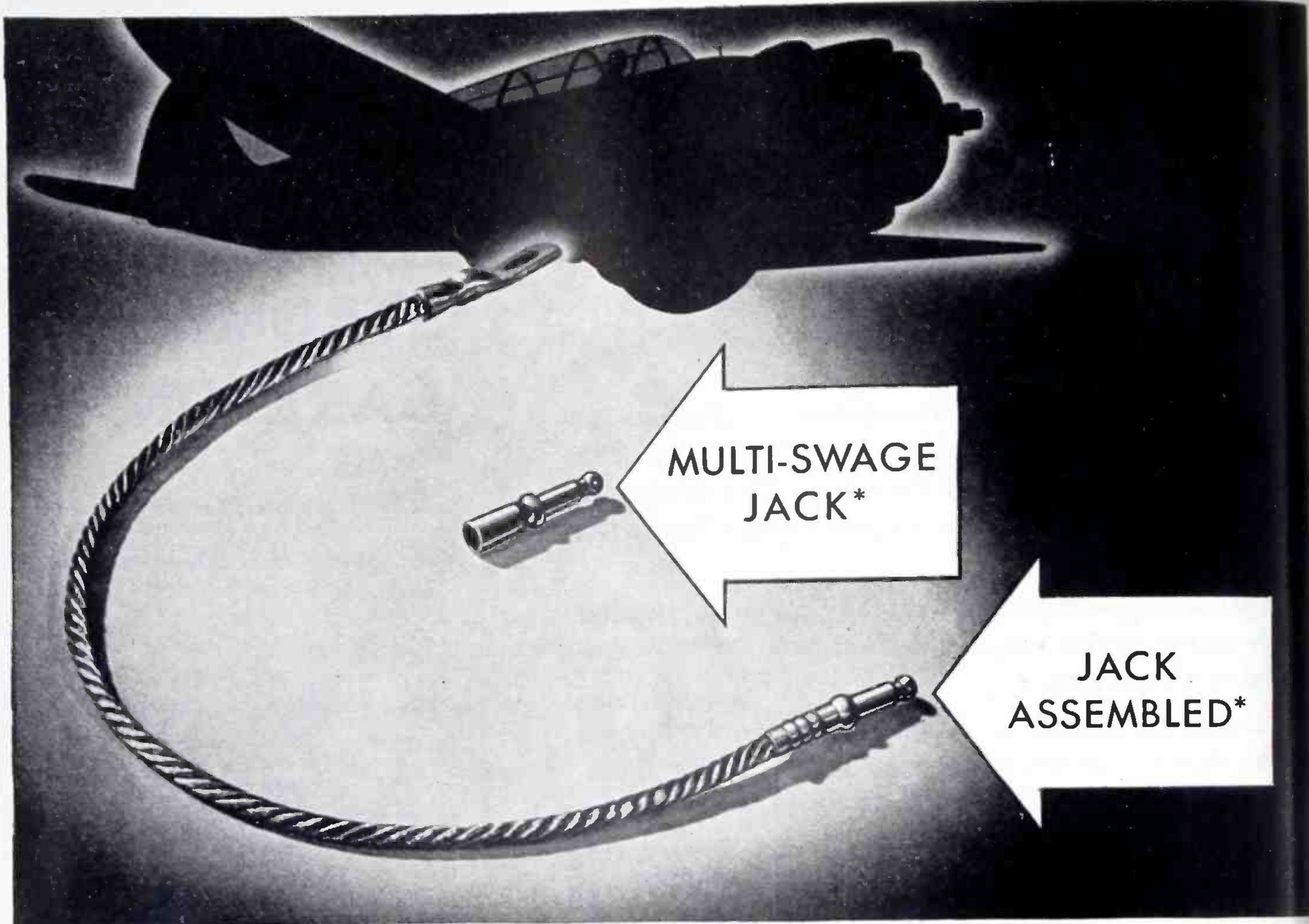
By A. C. PETERSON, JR.
Radio Transmission Engineering
Bell Telephone Laboratories

RADIO LINKS as extensions of land telephone lines are not new. There is one between Boston and Cape Cod that has been in service for a number of years, and there is the more recent installation between Crisfield and two of the islands in Chesapeake Bay. These installations use single-channel links; their radio circuits carry only single conversations.

Over a new radio link between Norfolk and Cape Charles, in southeastern Virginia, as many as twelve conversations may be transmitted simultaneously. Whereas the earlier radio links transmitted the frequencies from 200 to 3000 cycles comprising a single voice channel, the new link transmits twelve voice channels which have been modulated to form a group from 12,000 to 60,000 cycles.

Telephone communication from Norfolk and other points south and west of Chesapeake Bay has had to pass through Washington and Baltimore over some 400 miles of land line to reach Cape Charles. This situation has now been changed by the installation of the radio link. Not only is the circuit reduced to less than a tenth of its former length, but the traffic over the Baltimore and Washington routes is lightened.

The group of twelve channels



*Jack and complete disconnect bonding jumper designed and assembled by Aircraft-Marine Products, Inc.

THE MOST ECONOMICAL METHOD

GOVERNMENT specifications require that every part of a military aircraft be electrically bonded. This precaution eliminates the hazard of fire that might result from electrical energy built up in one section of the plane being suddenly discharged to another, creating an arc.

Disposable gas tanks, engine cowls and other accessory parts are fitted with a length of high-conductivity cable. When the units are assembled the jack on the cable is plugged into a receptacle on the plane. These jacks are made by MULTI-SWAGE at a fraction of the cost of other methods.

The BEAD CHAIN MULTI-SWAGE PROCESS forms small metal parts from flat stock. No metal is cut away and there is no drilling, thus no waste. Parts can be produced in volume and at high speed by MULTI-SWAGE while holding tolerances accurately. Our Research and Development Division will gladly assist you. Write for further information.

These are typical "Multi-Swage" products. This process will turn out large volume speedily while maintaining close tolerances accurately.

ARMY E NAVY

BEAD CHAIN
multi·swage
PROCESS

BACK THE ATTACK
BUY MORE WAR BONDS

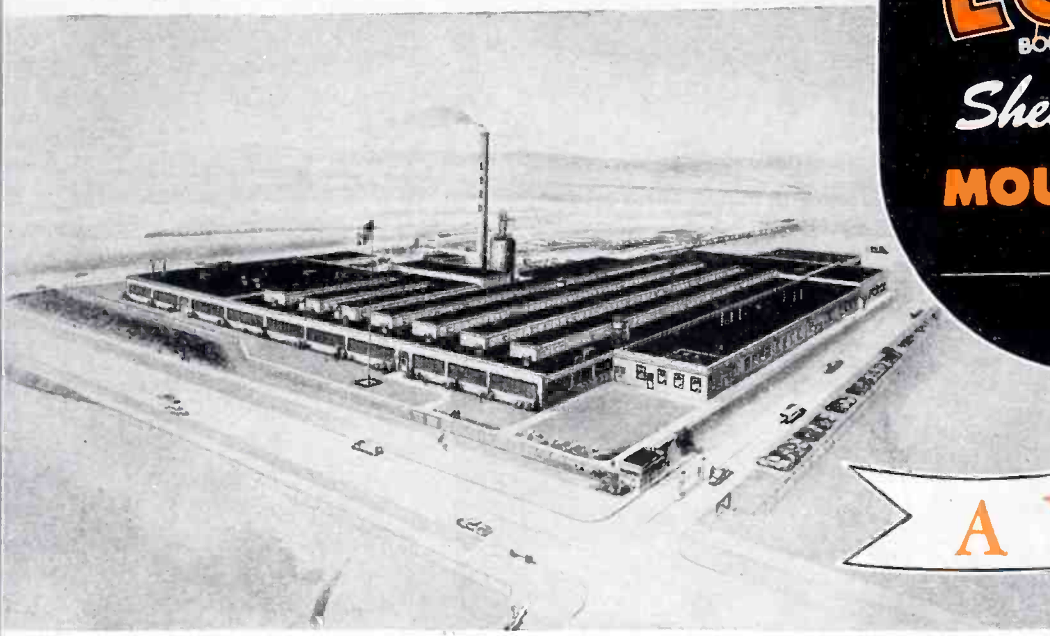
THE MOST ECONOMICAL METHOD OF PRODUCING SMALL METAL PARTS TO CLOSE TOLERANCES WITHOUT WASTE

THE BEAD CHAIN MANUFACTURING COMPANY
88 MOUNTAIN GROVE STREET, BRIDGEPORT 5, CONNECTICUT

MILLIONS OF

LORD BONDED RUBBER *Shear Type* MOUNTINGS

A YEAR



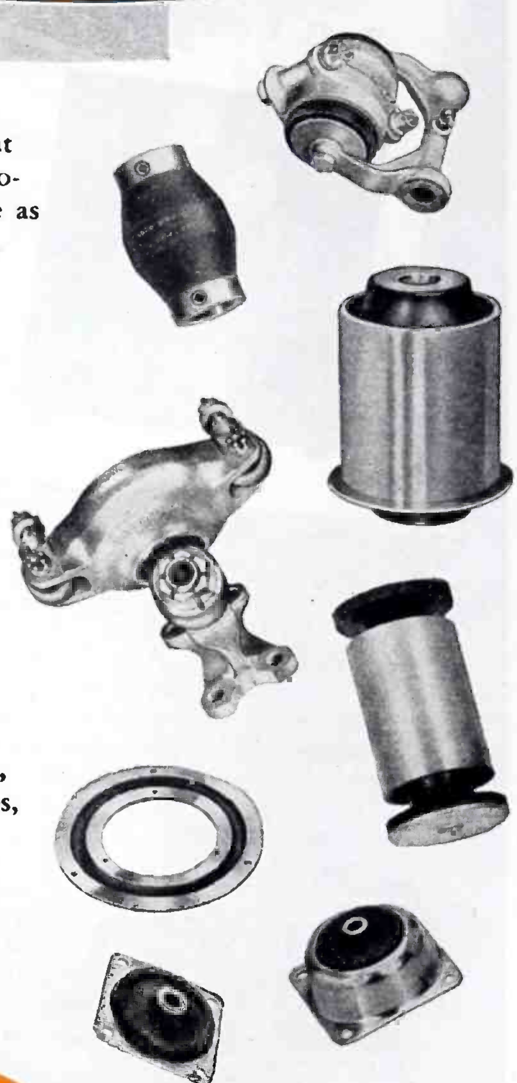
"LORD MOUNTS", as they are generally known, are being produced at the rate of many millions per year. A large proportion of this production is of *synthetic rubber*, which has proved in the main, to be as effective as natural rubber in flexible mounts for Vibration Control.

The entire facilities of the Lord factory are used to produce mountings and other bonded rubber products, and the energies of the research, development, and field engineering staffs, are devoted exclusively to the improvement of these products for industrial and military use. By specializing, Lord is producing mountings that are the criterion in the flexible suspension field.

The method of bonding rubber to metal, which Lord has developed, permits the use of the rubber in such manner that the stress is always in shear, thus providing the proper deflection for a given load. The final result is a mounting system which provides the greatest efficiency in vibration isolation.

Lord Mountings are small, compact, lightweight units, easy to install and load ratings range in small increments from a few ounces to several thousand pounds. They prolong equipment life, lower maintenance costs, insure greater accuracy of operation, reduce material weights by eliminating the necessity for inertia masses, increase personnel efficiency by eliminating nerve-wearing noise and vibration transmitted through solid conduction.

Send for literature on vibration control or call in a Lord Vibration Engineer for consultation on vibration problems. There is no obligation.



IT TAKES RUBBER *In Shear* TO ABSORB VIBRATION

LORD MANUFACTURING COMPANY
ERIE, PENNSYLVANIA

SALES REPRESENTATIVES
NEW YORK - - 280 MADISON AVE.
CHICAGO - 520 N. MICHIGAN AVE.
DETROIT - - 7310 WOODWARD AVE.
BURBANK, CAL. - 245 E. OLIVE AVE.
CANADIAN REPRESENTATIVES
RAILWAY & POWER ENGINEERING CORP., LTD.
TORONTO, CANADA

Do More Than Before— Buy EXTRA War Bonds

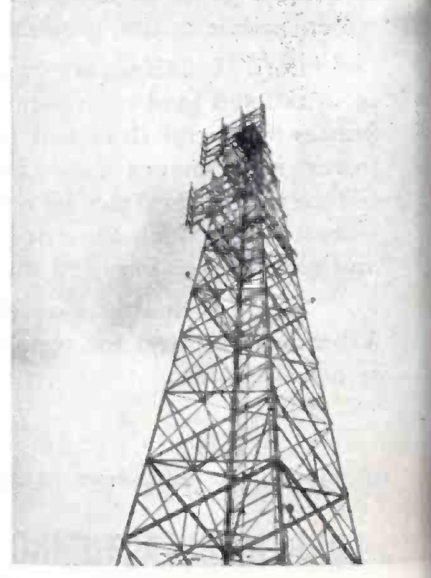
Originators of Shear Type Bonded Rubber Mountings employed is that used by the type-K carrier system (carrier system developed by Bell Labs in which lower sidebands of 12 carriers are transmitted over cable) now being installed on cables all over the country. Twelve voice frequency circuits arriving at Cape Charles, for example, are passed through a type-K carrier terminal. The resulting frequency band, extending to 60 kc, is then modulated in the radio transmitter and is sent through the ether to Cape Henry on a wavelength of about six feet.

After demodulation in the radio receiver, the 12- to 60-kc band is transmitted over a cable to the Norfolk office. Here it is passed through a type-K receiving terminal, and the twelve channels resulting are brought to the Norfolk toll switchboard as twelve separate voice channels. The arrangement is indicated schematically in an accompanying illustration. The radio system operates continuously and unattended.

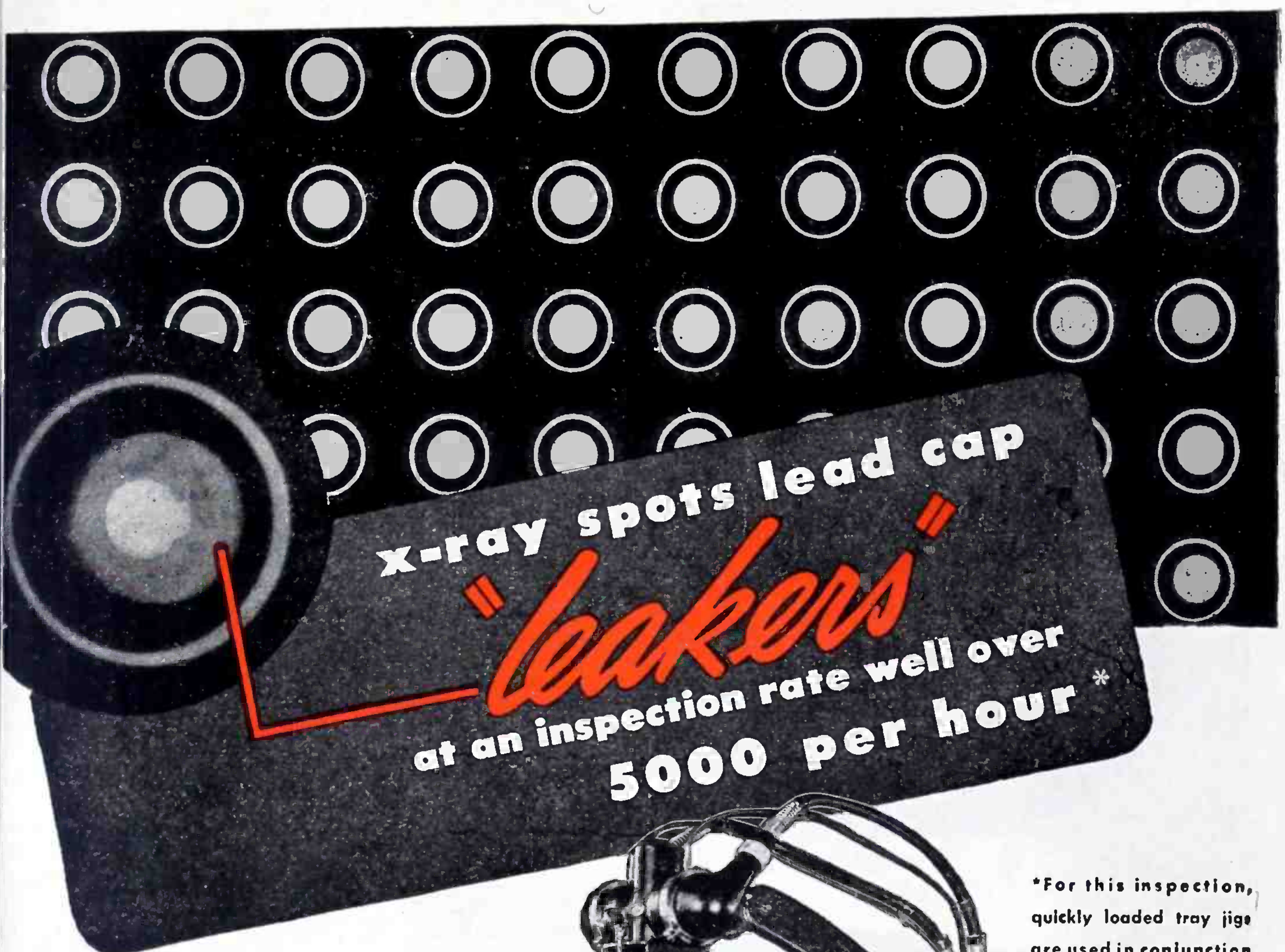
Antennas

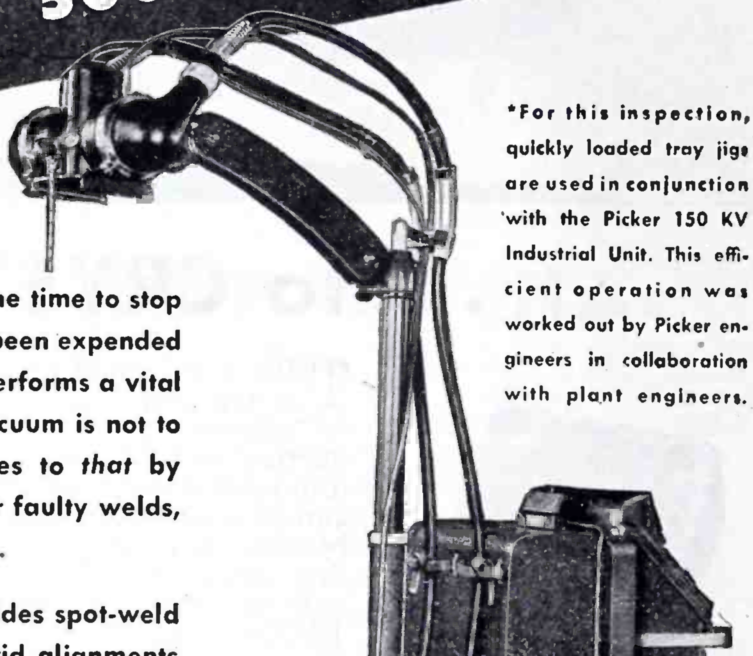
Steel towers nearly two hundred feet high support the antennas at each terminal. Each transmitting and receiving antenna consists of two parallel arrays of half-wave elements, one behind the other. The front array contains twenty-four horizontal radiating or receiving elements, while the rear array contains twenty-four similar elements that act as parasitic reflectors.

A view of the Cape Charles



Two parallel arrays of half-wave elements mounted 200 feet high form each antenna in the radiotelephone link across Chesapeake Bay





*For this inspection, quickly loaded tray jigs are used in conjunction with the Picker 150 KV Industrial Unit. This efficient operation was worked out by Picker engineers in collaboration with plant engineers.

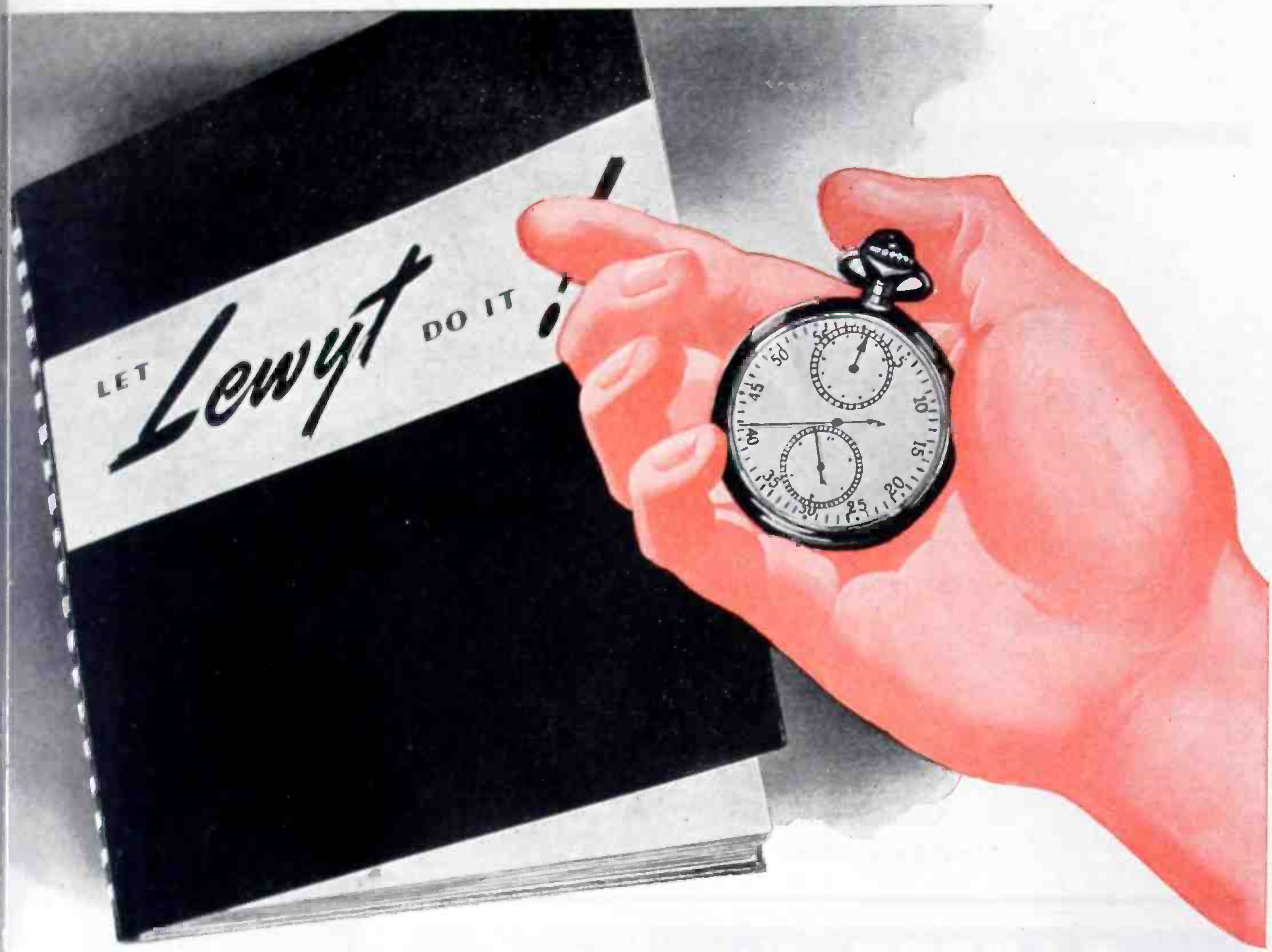
\ leak in a cathode ray tube is a disaster . . . so the time to stop t is *before* precious man hours and material have been expended n final assembly. Tiny as it is, this terminal cap performs a vital unction and must be structurally perfect if the vacuum is not to leed through it. Routine x-ray examination sees to *that* by lisclosing internal weaknesses, such as porosity or faulty welds, which would affect performance, *before* assembly.

n the electronic industries, radiography also provides spot-weld ontrol . . . checks on accuracy of filament and grid alignments . . discloses imperfect joints, broken leads, and similar common lefects in condensers, resistors, assemblies. *The Picker 150 KV (-Ray Unit, either stationary or portable, rated at 150 KV, 8 MA peration, has been found ideal not only for such inspection, but lso in hundreds of other applications where continuous production x-ray inspection is required.*

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

PICKER X-RAY CORPORATION • New York, N. Y.
WAITE MANUFACTURING DIVISION • Cleveland, Ohio

YOUR LOCAL PICKER ENGINEER WILL BE GLAD TO DISCUSS YOUR OWN INSPECTION PROBLEMS WITH YOU



-DAY WILL HOLD A STOP WATCH...

THIS BOOK is designed to help you prepare for CONVERSION DAY . . . it presents the story of a unique institution that may have the answer to your production problem . . . it suggests a plan for putting your new product development *in training* for the post-war starter's gun.

When materials are no longer ear-marked for war . . . when civilian goods are price-marked for peace . . . there will be no glory or profit at the *finish line* for any but the *winners!*

"Cost-Plus" profits will be outlawed . . . wartime regulations will give place to time studies . . . the stop watch will take over control in the competitive race for manufacturing economies.

Lewyt has set the pace in contract manufacturing ingenuity through two post-war periods of business readjustment. We've had long training in cost-sensitive specialization. We're ready to partner with other manufacturers in producing their component electrical and electronic assemblies, chasses and housings . . . or complete units.

With our exceptional facilities and skills in electrical and mechanical parts manufacture carefully developed through 56 years, it will pay you to talk with us . . . at least write for this 48-page book. Ask for "Series B". There is no cost or obligation.

• • •

LEWYT CORPORATION, 62 BROADWAY, BROOKLYN 11, N. Y.

Lewyt

LET LEWYT DO IT

tower and antennas is shown. The transmitting antenna is at the top of the tower, and the receiving antenna directly beneath it. Coaxial transmission lines connect the antennas to the radio equipment in buildings near the base of the towers.

The radio equipment is operated from commercial power lines but at each terminal a stand-by generator, driven by a gasoline engine, has been provided to insure adequate power in emergencies. These auxiliary generators start automatically on failure of the commercial supply.

Type-K Carrier

Although the radio link forms what is essentially a short type-K carrier line circuit, it differs from it in several respects. With the type-K carrier system, the group of twelve single sidebands resulting from the modulation of twelve speech bands is transmitted over the cable as a single sideband of the group carrier frequency.

Meter readings of the radio transmitter at Cape Charles are taken by D. M. Black

The radio transmitter, on the other hand, transmits a double sideband of the type-K carrier group, and thus requires a total band width of 120 kc, instead of the 60 kc transmitted over the cable. A double sideband transmitter was decided upon since it is simpler and less expensive to build.

Another difference is in the regulating scheme. The radio receiver employs automatic gain control to compensate for variations in loss over the radio path. Additional overall regulation is provided for the complete system

A GIFT OF RESEARCH TO THE ELECTRICAL INDUSTRY!

Recent Formica research assisted by new developments in the glass industry which produced glass mat and glass cloth fabrics, along with the perfection of new resins suitable for laminating, has made possible new Formica grades with many important electrical characteristics.

Formica grade MF-66 is a low loss insulator at high frequencies, which retains the high mechanical strength of other laminated grades, and can be machined for rapid production.

Grade FF-10 made with glass cloth base combines good insulating qualities with very high heat resistance, and is just what is needed for such applications as motor slot wedges.

Grade FF-41 made with glass cloth has been especially developed to resist surface tracking and arcing.

These valuable qualities are available in glass base Formica to a degree that was never offered before in laminated plastic materials. Perhaps they can solve some of your problems. Samples for testing on request.

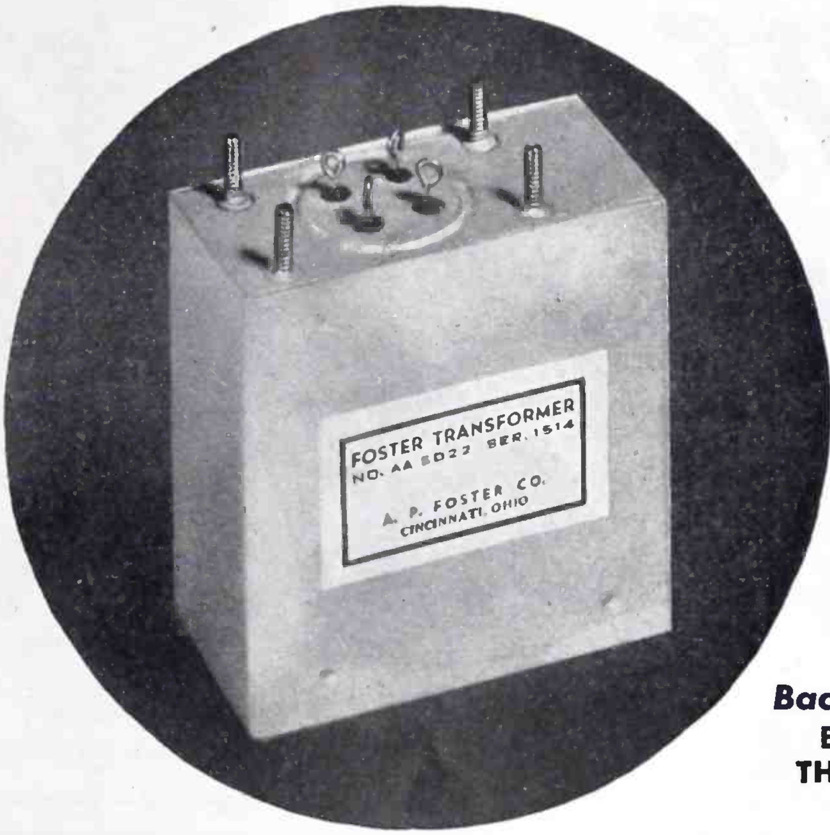
"The Formica Story" is a moving picture in color showing the qualities of Formica, how it is made, how it is used. Available for meetings of engineers and business groups.

FORMICA

ARMY E NAVY

THE FORMICA INSULATION COMPANY
4661 Spring Grove Ave., Cinti. 32, Ohio

DESIGNED "TO ORDER"



Back the Attack
BUY MORE THAN BEFORE

TYPICAL OF

FOSTER TRANSFORMERS

IS THIS AUDIO OSCILLATOR TRANSFORMER PACK BUILT TO A RIGID NAVY SPECIFICATION. IT IS TUNED TO A FREQUENCY TOLERANCE OF PLUS OR MINUS .4 OF 1%. PERFECT HERMETIC SEALING IS ASSURED BY THE USE OF OUR NEW VITROSEAL TERMINAL CONSTRUCTION FOR THE ENTRY OF THE CONNECTIONS INTO THE CASE.

Yes, we are designing and building transformers for the armed forces to meet specific requirements. This skill of being able to create exactly the right transformer for the individual need will be of great value after the war in the new world of electronic equipment. Our experience covers close tolerance vibrator transformers, output transformers, microphone transformers, saturable reactors, power transformers, audio filters and reactors . . . designed and custom-built to fit the most exacting individual requirements.

SPECIALISTS IN BUILDING TRANSFORMERS SINCE 1938

A. P. FOSTER COMPANY

TRANSFORMER ENGINEERS & MANUFACTURERS
719 WYOMING AVENUE, LOCKLAND 15, OHIO

between Norfolk and Cape Charles to maintain a substantially constant net loss between terminals. This follows type-K carrier practice, in that the gains of the receiving amplifiers are controlled by means of pilot frequencies transmitted in the frequency space between speech bands. As a result, the net loss of each of the twelve channels is held constant to within ±0.5 db.

To check the frequency of the carrier of the distant transmitter, each radio receiver has an alarm circuit fed through a crystal filter. A deviation in carrier frequency of

The voice-frequency bay of the Cape Charles terminal in the multi-channel radio link is checked by J. O. Smethurst

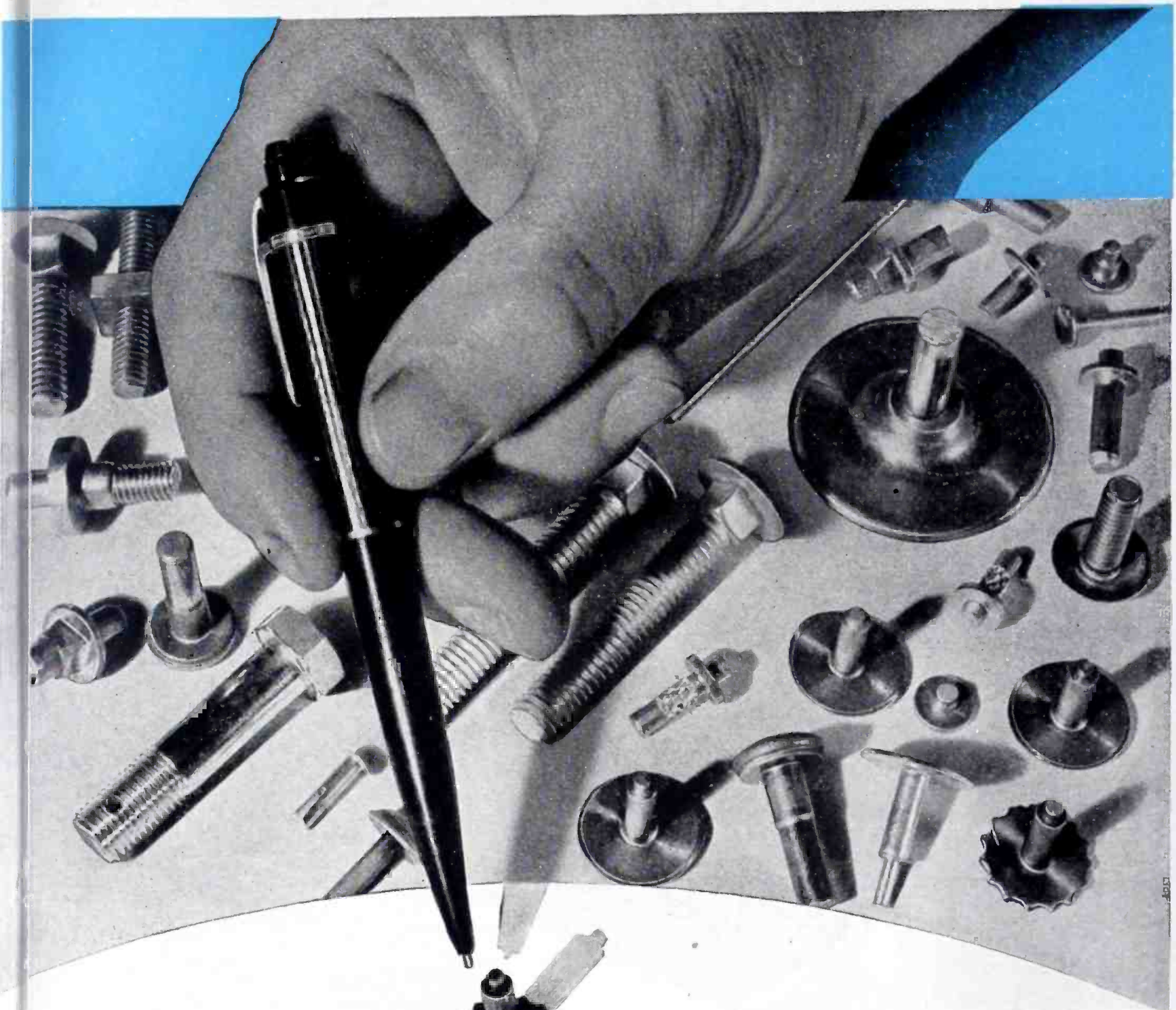
as little as 0.002 percent will operate this alarm. Alarms are provided to warn of excessive temperatures, power failure, and other conditions that might ultimately affect the satisfactory operation of the system.

Each receiver is also equipped with an oscillator of such a frequency as to permit the output of the local transmitter to be detected. This permits a "loop" test to be made through the local transmitter and receiver. Whenever the transmission alarm indicates a circuit failure, these loop tests are made at each end of the radio circuit to determine the location of the trouble.

• • •

Tropical Failures of Electronic Components

THROUGHOUT THE GEOGRAPHICAL belt called the wet tropics, electronic equipment gets its toughest test, not only in service, but even before it is unpacked for use. In this non-temperate climate, temp



Upsetting gets  work under way fast

In two quick steps, this little part is made. The head and the shank with projection are upset from Alcoa Aluminum wire in a rivet header. A blanking operation shapes the head, and the part is ready for heat treating.

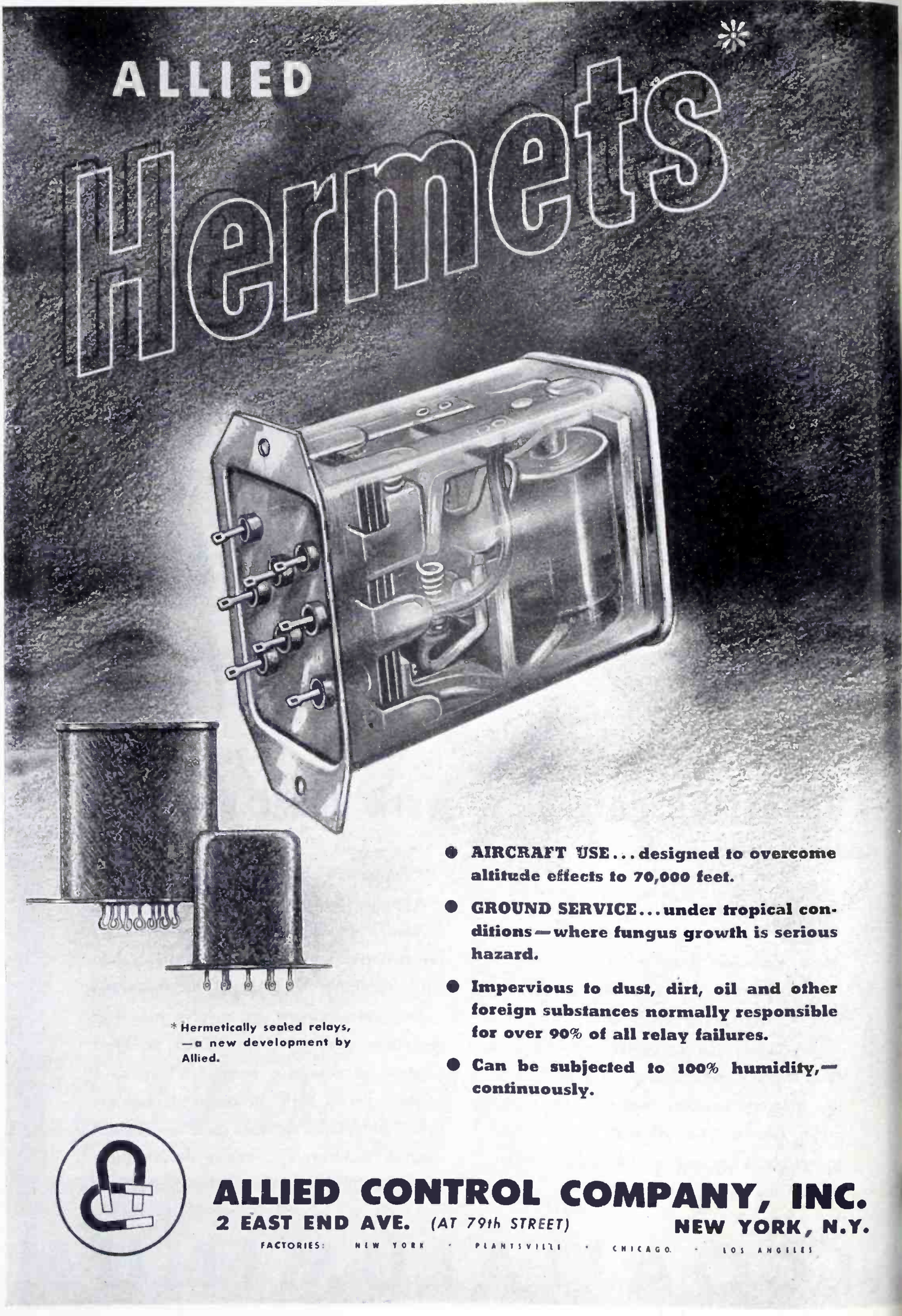
Dimensions can be closely controlled in these heading and blanking operations. Parts, like the carriage bolts you see in the photograph, can be produced with well filled-out square shoulders without the need of expensive milling operations.

Where design and quantities warrant production by upsetting, this process develops sizable economies. In addition to being fast, it saves raw material. You use all the metal you start with, obtaining final shapes by upsetting.

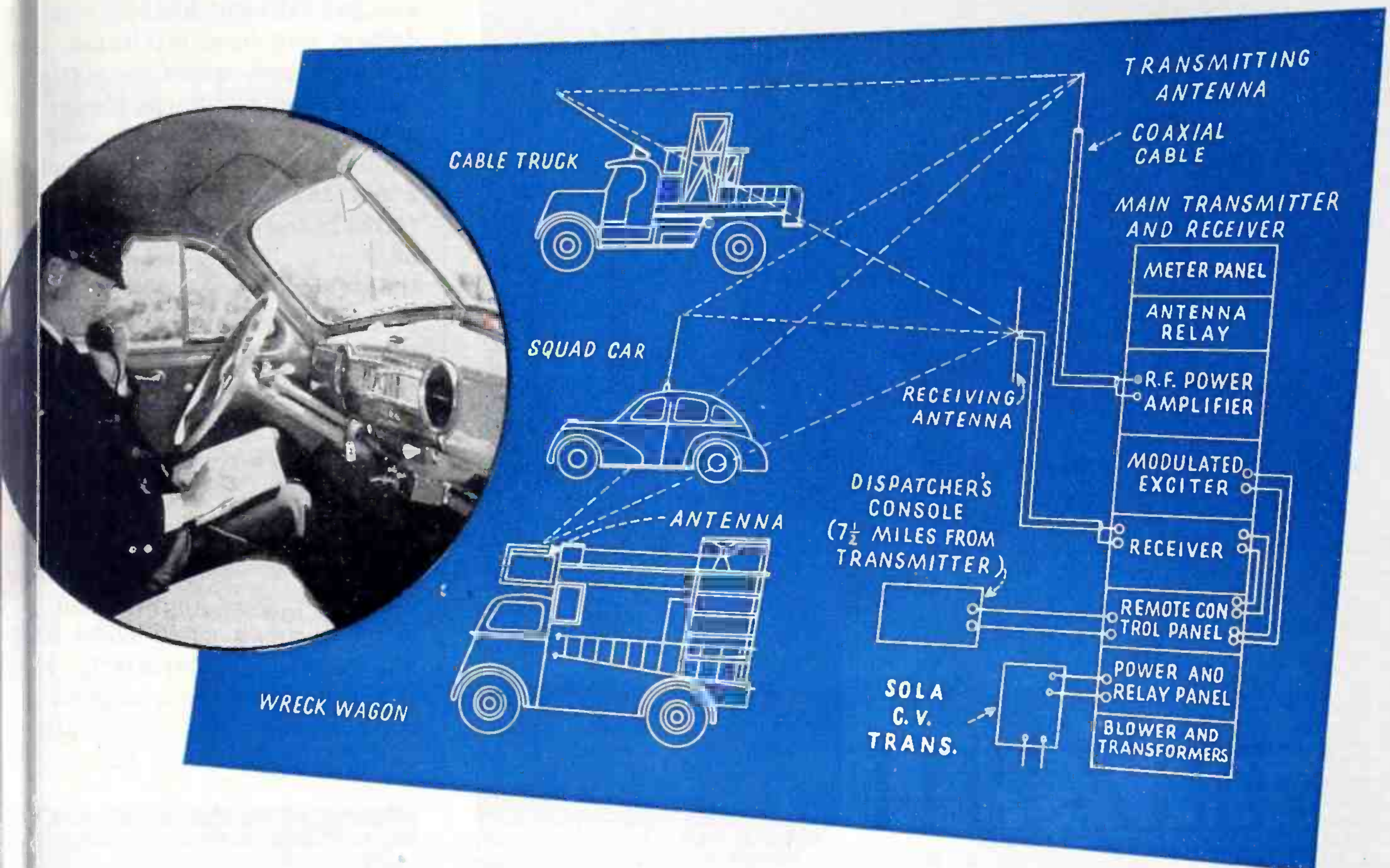
Alcoa is equipped to supply you with aluminum parts produced either on rivet headers, on automatic screw machines or a combination of both. Recommendations are based, therefore, on the most economical method. ALUMINUM COMPANY OF AMERICA, 2136 Gulf Bldg., Pittsburgh 19, Pennsylvania.

ALCOA ALUMINUM

ALCOA ALUMINUM REG. T. M.


ALLIED
Hermets*
● AIRCRAFT USE...designed to overcome altitude effects to 70,000 feet.
● GROUND SERVICE...under tropical conditions—where fungus growth is serious hazard.
● Impervious to dust, dirt, oil and other foreign substances normally responsible for over 90% of all relay failures.
● Can be subjected to 100% humidity,—continuously.
* Hermetically sealed relays, —a new development by Allied.
ALLIED CONTROL COMPANY, INC.
2 EAST END AVE. (AT 79th STREET) NEW YORK, N.Y.
FACTORIES: NEW YORK · PLANTSVILLE · CHICAGO · LOS ANGELES

R DIO COMMUNICATIONS operate with greater efficiency with built-in CONSTANT VOLTAGE



Th safety and convenience of two nd half million passengers, car- ied laily by the Chicago Surface in, are guarded continuously by ne aborate, phase-modulated radio om unication system by which all ivions of this vast transportation yst n are kept under constant sur- eil nce.

turally, any communication yst n so important to human safety nd vell-being cannot take chances it tsequipment. Line surges, volt- ge uctuations that distort and in- erpt signals or damage costly tubes nd quipment, cannot be tolerated.

In this, and in many other radio communication systems, SOLA Constant Voltage Transformers are playing an important role—constantly on guard against line voltage disturbances, instantly correcting fluctuations as great as 30% to less than $\pm 1\%$ of rated requirements. SOLA Constant Voltage Transformers require no manual adjustments or supervision. They have no moving parts. They protect both themselves and their loads against short circuit.

When supplied as a built-in part of any type of electrical or electronic equipment SOLA Constant Voltage

Transformers insure longer tube life, fewer service calls and greater satisfaction to the user. Consider these transformers in your basic design.

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

ransformers for: Constant Voltage • Cold Cathode Lighting • Mercury Lamps • Series Lighting • Fluorescent Lighting • X-Ray Equipment • Luminous Tube Signs • il Burner Ignition • Radio • Power • Controls • Signal Systems • Door Bells and Chimes • etc. **SOLA ELECTRIC CO., 2525 Clybourn Ave., Chicago 14, Ill.**

erature has a year-round average of about 80 deg. F, while humidity stays about 85–90 percent.

Moisture, resulting from this extreme humidity, corrodes metal parts directly and facilitates fungus growth which causes related damage and service failures. Once moisture penetrates insulation it causes leakage, shorts, electrolytic action, and eventual breakdown. Difficulties with electronic components take a number of typical forms in the cases of various specific parts. These are discussed in the following text, with notes on design factors that have been obtained from a branch of the armed forces concerned with such troubles.

Transformers

Breaks caused by electrolytic corrosion frequently occur in the windings of transformers. Moisture enters the windings and insulation through small holes in the impregnation, particularly where the leads enter the windings. Fibrous or paper insulation absorbs and retains moisture, and in addi-

Amid typical tropical surroundings, communications equipment is set up in Dutch New Guinea by American troops that landed at Hollandia

tion, contains water-soluble salts which, when combined with moisture, cause leakage and corrosion. Electrolytic action takes place, and the result is an open circuit. Failures of this sort are frequently preceded by intermittent noises.

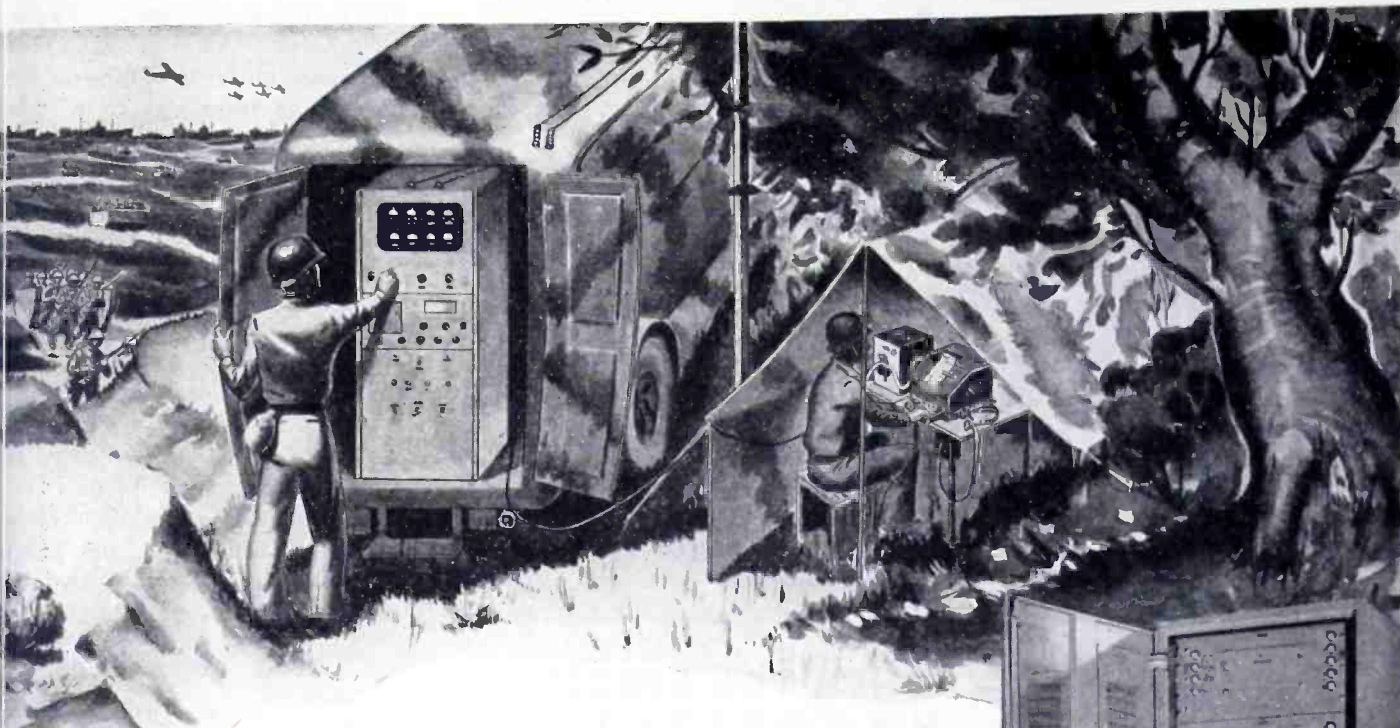
To prevent such failures, insulating materials should be used which do not absorb moisture, and the windings must be thoroughly

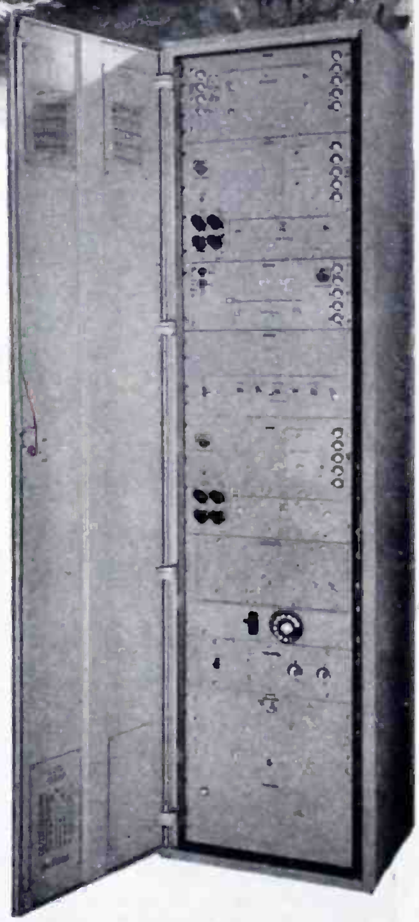
Dials by CRONAME

GLASS METAL
PLASTICS

CERAMIC
ETCHED
LITHOGRAPHED
ENGRAVED
EMBOSSED

CROWE NAME PLATE AND MANUFACTURING CO.
3701 RAVENSWOOD AVENUE CHICAGO 13, ILLINOIS
40 YEARS EXPERIENCE IN FINE METALCRAFT





THE FIGHTING "400"

AND THE "SIXTY-NINETEEN"

On the morning of D-plus-7 Day, Press Wireless made radio and wartime history when it sent and received the first news dispatch to be handled by a private agency *direct* from the beachhead in Normandy to America.

Transmission speeds of 250 words per minute and more are being regularly maintained. This fast, *direct*, close-to-the-battle-lines service of Press Wireless, authorized by the war theater command, has become the talk of the communications and newspaper worlds.

Press Wireless radio men are operating the transmitting and receiving stations. Press Wireless designed and manufactured the transmitter being used, a 400-watt set installed in a truck so that it can be kept close to the action, and the receiver, one of our "6019" series.

The last radio communications company to leave France at the time of the German invasion in 1940, and now, the first to return to help speed the liberation of France, Press Wireless is justifiably proud of the distinguished service its men and its products are rendering day and night through Station PX in Normandy. This achievement is brilliantly in keeping with the traditions of a company that has been performing outstanding feats in world-wide communications and engineering for more than 15 years.

RESS WIRELESS, INC. IS DEVELOPING OR MANUFACTURING

- HIGH POWER TRANSMITTERS
- DIVERSITY RECEIVERS
- AIRCRAFT AND AIRFIELD RADIO EQUIPMENT
- RADIO PRINTER SYSTEMS
- MODUPLEX UNITS "TRADEMARK"
- CHANNELING DEVICES
- RADIO PHOTO TERMINALS
- FACSIMILE MACHINES

AND OTHER TYPES OF RADIO AND COMMUNICATIONS EQUIPMENT

Awarded to our Hicksville, Long Island Plant for outstanding Achievement in War Production

Sales Office, Manufacturing Division
75 BROADWAY, NEW YORK 18, N. Y.

PRESS WIRELESS, INC.

Executive Offices
435 N. MICHIGAN AVENUE, CHICAGO

RIO DE JANEIRO · MONTEVIDEO · BERNE · SANTIAGO DE CHILE · NEW YORK · CHICAGO · LOS ANGELES · LONDON · HAVANA dry and sealed from the damp atmosphere. Among satisfactory coil assemblies are those which have been impregnated with synthetic ceresin and sealed in their cases by potting.

Most common failures from electrolysis result when fine wire is used in the coils. Whenever potential differences exist between windings and cases, it is sometimes feasible to prevent electrolysis by insulating the case and providing a leakage path between the highest voltage and the case. However, certain hazards may be introduced because additional high-voltage areas will be exposed. Electrolysis occurs only when differences of potential exist.

Capacitors

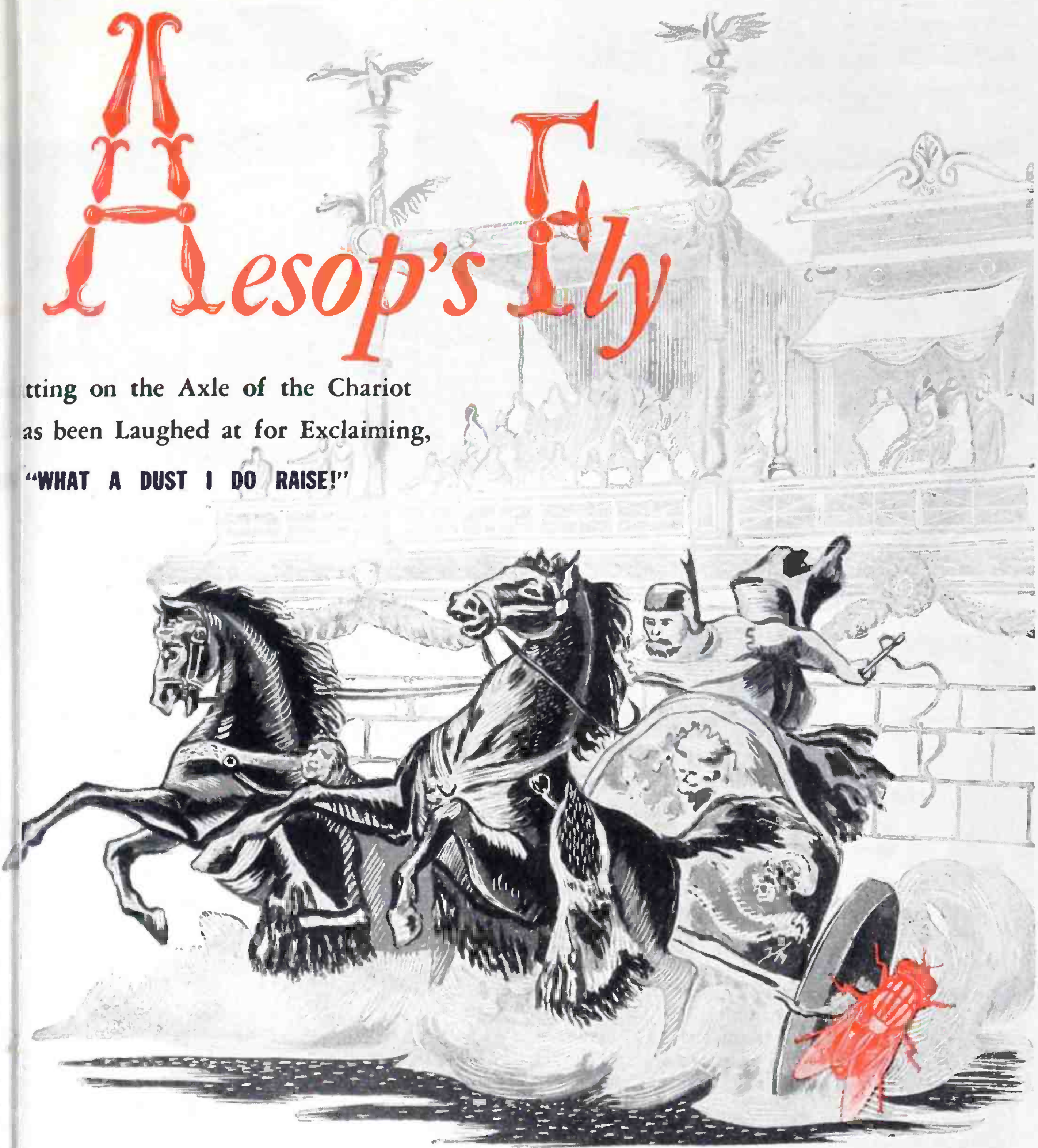
Unless they are properly impregnated, capacitors which are not hermetically sealed are not suitable for tropic use. Most capacitors, when new, have high leakage resistance, generally in excess of 1000 megohms. But unless they have been properly treated, this resistance, after a few weeks exposure to tropical moisture, may decrease to a few megohms. A resistance of five megohms or less is usually unsatisfactory in high-voltage decoupling capacitors and particularly in coupling units used between plate and grid circuits. Grid bias is made more positive than the proper value by the influence of the plate voltage.

Molded mica-type capacitors have a direct opening where the leads pass through the case; this leaves a path to the outside atmosphere. In the wet tropics, moisture will enter and follow this path and eventually cause failure of the unit.

This trouble can be largely prevented by impregnation with ceresin wax. If properly done, this will seal molded capacitors, provided the leads are not bent or disturbed so as to cause the seal around them to fail. Since ceresin has a relatively low melting point, the wax will become fluid at high operating temperatures. However, this will not prove serious in the operation of the capacitor since the wax will remain in the pores by capillary action and, upon cooling, will actually improve the seal rather than impair it. However,

Aesop's Fly

tting on the Axle of the Chariot
as been Laughed at for Exclaiming,
"WHAT A DUST I DO RAISE!"



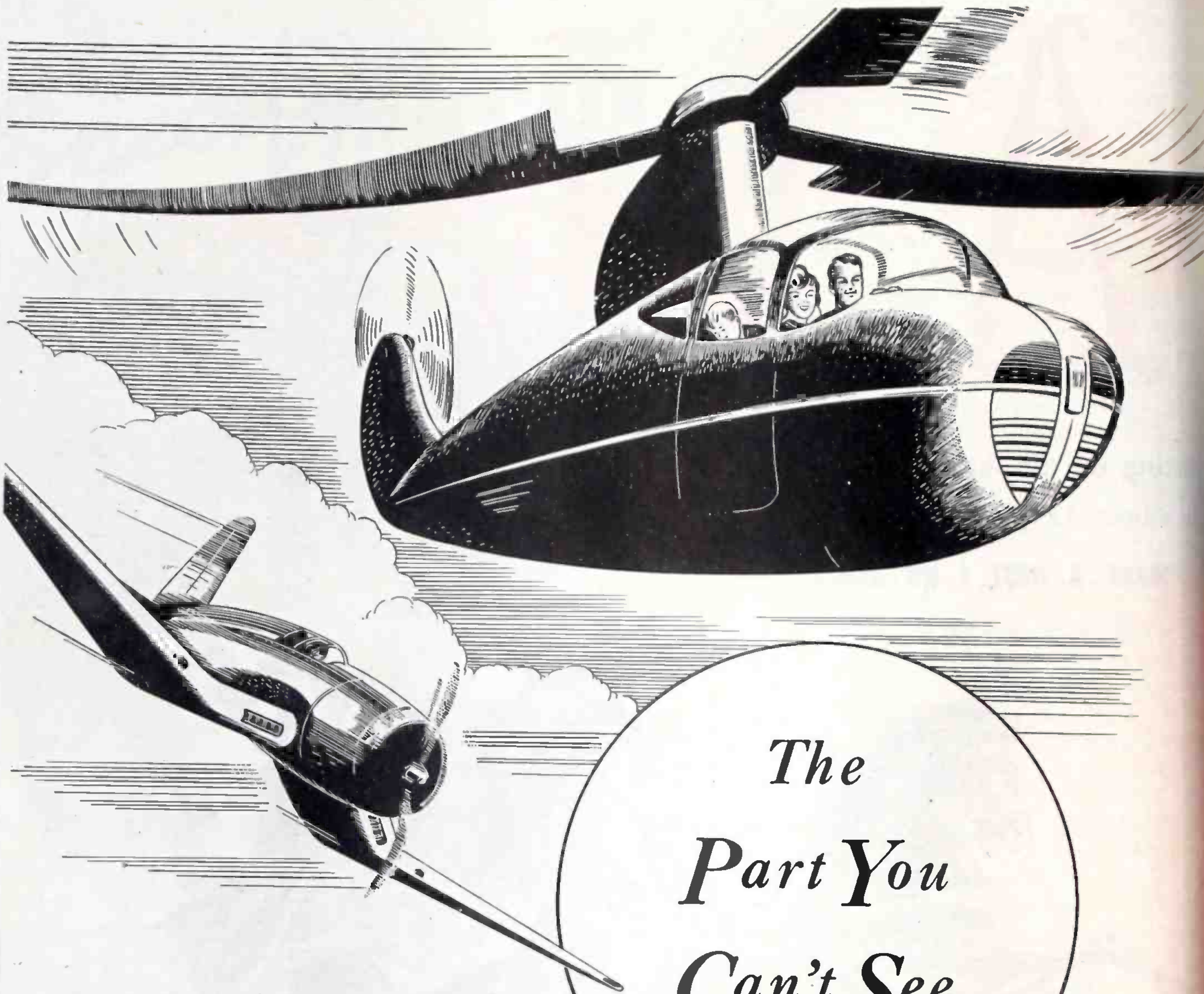
The wheels of American enterprise geared to war-paced production have been raising a high dust for the past few years. But it would be both absurd and naive for any one industrial unit to claim a large share of credit for this great accomplishment.

As a part of the over-all effort, G. I. was assigned to break a bottleneck in its special field of electronics and radar. By official admission this has long since been accomplished.

Variable condensers, many with circuit applications never before possible, automatic tuning mechanisms, complete wired assemblies and sub assemblies are all part of G. I.'s story. What we have learned in the way of new techniques short cuts and cost cuts will be of high interest in our industry when the last gun cools.

GENERAL INSTRUMENT CORP.

829 NEWARK AVE., ELIZABETH 3, N. J



A Good Firm to Connect With For Your Postwar Needs in:

CONNECTORS AND RELATED UNITS

Connector Division of IRC produces a comprehensive line of coaxial cable connectors, multiple contact connectors and cable plugs.

If your postwar products call for these or other small parts of a related nature, we suggest you avail yourself of our specialized knowledge, experience and volume manufacturing facilities. Inquiries are invited.

NEW COAXIAL ADAPTER

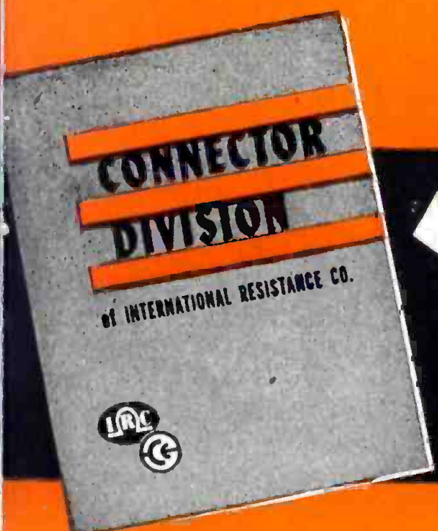
Adapts British to American Coaxial Connectors

Ever on the alert to meet industries' requirements, IRC offers this precision Adapter to fill a current need for this type unit. This Adapter is now available in production quantities.

HERE'S WHAT IT DOES

Connects British 10H/528 coaxial plug to the Navy 49195 plug and to the Signal Corps PL-259 plug.

Meets Navy Specifications RE49F242



Write for Your Copy of our Catalog

IRC

***CONNECTOR DIVISION OF**

INTERNATIONAL RESISTANCE CO.

401 N. BROAD ST., PHILADELPHIA 8, PA.

*FORMERLY CONNECTOR CORPORATION

heating a mica unit will change i its capacitance permanently; th change generally decreases tl value about 5 percent, but occa ionally the decrease may be much as 20 percent.

For efficient operation in tl tropics, paper capacitors should of the metal-clad, hermeticall sealed type. Ordinary paper cardboard-cased types are unsui able for use in the wet tropics b cause they quickly develop exce sive leakage resistance. Whi paper tubes which are proper wax-impregnated will keep o moisture, the solid wax and sea used in many early types are n adequate to protect the dielectr of the capacitor.

A tubular capacitor may tropic-proofed by being placed a second tubular casing of met and then dipped in a potting-ty compound which will not fractu easily when solidified.

Paper labels encourage th growth of mold and the accum lation of moisture. It is better mark the value with paint or ink.

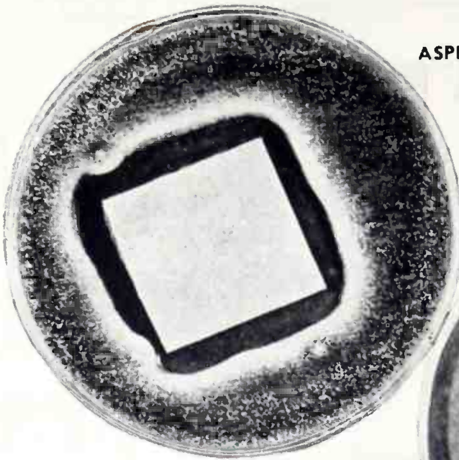
Resistors

Resistance values of carbo type resistors which are not he metically sealed usually increa slowly with time and eventuall the resistors become open. Resi tors of the type which are encase in molded material can be treate effectively with impregnating com pounds.

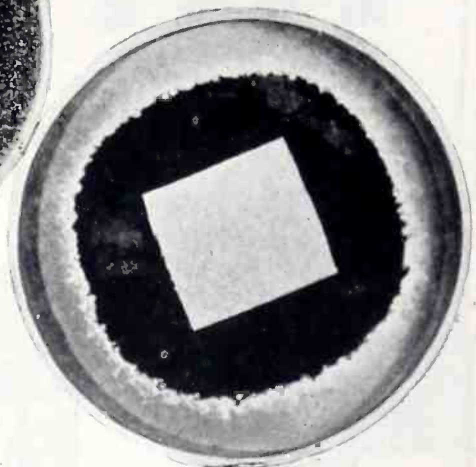
To ensure good operation and prevent breakdowns, resistor carrying current should have wattage rating at least four time that called for under normal cond tions.

Wire-wound resistors on glaze ceramic bases hold up better tha wire-wound types built on organi materials which are very suscep tible to fungus growth. Failure in wire-wound resistors are gen erally caused by corrosion and b other factors which affect fin wire coils in general. Practicall all low-wattage resistors can b impregnated successfully with sealing compound. Here agai paper labels should be avoided.

Carbon-type potentiometers op erating in the tropics have a tend ency to become noisy and develop dead spots. Frequent cleaning and drying is thus re-n the photographs shown here, only the quare patch of filter paper in the center as been treated with Tropicalized Q-Max acquer. The area free from fungus imme-liately surrounding the patch shows how ffectively Tropicalized Q-Max controls ıngus growth even on untreated surfaces djacent to the treated part.



ASPERGILLUS NIGER

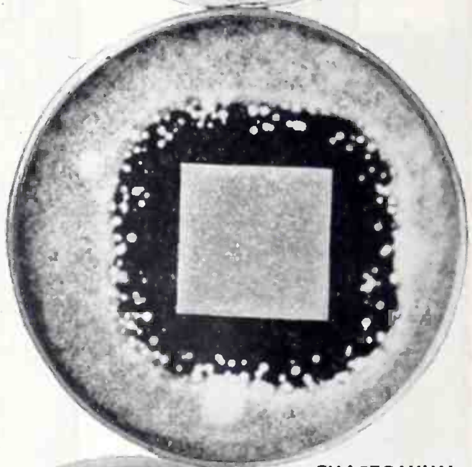


PENICILLIUM DIGITATUM

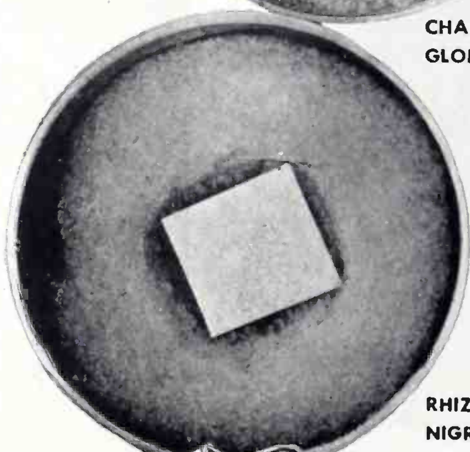
ropicalized

-MAX A-27 H.F. LACQUER

ow safeguards Communication and ctrical Equipment against FUNGI



CHAETOMIUM GLOBOSUM



RHIZOPUS NIGRICANS

Fungus and mold are ever-present in humid atmospheres, especially in the tropics...ready to impair and destroy the fine precision performance of radio, electronic, signal detector, communication and other electrical equipment used by our armed forces.

To meet this vital need for adequate fungicidal protection of war material, Q-Max chemists spent many months in search of an ideal fungicidal agent to incorporate into Q-Max lacquer ingredients. Many highly effective fungicides proved to be unsatisfactory because they disturbed excellent electrical characteristics or caused corrosion of metals.

But the search is now over, thanks to the effective blending of a potent fungicide with the outstanding dielectric coating material, Q-Max A-27 H. F. Lacquer.

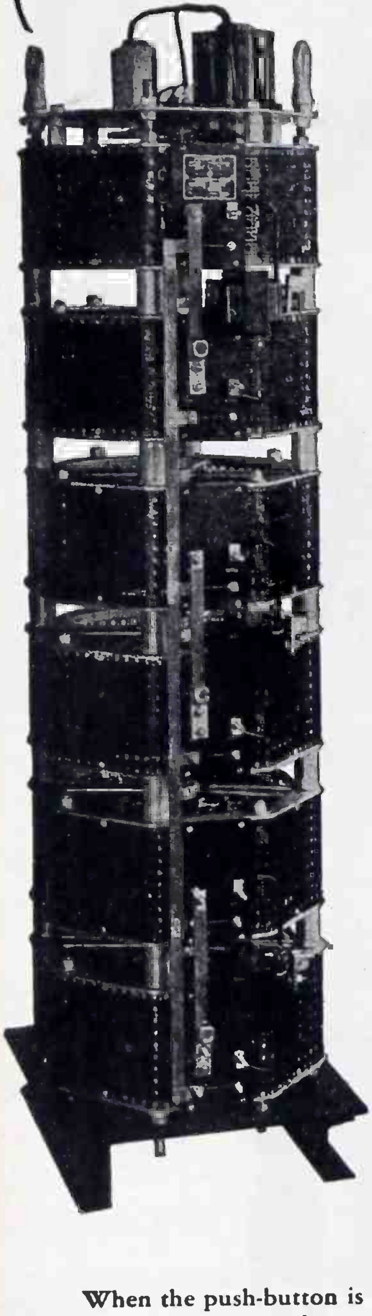
With Q-Max A-27 H. F. Tropicalized Lacquer, no mixing of fungicides and lacquer is necessary—all this is done at our factory. Look for the word TROPICALIZED on the Q-Max label.

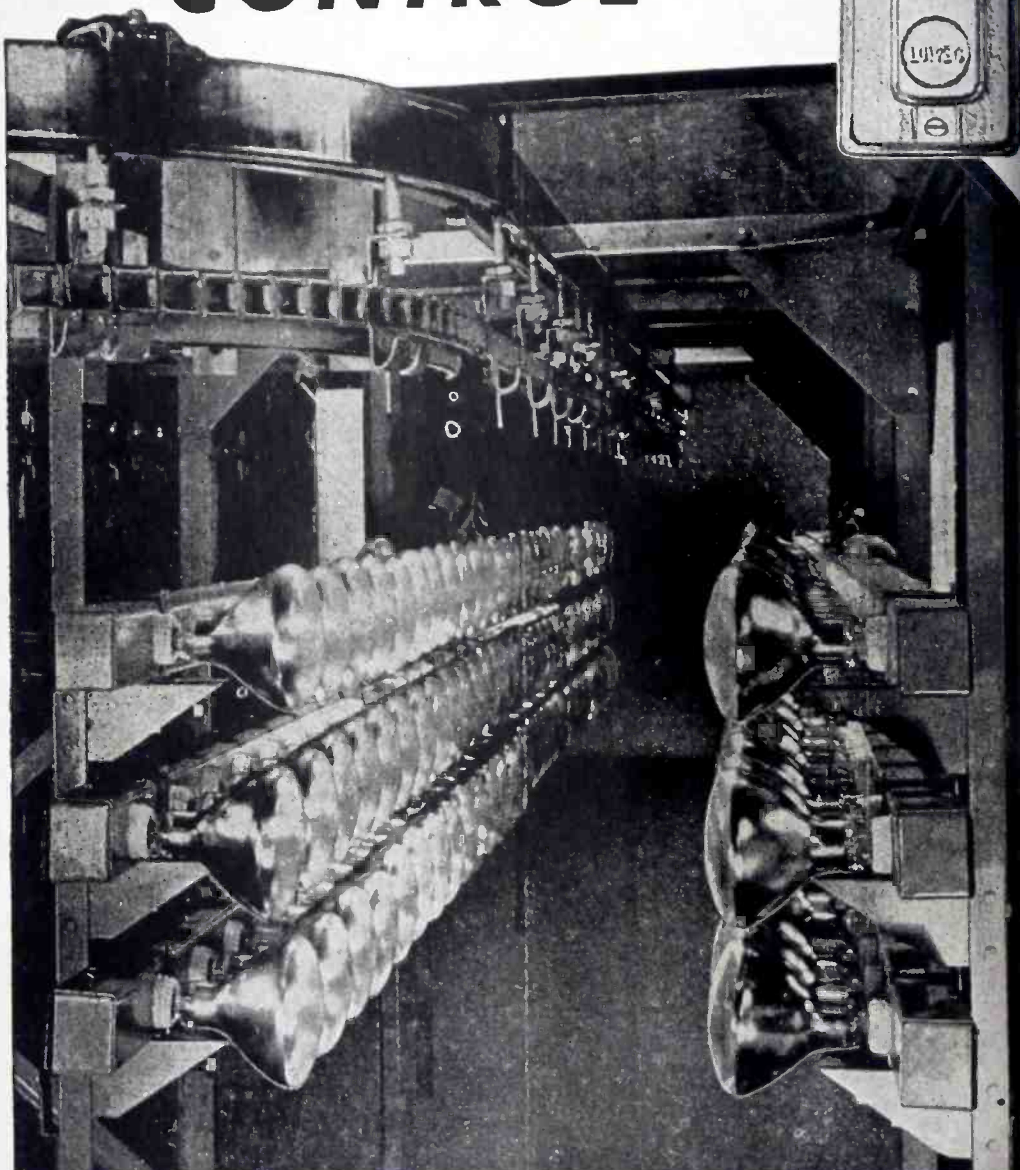
Communication
PRODUCTS CP COMPANY, INC.
744 BROAD ST. NEWARK, N. J.
FACTORY: 346 BERGEN AVENUE, JERSEY CITY, N. J.

Q-MAX CHEMICAL DIVISION

Coaxial Transmission Line and Fittings • Sterling Switches • Auto-Dryaire • Antenna and Radiating Systems • Q-Max A-27 Radio Frequency Lacquer

INFRA-RED
with POWERSTAT CONTROL





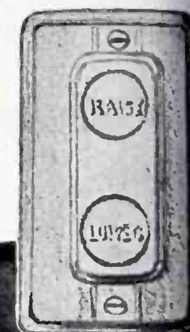


PHOTO COURTESY THE LEEDS ELECTRIC & MFG. CO.

When the push-button is pressed, this 42.8 KVA lamp bank is under finger-tip control for instantaneous adjustment of the 171 infra-red 250 watt lamps to the exact energy output required by each production demand. Controlling this installation is a type M1256L-6 wye connected, 3 phase, 440 volt input, POWERSTAT variable voltage transformer.

If your application is smaller or larger, our engineers will recommend a POWERSTAT to — control infra-red to produce a better job faster . . . increase lamp life . . . reduce operating costs and eliminate the need of adjusting cumbersome lamp brackets. Send for Bulletins 149 LE and 163 LE

Superior Electric Co., 208 Laurel Street, Bristol, Conn.

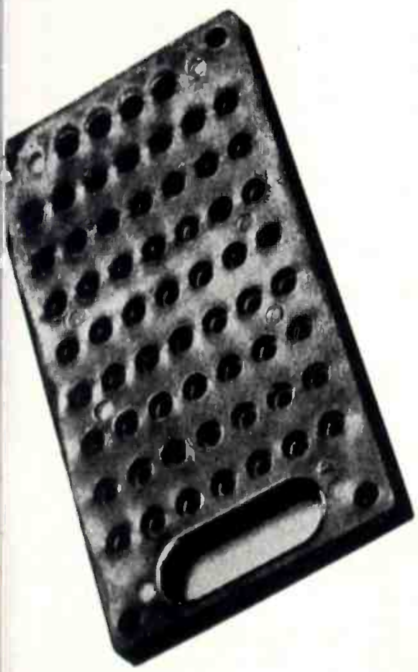
SUPERIOR *Electric Company*

HIGH FREQUENCY PREHEATING

...in the molding of plastics

■ This message has one idea...to emphasize wartime progress in molding methods which enlarge the field for Durez compounds. In the post-war period, high frequency preheating, along with many other new developments, will provide your custom molder with the means for making his service even more appealing than ever before.

e use of high frequency preheating the molding of phenolic materials opened up a completely new field ecially in heavy duty materials that *natural* for Durez compounds. The ncipal advantages of this method sist of (1) a reduction in the mold- time cycle and (2) a better molded oduct with greater density, improved ctrical properties and a more uni- m cure.



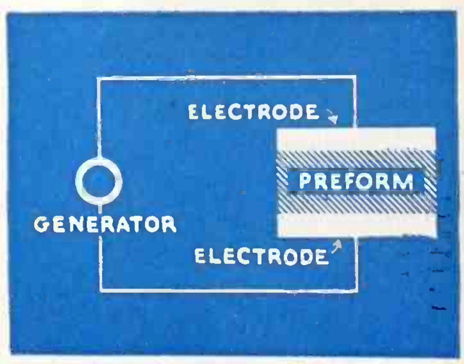
The illustration at left serves as an excellent example of the successful application of high frequency preheating in the production of a molded plastic part. The item pictured is a terminal board for military use which was molded from a preform of high-impact macerated-fabric-type Durez phenolic molding compound.

The basic operation of all high frequency preheating is shown in the simple diagram at right (notice the preform in position between the high frequency electrodes). Since the preform is never a perfect non-conductor, some leakage takes place through it. This leakage current manifests itself in the form of heat and thus the preheating of the preform takes place quickly and thoroughly. This method of preheating is particularly valuable when the preforms are of unusually thick, heavy duty material.

The use of high frequency preheating in the molding of plastics is still in the process of development and therefore is extremely limited at the present time. However, the fact that its usage results in a reduction of the molding time cycle and a better product, seems to indicate that it can be viewed as one of tomorrow's certainties.

This is but one of many developments in which Durez phenolics fill the bill. Because of their excellent dielectric properties, inertness to solvents, resistance to impact, high heat, climatic changes, mild acids and alkalies, Durez versatile phenolics have found a place in practically all fields of industry.

Perhaps there is some question in your mind about the inclusion of plastics in your post-war plans. Why not get a competent answer to that question now? Our staff would welcome the opportunity to discuss any plastic material problem with you. Durez Plastics & Chemicals, Inc., 89 Walck Road, North Tonawanda, N. Y.



DUREZ

PHENOLIC MOLDING COMPOUNDS AND RESINS

PLASTICS THAT FIT THE JOB

quired. Provision of adequate ventilation is another help; units without covers often exhibit better operation and longer life. Wire-wound potentiometers used in current-carrying circuits suffer corrosion of the winding and of the sliding arm. Potentiometers of this type must be cleaned periodically. Filling with white vaseline improves their operation and prevents failure.

Insulators

In the damp heat of the tropics ordinary sheet fibers and materials which absorb moisture will warp and yield. This characteristic, together with differential expansion, will result in misalignment of component assemblies and will cause changes in circuit constants.

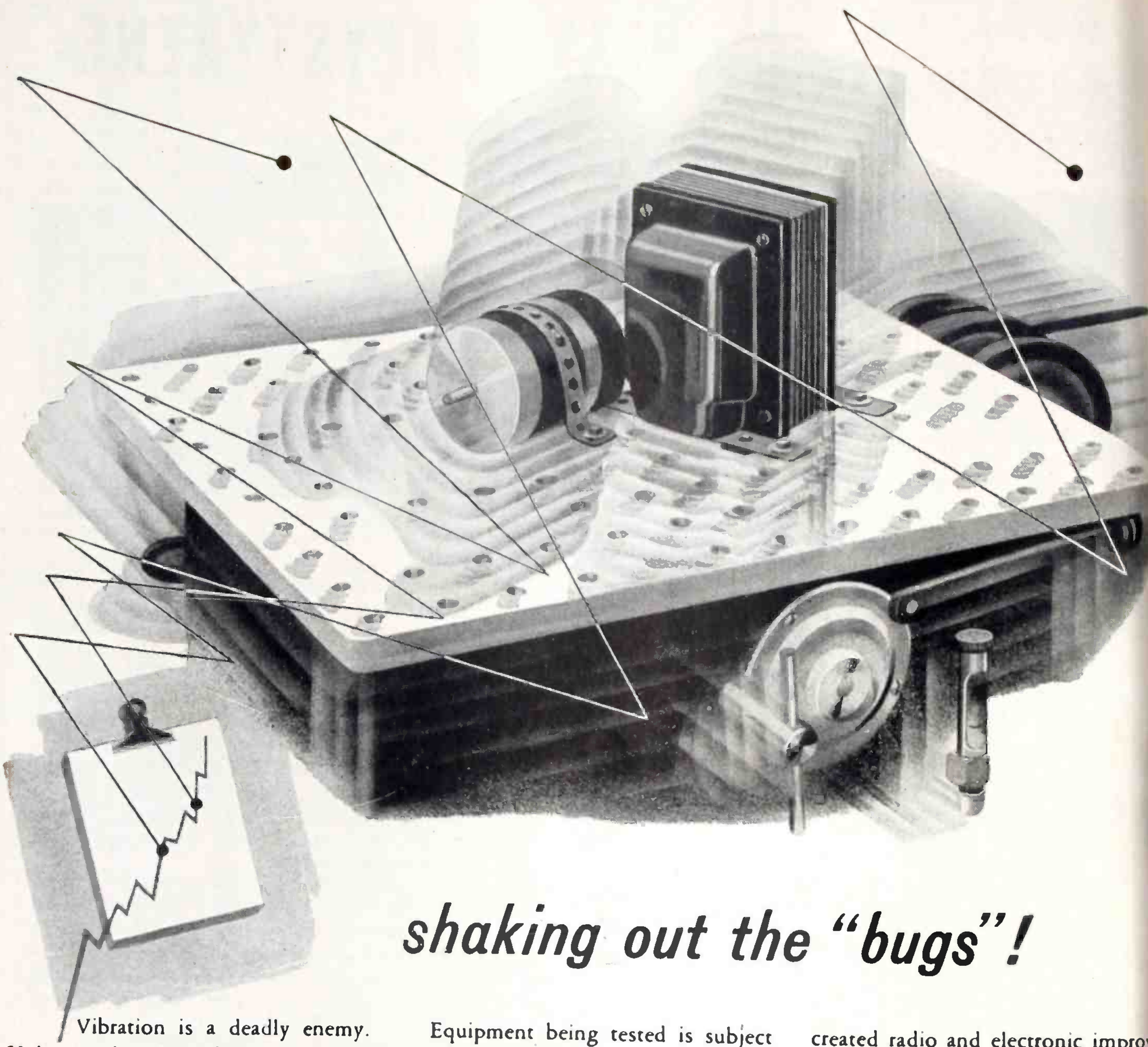
For use in the wet tropics, insulating materials in sheet, block or molded form should be of phenolic composition which resists moisture. Acrylate and methacrylate resins are fair insulators and may be used in low-frequency circuits where a very high dielectric constant is not required, or where it will not be subject to extreme heat. Since this material generally can be obtained easily around airfields in scrap form it is often used to replace defective insulation.

Whenever plastic insulating material is cut or drilled, the edges of all holes and cut surfaces should be buffed and then sprayed or brushed with insulating varnish or lacquer. This treatment will prevent moisture absorption and prevent the support of fungus growth.

Wiring

The use of hook-up wire having rubber or cotton insulation should be avoided. Cotton braiding, even if waxed, will absorb moisture. If an organic wax is used, fungus growth will attack it. Even non-susceptible wax impregnation disappears in time and decomposition of the cotton will eventually result. Hook-up wire with Neoprene insulation in place of rubber, and wire with Celanese or Fiberglas insulation in place of cotton, are suitable.

When high-impedance leads are involved, surface wiring is more satisfactory than wiring laced into harness cables. If wires must be laced into forms, the lacing



shaking out the "bugs"!

Vibration is a deadly enemy. Unless equipment and parts can withstand its destructive force, irreparable damage results at crucial moments.

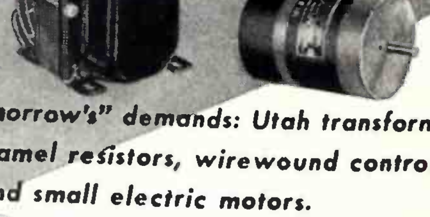
Parts tested on Utah's *Vibration Life-test Equipment* have the "bugs" shaken out of them before they are ready for quantity production; are again proved by this "power dive" test of production runs...assuring unfailing performance.

Equipment being tested is subject to vibration up to 25G.

As a result of this and other tests, many engineers' "brain children" grow up in the Utah Laboratories and on the production lines to play their parts in today's war effort. *Tomorrow*, these war-created radio and electronic improvements will be adapted to peacetime needs—aided by these new and more comprehensive testing techniques.

★ ★ ★

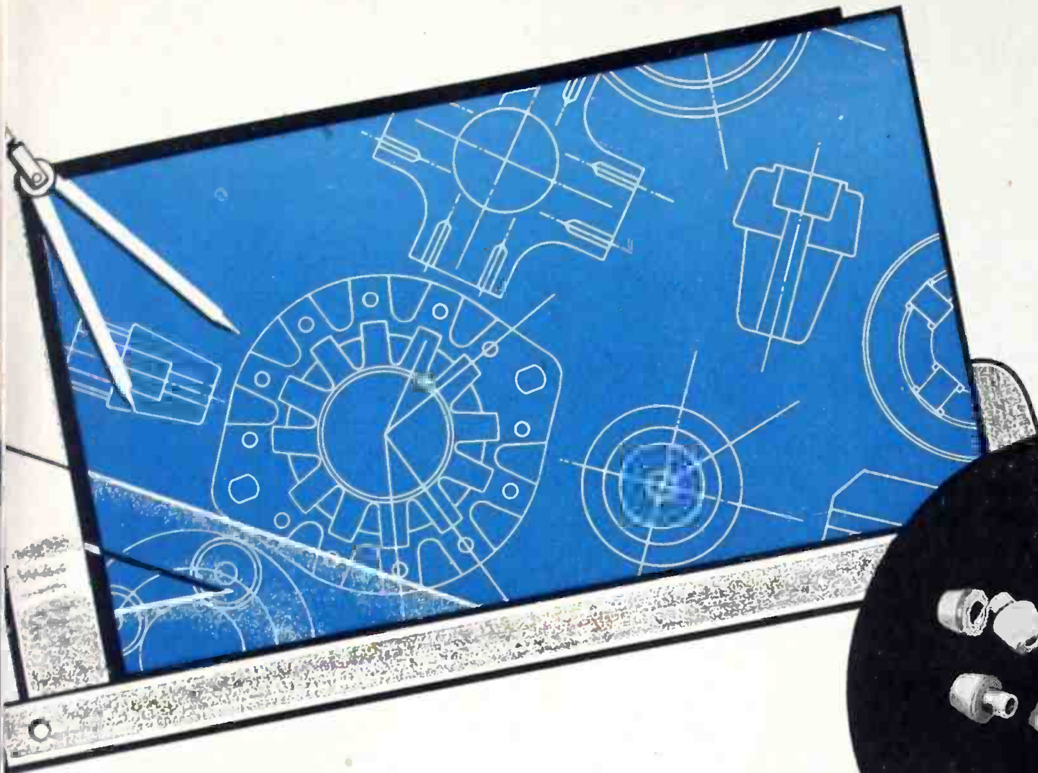
Every Product Made for the Trade, by Utah, Is Thoroughly Tested and Approved

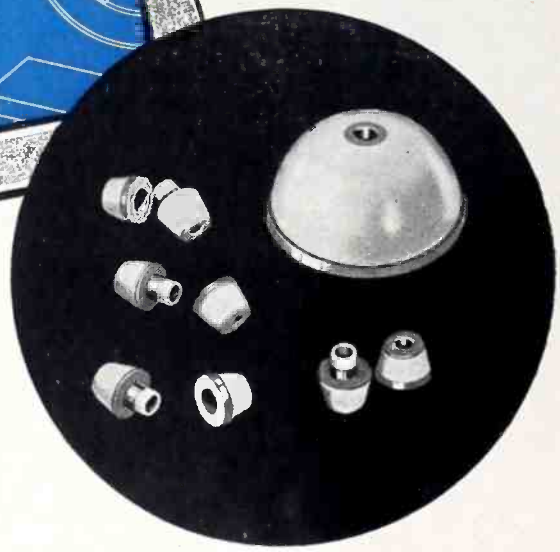


Keyed to "tomorrow's" demands: Utah transformers, speakers, vibrators, vitreous enamel resistors, wirewound controls, plugs, jacks, switches and small electric motors.

utah

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





NEW INSULATOR DESIGN POSSIBILITIES FOR RADIO

General Ceramics' successful surfacing of steatite with thin films of silver, fired at a high temperature and then built up with an electroplated metal (silver, copper or tin), opens up new insulator design possibilities for very high frequency equipment, as well as for certain applications in the lower radio frequency field.

The metallic film can be applied to the surface of insulators to eliminate corona effect. The use of this combination permits improvement in the design of airplane strain and lead-through insulators.

The addition of a thin metallic surface film also permits soldering of metal parts directly to the steatite insulators. Water-tight seals may be made in this manner where temperature ranges encountered in service are limited.

Your inquiry regarding *Silver Surfaced Steatite* is invited.

General Ceramics
AND STEATITE CORP.
GENERAL CERAMICS AND STEATITE CORPORATION — STEATITE INSULATORS
KEASBEY NEW JERSEY

5290

materials should be waterproof and inorganic in makeup so that it will not support fungus growth. Bindings should not be drawn more tightly than is required to support the form.

In general, solid wire will hold up better than stranded wire for surface wiring. When dressing wire at terminals, care should be taken not to bend sharply, stretch, dress and redress lacquered or varnished wire unnecessarily; otherwise, the coating may crack and the insulation will absorb moisture. Wiring should be as straight as possible; bunching or knotting must be avoided. Fungus growth is heaviest where wires are crowded.

Plugs

Condensation attacks plugs; moisture gets inside, runs down on cables and is often the cause of failure due to electrolysis and final shorting of leads. Holes could be provided in the bottom part of the plug to drain off water.

Batteries

Dry cell batteries have a very short life in the wet tropics. Satisfactory service has been obtained from those in which both inner and outer cases are well impregnated with wax or sprayed with a moistureproof coating.

Batteries which are mounted in cases should be well screened and separated from metal surfaces by a liner of high-quality moisture-resistant insulation. The battery case should not be allowed to come in contact with metal at any point, even though the battery case appears to be well-impregnated with wax. This precaution is especially important where fairly high wattages are used.

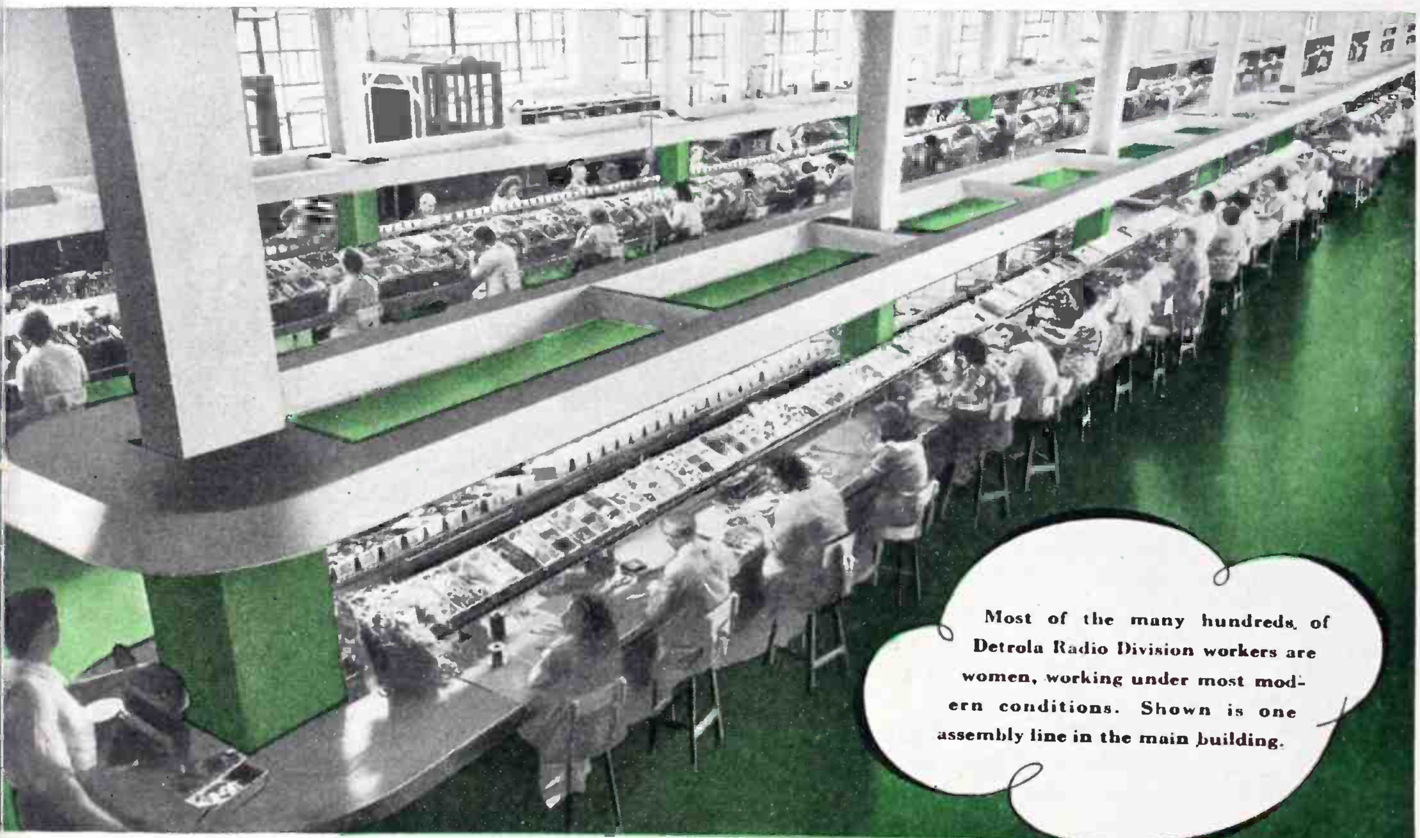
In the field, the life of dry cell batteries is prolonged by repacking them in tins—eight cells to a tin—and soldering the tins airtight. The batteries are left in the tin until needed.

Dynamotors

The failure of dynamotors has been reported in which the cause has been found to be the high-voltage output shorted to the case because of exposure of wire insulation to excessive moisture. Where there is excessive leakage,

Quality in Quantity

Building a quality product calls for skilled engineering, superior materials and extra-fine craftsmanship. Building a quality product *in quantity* calls for all these things, plus a plant laid out and organized for maximum production efficiency. The streamlined and efficient assembly lines which have poured forth unrevealable numbers of the SCR 299 and 399 Mobile Radio Stations, Mine Detectors, Aircraft Radio Receivers and transmitters and other equipment are International Detrola's promise of great quantities of the best in radio, television and electronics for a world at peace.



uy War Bonds—and Keep Them

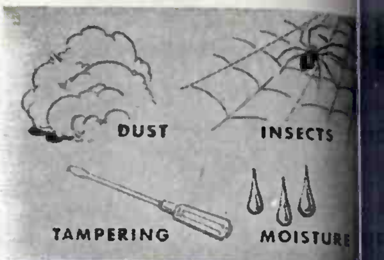
DETROLA RADIO

DIVISION OF INTERNATIONAL DETROLA CORPORATION • BEARD AT CHATFIELD, DETROIT 9, MICH.

C. RUSSELL FELDMANN dr PRESIDENT

How to make your product Environment-Free . . . . . . Have it

Fedelco-Sealed by Federal Electric Company, Inc. Fedelco-Sealing Service



You Can Control These "Conditions Beyond Your Control"

Environment

can be the cause of defeating all your careful design . . . skilled engineering . . . conscientious manufacture . . . all your painstaking effort to assure the long, dependable operation of your product.

Fedelco-Sealing

offers a sure means of sealing-*in* ideal working conditions . . . sealing-*out* moisture, dust, bugs, and tampering. This new method seals your electrical or mechanical device inside a housing which is proof against these common enemies. This sealing assures your customer of getting, for a long, long time, the reliable operation you built into your product.

We can Fedelco-Seal it for you . . . or you can Fedelco-Seal it yourself

You can send your product to us, and we will return it to you completely Fedelco-Sealed. Or we can show you how you can Fedelco-Seal in your own plant, with our equipment, and by the methods we use.

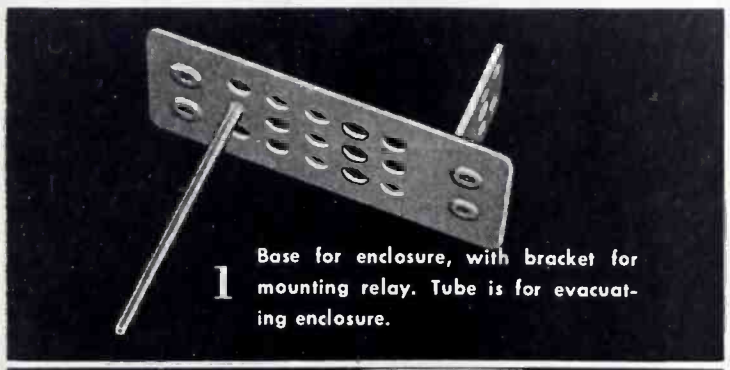
Get the Details . . . Now!

The growing importance of Fedelco-Sealing is shown by its rapidly increasing use. You will want to know about it. Write Federal Electric Company, Inc.; describe your product and your problem; and ask for details of Fedelco-Sealing and how it can be applied to your product.

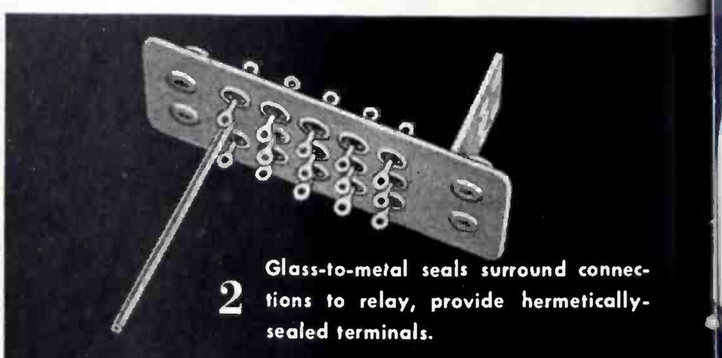
FEDERAL ELECTRIC COMPANY, INC.
225 No. Michigan Ave., Chicago 1, Illinois
8700 So. State St., Chicago 19, Illinois

E. B. MATHEWSON COMPANY • *Sales Agents*
New York 17, N. Y.—Greybar Bldg.; Chicago 11, Ill.—612 No. Michigan Ave.; Philadelphia 7, Pa.—Real Estate Trust Bldg.; Cleveland, Ohio—Bulkley Bldg.; Kansas City 8, Mo.—2017 Grand Ave.; Atlanta, Ga.; Troy, N. Y.—17 Bank Street.

Here's how we Fedelco-Seal a Clare Type "C" Relay

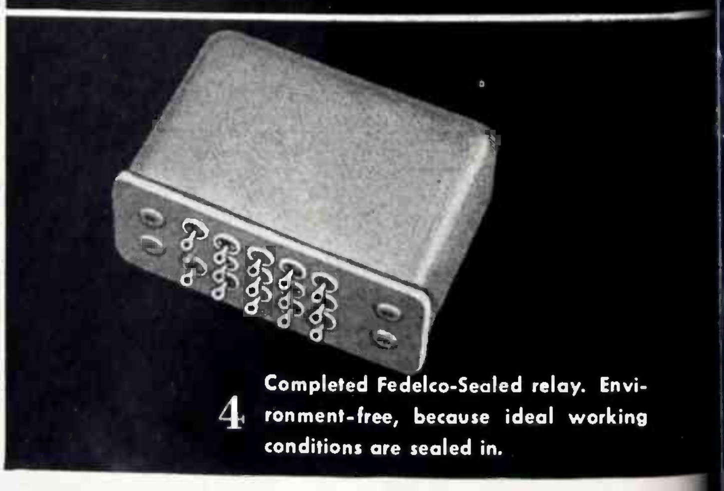


1 Base for enclosure, with bracket for mounting relay. Tube is for evacuating enclosure.



2 Glass-to-metal seals surround connections to relay, provide hermetically-sealed terminals.

3 Relay mounted on base assembly and wired to sealed terminals. Enclosure may be filled with dry air, or inert gas, after sealing.



4 Completed Fedelco-Sealed relay. Environment-free, because ideal working conditions are sealed in.

FEDERAL ELECTRIC COMPANY, INC.

arc-over will occur and the arma-ture winding will burn out.

Occasionally, the insulation wil test satisfactorily during a late inspection if the equipment drie out, but failures will recur when ever the same conditions of previ ous failure exist. The best way t eliminate such failure is to replac the insulation and to rearrange th high-voltage lead so that it is ke away from the dynamotor case an other areas of ground potential.

Test Instruments

In panel-type meters, corrosio attacks the leads to coils, espec ally near newly soldered joints. also attacks the pivots and arm tures in meters which are n properly sealed.

Varnish or lacquer must be use to seal test instruments after the have been opened for repairs for any other reason. Meter glass should be sealed to the case, an other openings, such as scre holes and terminals need attentio Edges of the back panel requi sealing with tape and varnishin over. The zero-setting adjustme screw is often a big source trouble because it allows moistu to get in. After each readjus ment, it must be painted over wit varnish or lacquer.

Even after applying these mea ures, test instruments will still fa under conditions of high humidit It has been found practical to kee ohmmeters and other test instr ments in heated storage boxes wit batteries removed when the instr ments are not in use.

• • •

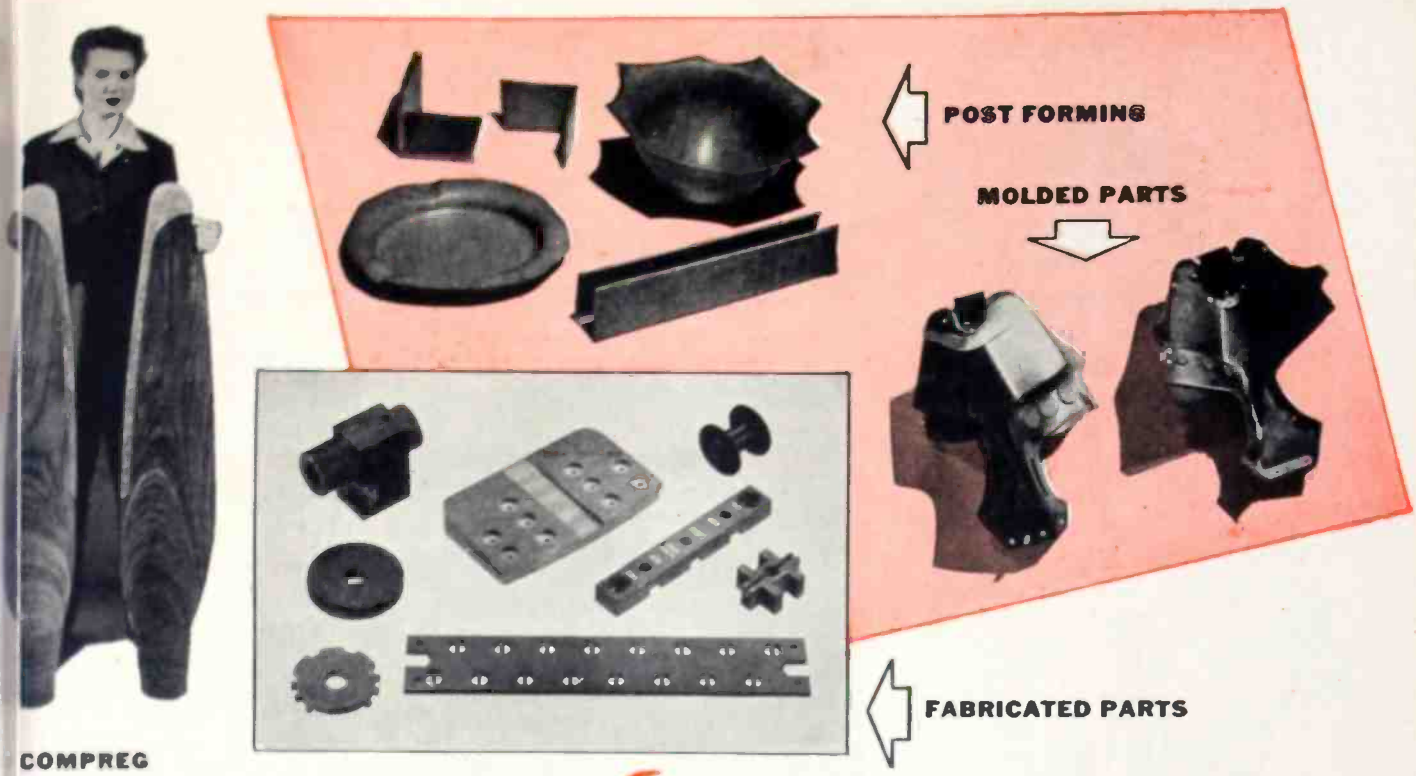
Electronic Indicator for Detonation

By E. A. Traver

General Laboratories
Socony-Vacuum Oil Co.

The device whose circuit is show in the diagram is essentially a de tonation or knock indicator whic was especially designed to indica the intensity of the knock occu ring in an automobile engine whe determining the octane number a gasoline. The conventional soun level meter and sound analyzer ca not be used for this purpose b cause of the transient nature the sound.

Engine knock is a sound of sho duration which dies out rapidly an



ome to PANELYTE* for DIRECT, TIME-SAVING ANSWERS TO ALL QUESTIONS ON MOLDED AND FABRICATED THERMO-SETTING PLASTIC PARTS

t nationwide organization of the Panelyte Divi- n is a clearing house for authentic, up-to-the-min- information on structural laminated resinous stics.

ur replies to your inquiries are founded — not on ry — but on basic experience in the mass produc- of fabricated and molded thermo-setting plastic ts for all branches of industry. Nor is this technical limited to knowledge gained within our plant. r policy of working closely with customers' engi- ring departments enables us to give designing aid — and from performance data on hand, to make accurate estimates on the service life of proposed plastic applications.

New type plastics and improved molding and fabrication techniques, developed by our engineering staff, increase efficiency and cut costs on widely divergent applications.

We are always glad to answer *any* question regarding the design, production cost or use of molded and fabricated laminated plastic parts.

Write for factual "Data Book"

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

ASS PRODUCTION OF SHEETS, RODS, TUBES, MOLDED FORMS, FABRICATED PARTS


SHEET METAL FABRICATION
Long before the war, "Cole Steel Equipment" had earned its reputation for quality. Tough assignments are part of our everyday job... instrument housings... boxes... and chassis. If your blueprints call for close tolerance sheet metal fabrication, send us your specifications.
Send for our Brochure
"The Plant Behind Your Plant"
COLE
STEEL EQUIPMENT CO.
349 Broadway, New York 13, N. Y.
Factory: Brooklyn, N. Y.
COLE STEEL
OFFICE EQUIPMENT
will again be available after the war

Don't Handicap Important Designs

for Lack of a SMALL Electric Switch

3 basic contact arrangements

single-circuit, normally open

single-circuit, normally closed

double-circuit; one normally open and one normally closed

and many special forms. For example:

three-point structure

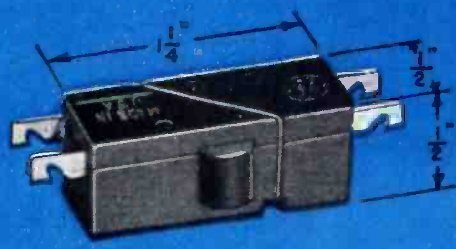
single-break, normally open

single-break, double-throw

SWITCHETTES

BUY WAR BONDS

THE G-E SWITCHETTE IS ONLY THIS BIG



(This one is ACTUAL SIZE)

WHEREVER you need a tiny contact mechanism in ratings up to 10 amperes at 24 volts d-c—an enclosed, self-contained unit that's light and compact, yet can withstand thousands of operations—there's a G-E Switchette to do the job.

This tiny switch weighs only 9 grams, and is suitable for use at altitudes up to 50,000 feet and in ambient temperatures from 200 F to −70 F. It's corrosion-proof—meets 50-hour salt-spray tests. It's vibration-resistant. The contacts will not chatter when subjected to mechanical frequencies of 5 to 55 cycles per second at 1/32-inch maximum amplitude (1/16-inch total travel), or to a linear acceleration of 25 g in any direction.

Two terminal arrangements are available—out the ends of the case as shown above, or out the top through the cover. This makes for easy mounting in any position.

More than 200 design modifications of the G-E Switchette are available to provide for a wide variety of electrical and mechanical arrangements.

SHIPMENT FROM STOCK

Some forms are now available from warehouse stocks in substantial quantities, to give you quick delivery for your important war jobs.

For your copy of our new catalog (GEA-3818B) which gives dimensions, ratings, and ordering directions for both standard and modified Switchettes, call our local office. *General Electric Co., Schenectady 5, New York.*

GENERAL ELECTRIC

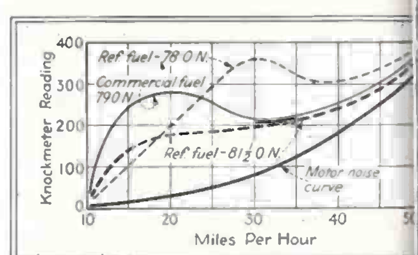
676-140-8940

recurs at varying time interv
Also, the sound intensity tends
vary with each recurrence. T
instrument is used as a compara
for indicating the relative kn
intensities produced by two diff
ent fuels, instead of measuring
knock intensity of each fuel on
energy scale.

The knock comparator consist
the following elements: a mic
phone, vacuum-tube amplifiers,
ters, a vacuum-tube detector
an indicating meter. All the pa
with the exception of the mic
phone, are built into a port
metal case which contains
necessary batteries and also ser
as a shield to prevent interfere
from the engine ignition systen

Operation

The sounds of knock and ot
engine noises are picked up b
microphone which is mounted
the engine compartment.
microphone is sensitive to all
sounds between 40 and 10,000 cy
per second occurring in the eng
which includes the transient so
of knock or detonation. The elec
cal output of the microphone

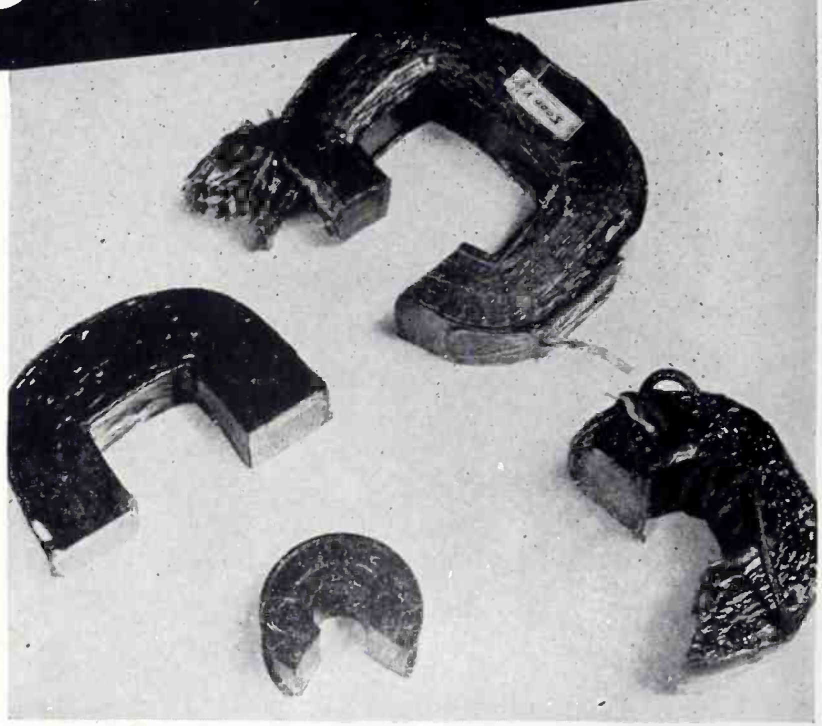


**Typical knockmeter curves of unkno
and reference fuels during accelerati
of a 1939 Oldsmobile automobile**

passed through several stages
amplification and then impressed
the grid of a vacuum-tube detec
A variable bandpass filter is
terposed between the stages
amplification to eliminate eng
noises of lower and higher f
quency than those compris
knock. The frequency of the fil
to be used is determined by exp
ment and varies with different
gines. The detonation or kn
usually has a frequency betw
4000 and 7000 cycles per second

The detector circuit uses s
values of capacitance and resista
that the effect of the high
tensity knock sounds are ma
tained for a period many tin
longer than their own durati
The time constant of the capacit

Why coils should be VARNISH IMPREGNATED UNDER VACUUM



ıe photograph at the right illustrates ghtly wound fine wire coils which have een treated with varnish under vacuum. ote the firmness at the points where the oils have been cut with a saw. This firmess was achieved by using the proper rade of varnish for deep penetration nder vacuum. To further illustrate this oint, it was necessary to use a hammer nd a chisel in order to break apart a ection of the large coil. For maximum enetration of varnish, impregnate coils nder vacuum.

ere are some of the advantages

irst of all, it is possible through the use a vacuum to remove air pockets beveen coil layers which under ordinary tmospheric impregnation would prevent e varnish from penetrating the interiors the coils. Moisture which was not riven off during preheating will be reoved under a vacuum due to the fact at the boiling point of water is greatly duced at sub-atmospheric pressure. The ir and water in coils which are removed nder vacuum will be replaced with varish when the vacuum is broken and tmospheric pressure restored. Those are aly a few of the advantages of treatg units with varnish under vacuum.

urther information on the treating of ectrical units with varnish is contained DOLPH'S Booklet on "Application of sulating Varnishes". A copy may be ad by making your request on your ompany letterhead.

Coil Treatment Service

One section of our laboratory contains vacuum equipment having a 12 inch diameter vacuum tank and also modern electric thermo-control ovens. Through the use of these facilities, we are in a position to treat some of your newly designed electrical units which require varnish insulation. Upon completion of this experimental work, a report will be issued covering the several procedures followed and recommendations made accordingly. Of course, this service is offered without any obligation on your part.

MANUFACTURERS OF
CHINALAK BAKING VARNISHES
SYNTHITE BAKING VARNISHES

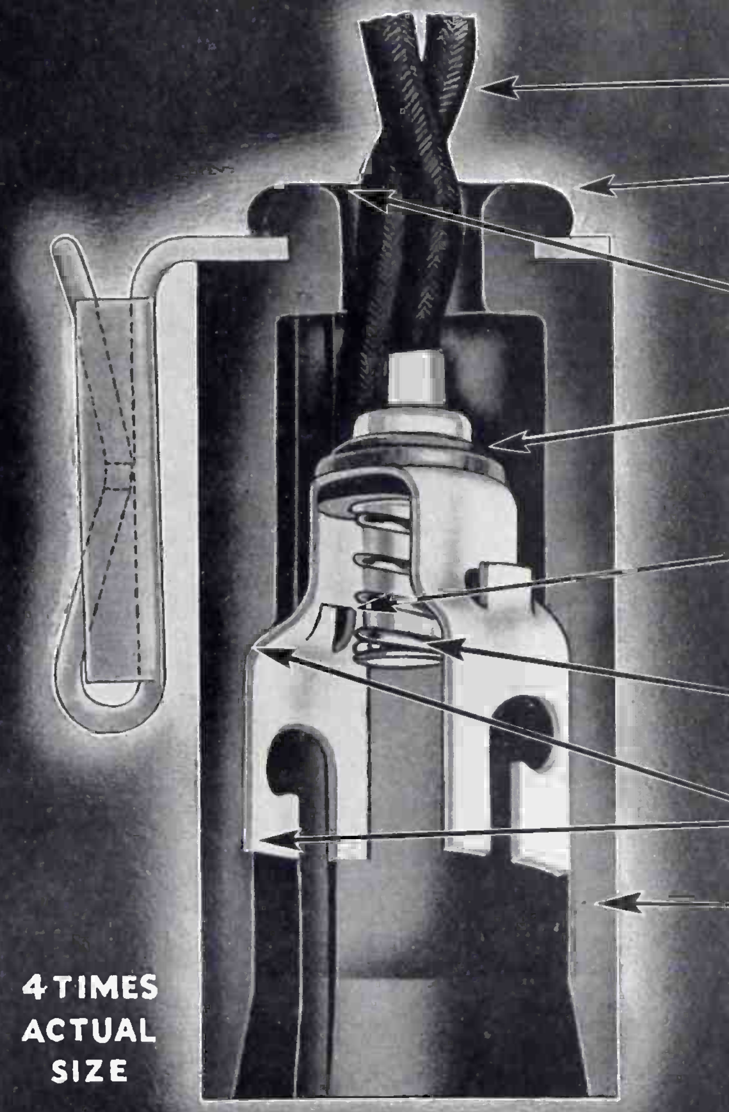
Dolph's

JOHN C. DOLPH COMPANY

Insulating Varnish Specialists

169A Emmet Street, Newark, New Jersey

a New and Superior DIAL LIGHT SOCKET



Tensile strength of leads and connections far in excess of requirements.

Tough, plastic shell molded around bracket providing a secure bond with mechanical strength far beyond any normal requirement.

Rounded edge will not cut or fray wire insulation.

Voltage Breakdown between contacts—1200 Volts. Voltage Breakdown to ground —5000 Volts.

Lug on contact fits in groove in shell so that contact cannot be turned or twisted when inserting lamp.

Center contact mounted so that it cannot protrude from shell and short on chassis when lamp is removed.

Plastic shell is recessed for contacts, which cannot be pushed or pulled out of position.

Stronger, tougher, heavy walled plastic shell.

A variety of different mounting bracket styles available, suitable for practically any mounting.

For Your Present and Post-War Production

40th ANNIVERSARY
1904—1944

This year Lenz celebrates its 40th year of service to the communications industry.

Lenz Dial Light Sockets have always been known for their superior mechanical qualities and electrical characteristics.

Now these sockets are still further improved, with even greater mechanical strength. A stronger, tougher plastic shell is attached to the bracket with a new type of construction that provides a virtually unbreakable bond between shell and bracket. Its excellent electrical characteristics are maintained.

Consider these Lenz Dial Sockets for your present and post war production. Write for sample today.

LENZ

In Business *Since 1904*

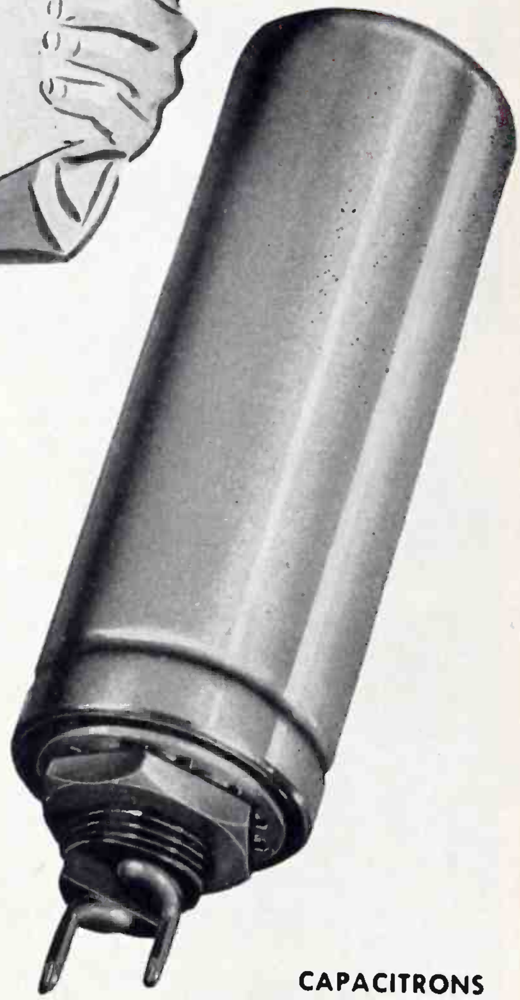
LENZ ELECTRIC MANUFACTURING CO.

1751 N. WESTERN AVE. **CHICAGO 47, ILLINOIS**

ELECTRIC CORDS, WIRES AND CABLES

Solve Your Capacitor Problem with Oil Type EC CAPACITRONS

PROMPT DELIVERY!



Phone Your Requirements Now!

Catalog Number	Capacity in Mfd	Working Voltage D.C.	Height Inches	Diameter Inches
6EC200	2.0	600	2¾	1½
6EC300	3.0	600	4½	1½
6EC400	4.0	600	4½	1½
6EC600	6.0	600	4	2
6EC800	8.0	600	4½	2
6EC1000	10.0	600	4	2½
10EC100	1.0	1000	2¾	1½
10EC200	2.0	1000	4½	1½
10EC400	4.0	1000	4	2
10EC600	6.0	1000	4	2½
10EC800	8.0	1000	5	2½
15EC50	.5	1500	2¾	1½
15EC100	1.0	1500	4½	1½
15EC200	2.0	1500	4	2
15EC400	4.0	1500	4½	2½

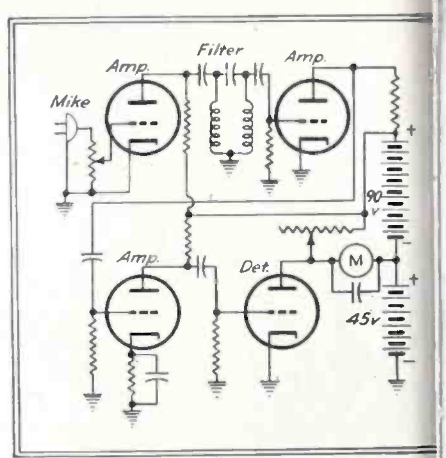
Telephone: MIChigan 9656-7

CAPACITRONS Meet U. S. Signal Corps and Navy Specifications

The CAPACITRON Company
318 West Schiller St. Chicago 10, Illinois

resistor combination is made somewhat longer than the expected interval between successive detonations so that the average voltag on the grid of the detector tube depends upon the more intense detonations while other sounds of th same frequency have very little effect. In this manner, the instrument tends to indicate an averag of the loudest detonations and nc an average of all sounds occurrin at the filter frequency.

The meter circuit has been de signed so that a decrease in curren through the detector tube, which i caused by an increase in knock in tensity, will be indicated as an in crease in meter reading. In orde to make it possible to read the in



Circuit of the knockmeter used to show the relative intensity of two fuels

tensity accurately, the meter damped so that it averages th knock indication for a somewh longer period of time than the de tector tube circuit. The variabl resistor in the plate circuit of th detector permits setting the mete to zero at any level of sound in tensity.

The automobile is operated wit a non-knocking fuel under norm conditions to determine the nois level incident upon such operatio This operation may be expressed b a curve as shown in the graph. investigations of knocking at single speed are to be made, onl the noise level at that speed nee be determined, but in the usu case, knocking over an acceleratio range is investigated. Then th auto is operated under knockin conditions and the meter adjuste to give a center-scale reading a the conditions of knock encoun tered. This adjusts the meter t the motor with which it is to b

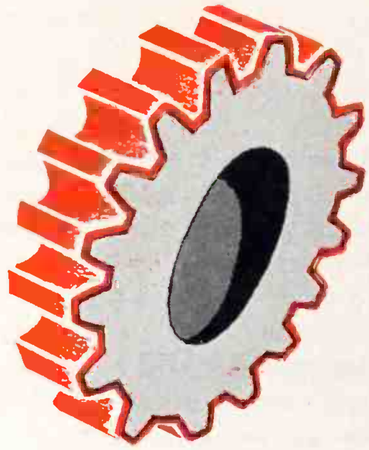
HEAT IT *fast!*

✓ SAME DEPTH

✓ SAME AREA

✓ SAME TIME

✓ SAME TEMPERATURE



. . ONE OR A MILLION

Westinghouse 20 Kw Radio Frequency Generator

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

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

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

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

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

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

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

J-08084

Electronics at Work

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

WESTINGHOUSE W

RADIO FREQUENCY HEATING

A PORTABLE TESTING INSTRUMENT WITH NO PROJECTING PARTS

ROLLER-SMITH TYPE NP . . .

Roller-Smith Type NP Portable Testing Instruments are designed for general service where a highly accurate and extremely rugged instrument is required. The case is made in two parts: an outer walnut case and an inner two-piece metal case. This construction furnishes full magnetic shielding, protects the mechanism from external strains, and the movement from dust and moisture. The lid of the instrument is designed to completely cover the dial and all binding posts, so that when closed there are no projecting terminals or other parts. The window is of maximum area for high dial visibility; scale length is 5¼". Instruments are 8" square by 5½" in depth and weigh approximately 7 pounds. Ratings cover a broad range of testing requirements.

Roller-Smith Type NP Testing Instruments are supplied for the measurement of direct current in milliamperes, amperes and volts. Voltmeters can be supplied with single or double range. Catalog 4340 contains complete description and full information with prices. Write for a copy.

OTHER R-S INSTRUMENTS

Panel, switchboard and portable instruments of practically every standard size, shape, capacity, type and style are included in the R-S line of electrical instruments. Let us quote prices and deliveries on your instrument requirements.

"Steel-Six" Portable Ammeter. Scale length 5³⁄₁₆". Size 6" x 6" x 4". Accuracy ½ of 1%.

Type "T-3.5" Miniature Panel Ammeter. American War Standard type conforming with AWS C39.2—1944.

ROLLER SMITH

Sales Representatives
In all Principal Cities

ROLLER-SMITH BETHLEHEM, PENNA.

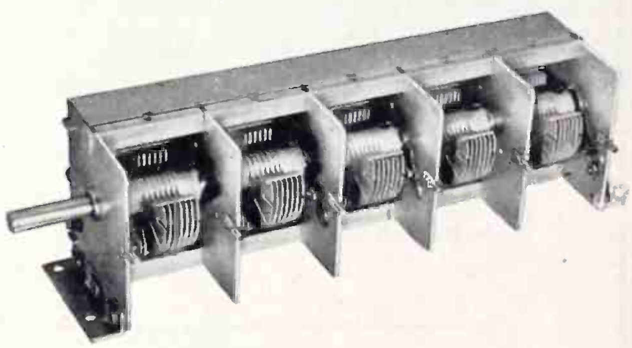
Canadian Plant: ROLLER-SMITH MARSLAND LTD., Kitchener, Ontario

STANDARD AND PRECISION ELECTRICAL INSTRUMENTS OF EVERY TYPE

What type Air Condenser will post-war radios have?

You can be sure of one thing. They will provide *accurate* and *distinct* tuning as never before!

Air condensers of Radio Condenser Co. are used today on radio apparatus of our armed forces and provide such accurate tuning that these men — your post-war prospects — will want the same type reception in their commercial sets. Give them this reception by using our condensers and push button tuning devices.



RADIO CONDENSER CO.

CAMDEN, N. J.

RADIO CONDENSER CO. LTD., TORONTO, CAN.

. . . Doing a war job today

used in the contemplated test.

The knock indicator, when properly adjusted for the car engine and test conditions, will indicate knock intensities in much smaller increments than can be detected by the ear. The instrument will also reproduce the knock intensity comparison much better than the same observer on successive trials or on successive days.

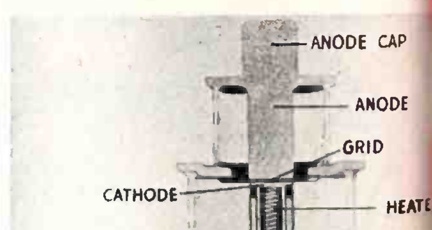
• • •

Secret Military Tube has Elements in Parallel Planes

A LARGE NEW FAMILY of uhf electronic tubes, circuits and apparatus has been made possible by the invention of an electronic disc-seal tube, called the "light-house tube" by radio engineers in the military services. The existence of the new tube, was acknowledged publicly early in April when General Electric was allowed to disclose that the tubes are available to make possible radio relaying of television and f-m radio programs post-war. Beyond that, no further information could be revealed.

The Army and Navy have now approved the release of further information on the tube, including the fact that it has given the Allies a decided edge over the Axis in the military radio field.

The new tube eliminates the conventional type of grid anode and cathode. Instead of components being fitted around one another as in the past, they are now constructed in simple, parallel planes or layers.



Cross-section of the new uhf tube used in military equipment

The Basic Advantages of
SUPERIOR SMALL METAL TUBING
are the same in peace as in war

● In planning for tomorrow, make use of our experience yesterday and today . . . production in tubing from 5/8" O.D. down in seamless and drawn welded.*

*"Weldrawn" Stainless and "Brawn" Monel

SUPERIOR

THE BIG NAME IN
SMALL TUBING

SUPERIOR TUBE COMPANY, NORRISTOWN, PENNSYLVANIA

FOR EVERY SMALL TUBING APPLICATION FROM 5/8" OD DOWN

SUPERIOR Seamless in various analyses. WELDRAWN Welded and drawn Stainless, "Monel" and "Inconel"

SEAMLESS and Patented LOCKSEAM Cathode Sleeves

Smooth Operation calls for *Smooth Power* motors

PLANNING a new or improved device of small size that will need low torque power? Then you're going to need motors that will deliver it, smooth as velvet, with instant starting, quick pick-up and reliable operation.

GENERAL INDUSTRIES *Smooth Power* motors fit these specifications. For years, they've been driving such peacetime products as phonographs, record changers, control mechanisms and automotive devices. In the war, they're on every front, doing their jobs day in and day out with the reliability of a United States Marine.

VERY LIKELY the motor you'll need will come from our long line of standard *Smooth Power* motors. But if not, we can adapt a standard model or design a new one for your specific needs.

IF your new or improved products call for comparatively small metal fabricated parts or assemblies, that's another way we can serve you. When our present war work is finished, our modern plant and capable personnel will be ready to go to work for you. We'd like to have you call on us.

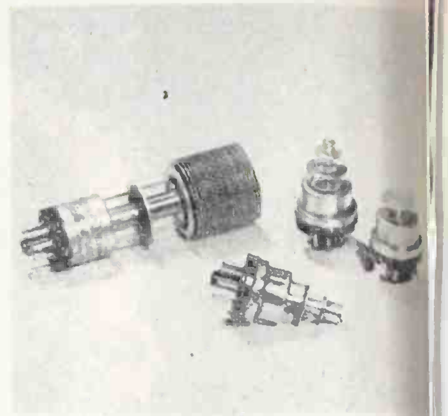
ARMY E NAVY

THE GENERAL INDUSTRIES COMPANY
ELYRIA • • OHIO

THE GENERAL INDUSTRIES COMPANY

G I

Smooth Power



Four of the hitherto secret tubes having the disk-seal construction. The one at left is a transmitting tube, the others are receiving types

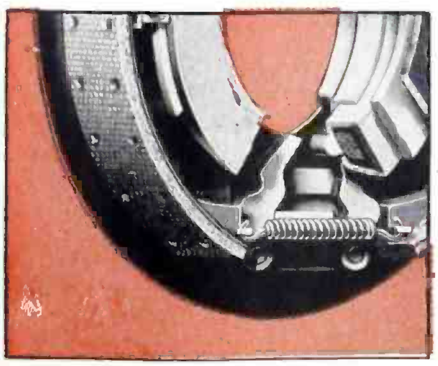
with glass and metal fused togeth[er] in rigid, inseparable units that ar[e] strong and capable of withstand[-] ing severe jolts. This design pe[r-] mits an extremely compact over-a[ll] tube structure, while providin[g] high frequency and high power ou[t-] put. It gives uniform co-planar ele[c-] trode design, very low plate-t[o-] cathode interelectrode capacitanc[e] and very high permanence of char[-] acteristics. Megatron is the ger[-] eric name applied to tubes of thi[s] design.

General Electric's developme[nt] was made available to Allied pri[-] vate and government research an[d] engineering groups. The Naval Re[-] search Laboratory and the Cam[p] Evans Signal Laboratory of th[e] Army were among the governmen[t] groups which actively engaged i[n] the early applications of the ne[w] development.

• • •

CHINESE TRANSMITTER

Two engineers from the Chinese Central Broadcasting Administration fit tubes into the rectifier unit of a high-power broadcast transmitter recently built in Great Britain for China



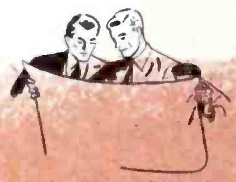
MUEHLHAUSEN SPRINGS PREVENT FROZEN BRAKES

As applied to motion, electricity has been considered generally as a starting and moving force—but now, with Warner Electric Brakes, it is used for stopping as well.

This brake has another thing in common with many other products—the use of well-engineered springs to control important mechanical actions. Warner relies on Muehlhausen Springs to free the brake bands after the vehicle has slowed or stopped. On one grueling run after another, through heat, rain and crystallizing cold, Muehlhausen Springs perform this job automatically.

A big responsibility for a little spring! But, because of careful design by experienced engineers, it does its job unfailingly.

MUEHLHAUSEN SPRING CORPORATION *(Division of Standard Steel Spring Company)*, 760 Michigan Avenue, Logansport, Indiana



Leading product designers in every industry are consulting Muehlhausen Engineers to secure springs of lasting efficiency.

MUEHLHAUSEN

SPRINGS

EVERY TYPE AND SIZE

ROCKBESTOS

Permanently Insulated Wires solve wiring problems in Electronic and Communications Equipment

Permanently insulated wires designed for severe operating conditions, wires to meet unusual wiring problems — that's what Rockbestos builds for manufacturers of electrical equipment, electronic devices and apparatus.

122 standard constructions, each with the built-in *permanent* characteristics that provide resistance to heat, flame, moisture, cold, grease, oil and corrosive fumes, present a wide range of selection. A few of the wires especially adaptable for electronic and communications equipment are shown here. For information or recommendations phone or write nearest branch office or:

Rockbestos Products Corporation
415 Nicoll Street, New Haven 4, Conn.

ROCKBESTOS ASBESTOS INSULATED APPLIANCE LEAD WIRE

Sizes No. 8 to 20 AWG solid or stranded copper, monel or nickel conductors insulated with .031" or .040" of felted asbestos in black, white or colors.

This Rockbestos All-Asbestos Insulated Lead Wire will not dry out and crack under heat and vibration, won't rot, swell or flow as a result of contact with oil or grease, and has ample moisture resistance for most applications.

ROCKBESTOS TYPE CA LEAD WIRE

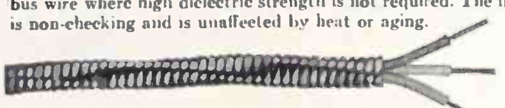
Sizes No. 8 to 20 AWG solid or stranded copper, monel or nickel conductors insulated with synthetic tape and varying wall thicknesses of felted asbestos in black, white or colors.

Rockbestos Type CA Lead Wire has the same general characteristics as mentioned above, plus additional moisture resistance and higher dielectric strength provided by the thin, tough, moisture-resistant synthetic tape next to the conductor.

ROCKBESTOS ASBESTOS INSULATED MAGNET WIRE

Round, square and rectangular asbestos insulated conductors finished to meet varying winding conditions and coil treatment requirements.

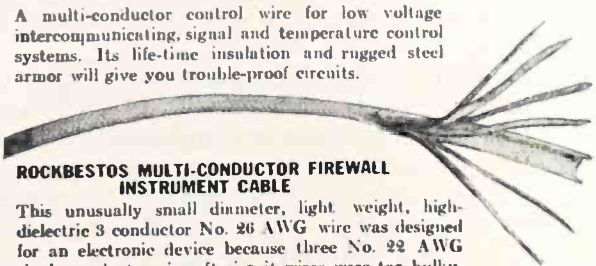
Designed for Class B windings and also suitable for use as insulated bus wire where high dielectric strength is not required. The insulation is non-checking and is unaffected by heat or aging.



ROCKBESTOS THERMOSTAT CONTROL WIRE

Sizes No. 14, 16 and 18 AWG in two to six conductors with .0125", .025" or (for 115 volt service) .031" of felted asbestos insulation and plated steel armor.

A multi-conductor control wire for low voltage intercommunicating, signal and temperature control systems. Its life-time insulation and rugged steel armor will give you trouble-proof circuits.



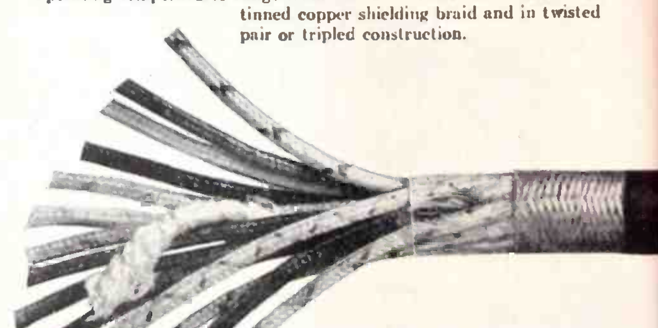
ROCKBESTOS MULTI-CONDUCTOR FIREWALL INSTRUMENT CABLE

This unusually small diameter, light weight, high-dielectric 3 conductor No. 26 AWG wire was designed for an electronic device because three No. 22 AWG single conductor aircraft circuit wires were too bulky. It is made to a nominal diameter of .125" (smaller than a No. 14 AWG single conductor 1000 volt Rockbestos Firewall Radio Hookup Wire).

ROCKBESTOS S/C FIREWALL RADIO HOOKUP WIRE

Sizes No. 22 to 4 AWG in 1000 volt rating, and No. 12, 14 and 16 AWG in 3000 volt.

The first light weight, small diameter, flame resistant hookup wire, designed in 1937 and widely used since in airborne and ground communication systems, electronic devices, instruments and apparatus. Operating temperatures range from 125°C. to minus 50°C. Also with tinned copper shielding braid and in twisted pair or tripled construction.



ROCKBESTOS MULTI-CONDUCTOR FIREWALL RADIO HOOKUP CABLE

This type of cable is made up of 1000 V. individual Firewall Radio Hookup Wires (see above) of required size and number of conductors, cabled, and braided or shielded according to customer's specification. For example, this special 14 conductor #22 AWG cable was taped, shielded with tinned copper braid, then jacketed with a black, glazed cotton braid with a flameproof finish.

ROCKBESTOS RESEARCH Solves Difficult Wiring Problems

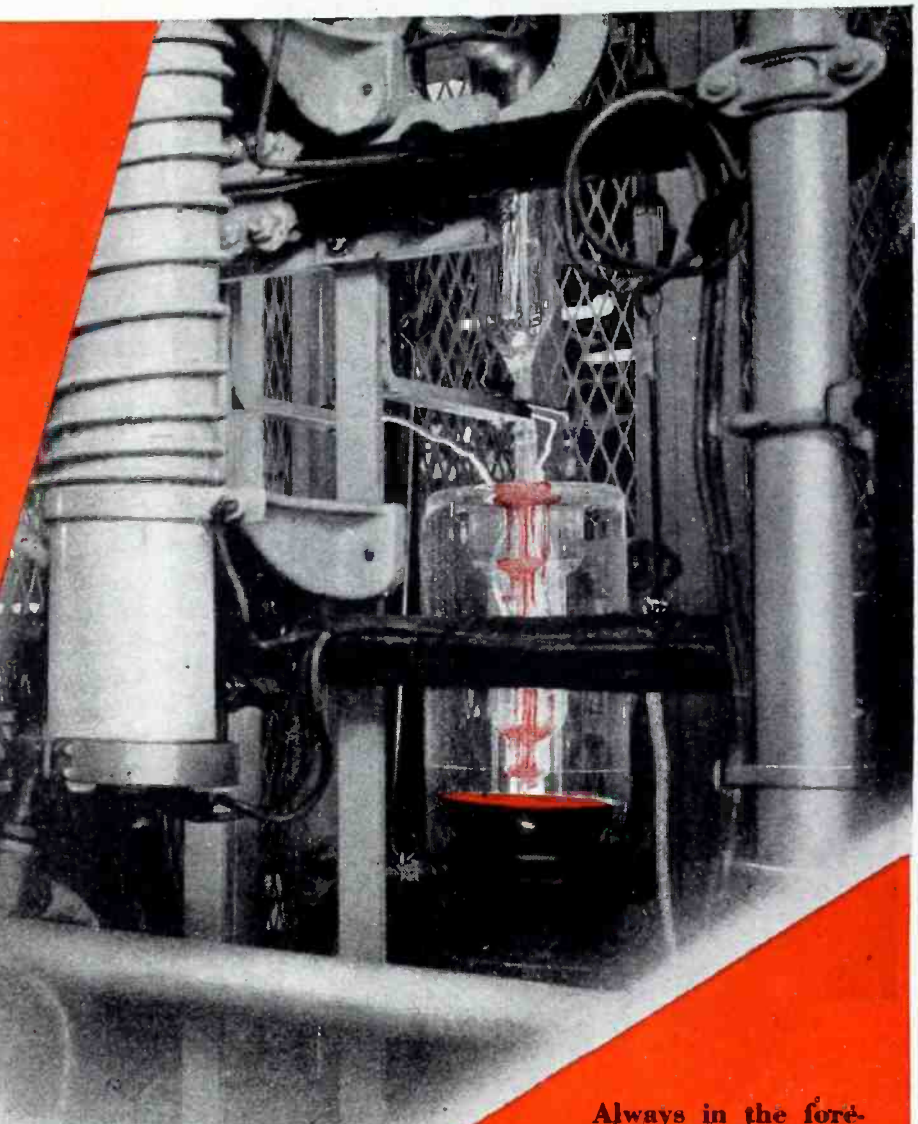
NEW YORK, BUFFALO, CLEVELAND, CHICAGO, PITTSBURGH, ST. LOUIS, LOS ANGELES, SAN FRANCISCO, SEATTLE, PORTLAND, ORE.

INVEST IN BONDS • MAKE EVERY PAYDAY A LAY-AWAY DAY

Federal Tubes...

ime CLOSER to the

PERFECT VACUUM

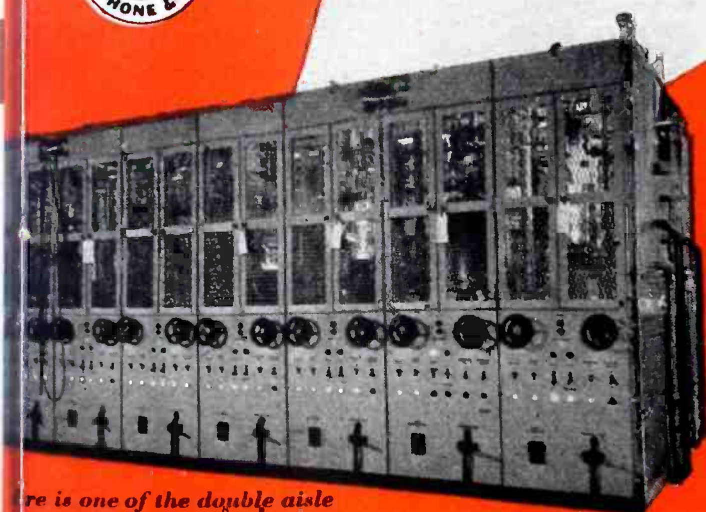


Always in the forefront of tube research and development, Federal makes another advance and now has added exhaust units of entirely new and original design to its production equipment.

This latest Federal achievement produces a tube that is substantially closer to the perfect vacuum—a tube with greater efficiency and longer life.

Arranged in banks of eight and operated with identical control equipment, these units exhaust uniformly every size of Federal tube—assuring a consistent and high standard of quality.

For any communication and industrial power tube need, turn to Federal now—test its reputation that "Federal always has made better tubes."



re is one of the double aisle haust banks where 16 high wer tubes can be exhausted one time, each with indivi- al control.

FEDERAL TELEPHONE & RADIO FTR

Federal Telephone and Radio Corporation

AN IT&T ASSOCIATE

Newark 1, N. J.

Control of Stills

(*Continued from page 99*)

twice the values indicated. The optimum value is determined by the current requirements of the control cell connected between T_1 and T_2 and its maximum resistance. In any event, the sensitivity is influenced by the potentiometer setting.

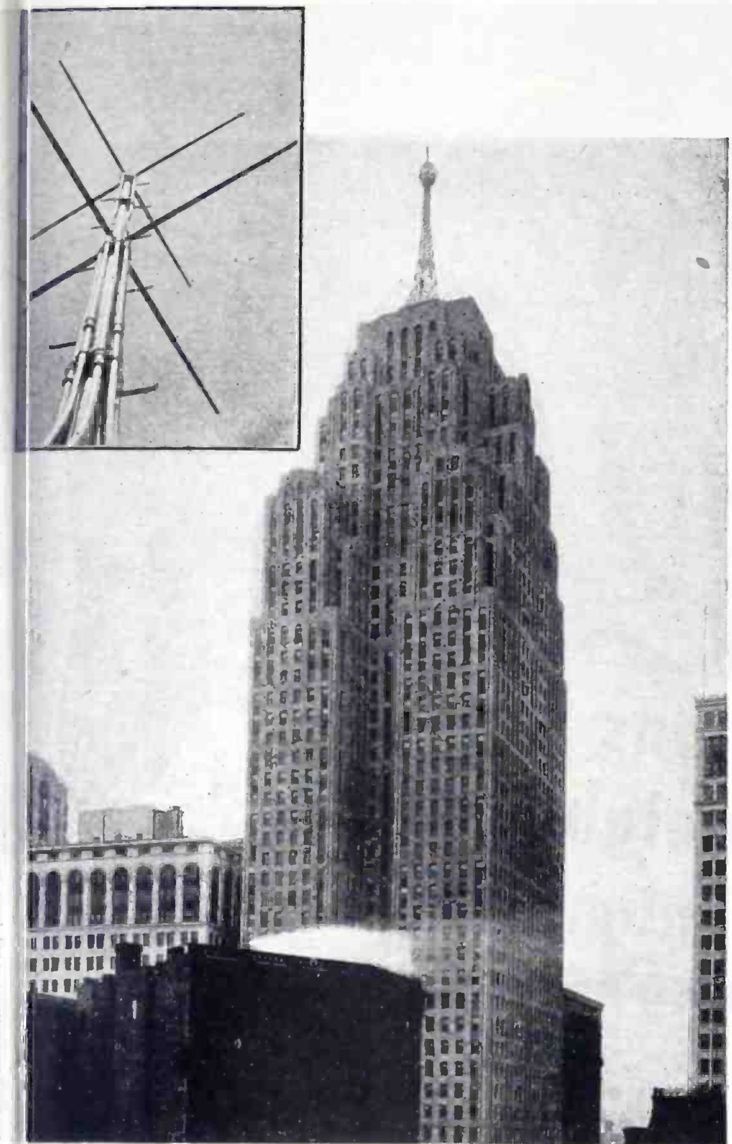
When adjusting the unit, should the gas tetrode fail to conduct with the potentiometer set for maximum bias and T_1 and T_2 connected together through the control cell having its electrodes immersed in single-distilled water, the bias is reduced until conduction does take place. In the event that the tetrode conducts with the control circuit open and with the potentiometer set for maximum bias the value of C is increased. A shield for the lead connecting the grid and the control cell has been found necessary in applications where considerable sensitivity is required.

Limiting resistor R_5 is selected to limit the surge current to the rated value. The two resistors, R_5 and R limit the average current to that required for reliable operation of the plate circuit relay. Capacitor C must be of sufficient capacitance to smooth the relay current for noiseless operation. Where variable conditions are present in the control cell, relay chatter can be reduced by increasing the value of C_2 as much as space factors permit.

The circuit described has the usual advantage over similar hard tube circuits in that the gas tetrode will close the plate circuit relay with no uncertainty if it closes it at all, regardless of some abnormal behavior of the control cell. The circuit described has been in operation without a single failure for nearly one year. No adjustments beyond those made during the original installation have been required.

Some System Refinements

In some applications better performance may be obtained by connecting the grid lead to one side of the control cell rather than to the other. The control cell used in the present application, shown in Fig. 3, consists of a tubular unit with two platinum electrodes extending down to the level which determines



REL

THE FORERUNNER OF POSTWAR

HIGH-POWER FM SKYSCRAPER INSTALLATIONS

THE first high-power FM transmitter to be installed atop a skyscraper is the 50-kw. REL model 521 equipment, completed in October, 1941 for the Evening News Association in the Penobscot Building, Detroit — first FM station in Michigan.

To those who do not have suitable high ground available, and must therefore use a tall building to obtain sufficient antenna height, WENA (formerly W45D) is of special interest.

Primary power equipment is installed in the basement. The 3-kw. REL driver and the 50-kw. REL amplifier, together with the speech and control equipment, are on the 45th floor, where the studios and offices are located. On the 46th floor are the water circulating pumps, filament motor-generator, and gas tanks for the transmission line. Phasing and matching section for the antenna is on the roof. A 2-bay REL turnstile is mounted above the ball at the top of the tower, as the illustrations show.

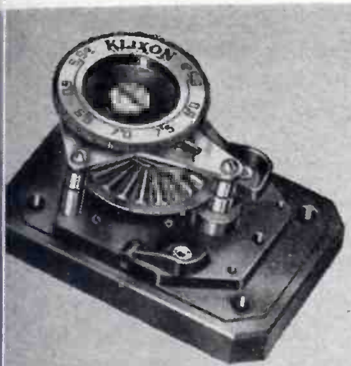
This is probably the most difficult installation that any manufacturer of radio transmitters has been called upon to make. To REL engineers, it was another opportunity to apply our unequalled background of experience. The highly successful performance of WENA over a period of nearly three years is proof that the job was well done.

Such is the engineering service available to all purchasers of REL Frequency Modulation transmitters and associated equipment.

PIONEER MANUFACTURERS OF FM TRANSMITTERS EMPLOYING ARMSTRONG PHASE-SHIFT MODULATION

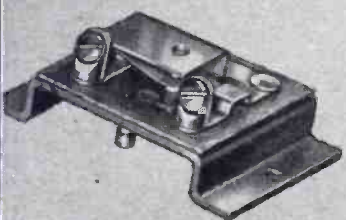
RADIO ENGINEERING LABS., INC.

Long Island City, N.Y.



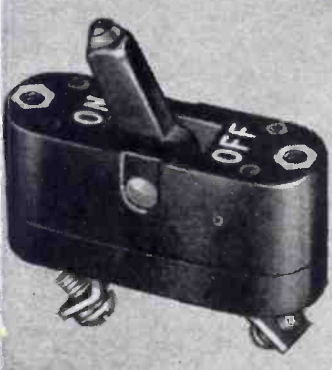
Type RT Thermostat. Adjustable Temperature Control.

Type B-3120 Thermostat and Heater, Crystal Dew Point Control.



Type C-4351 Thermostat Used for Tube Warming, Tube Cooling, High Limit Controls, etc.

Type C-2851 Thermostat. For such use as Roughing Controls on Outer Crystal Ovens.



Type C-6363 Switch Circuit Breaker.

Type C-7220 Precision Snap Switch. 12 amps. 30 Volts D.C., 125 Volts A.C.

Type ER Series. Ambient Compensated Time Delayed Relays.

For Positive *SNAP-ACTION* Control or Protection

use

Klixon Disc-Operated Controls

No relays, toggles, magnets or other fussy complicated operated parts—but a simple snap-acting thermostatic disc operates Klixon Controls. That's why you get positive control or protection when you use Klixon Disc-Operated Controls for motor and transformer overheat protection, electrical circuit overcurrent protection, thermal time delays or temperature control for radio equipment.

The foolproof actuating element snaps "on" and "off" for a quick clean break or a positive solid make. Klixon Controls are small, compact, light weight . . . are easily installed in circuits. Their accurate operation is unaffected by shock, vibration, motion or altitude. They are available in a wide range of standard types and ratings to meet practically all control requirements. Write for complete information.

KLIXON

SPENCER THERMOSTAT COMPANY, ATTLEBORO, MASS.

the minimum level of the water in the boiling flasks. It has been found advantageous to set the electrodes at slightly different levels, with the grid connected to the higher one. Electrolysis in the control cell has produced no difficulties, probably due to the use of a. c. in the control circuit and the exceedingly small currents flowing.

The solenoid valve is placed in the water line leading from the single-distilled water storage tank to a reservoir and the control cell. The reservoir was added in order to lengthen the period between successive operations of the system. Since it is the minimum level that requires control rather than the maximum level, it is preferable that water be added in relatively large amounts at infrequent intervals rather than in small amounts at frequent intervals. The amount added is controlled by a self-starting siphon in the reservoir and by the rate of flow from the reservoir to the control cell. By partially filling the connecting tube between reservoir and control cell with glass wool the rate of flow may be adjusted to the point where the reservoir fills just as the water level in the control cell reaches the electrodes and closes the electromagnetic valve. The glass wool restriction also serves to damp out level fluctuations due to boiling action as the water level approaches the operating point.

The sensitive electronic relay controls simultaneously the valve and electric heater circuits, opening the valve and turning off the heaters whenever the system calls for water. In the event that the single-distilled water tank becomes empty, or the valve fails to open, or any other condition prevents the normal supply of water, the still heaters are shut off. Similarly, most failures in the control itself will result in opening both the heater and the valve circuits, thus effectively turning off the stills. By inserting a time-clock switch in the line side of the control circuit the system may be set to operate automatically for a predetermined time.

The heater system as installed originally was provided with a three-phase electromagnetic switch operated from the usual "off-on" pushbutton station. To give the electronic unit control of the switch with a minimum amount of rewir-

Featuring

The New HARVEY Regulated Power Supply 206 PA

RANGE 500 to 1000 VOLTS

This new Harvey development is bound to be a star, because it fills the need for a Regulated Power Supply in upper voltages. It may be operated in two ranges, 500–700 at ¼ of an ampere and 700 to 1000 at .2 of an ampere. Both ranges have accurate regulation to *one per cent or less*.

The new HARVEY Regulated Power Supply 206 PA is a model of efficiency and operating convenience. All parts are readily accessible to the operator. It is equipped with spare fuses, a 6 ft. heavy duty Tyrex cord with a handy two prong plug.

The HARVEY 206 PA is fused on the primary side and has both an overload relay and time delay relay. Two interlocks on the chassis afford the operator complete protection. A black, crackle-finish panel and copper plated chassis make the 206 PA an instrument of beauty as well as precision.

Although the HARVEY 206 PA is too new to picture publicly, it has been thoroughly tested and proved and is now in production. Made by the makers of the HARVEY 106 PA that is providing fine, dependable performance in the 200 to 300 volt range, the HARVEY 206 PA will provide equally fine performance in the higher voltages.

Now is the time to get the complete story on this important new contribution to the radio-electronics field. Write, phone or wire

HARVEY
OF CAMBRIDGE

HARVEY RADIO LABORATORIES, INC.

439 CONCORD AVENUE • CAMBRIDGE 38, MASSACHUSETTS

+7.5V
-7.5V
+150V
-150V
Assigned to
"SPECIAL SERVICE"
In the electrical as in the electronic field, National Fabricated has engineered battery sockets and receptacles to meet every specialized need. High speed production soldering, rugged construction and positive electrical contact under severe conditions of corrosion and usage characterize National Fabricated Products Battery Sockets.
Courtesy U. S. Signal Corps.
NATIONAL
FABRICATED PRODUCTS
2650 WEST BELDEN AVENUE, CHICAGO 47, ILL.
Manufacturers of SOCKETS, TERMINAL ASSEMBLIES, JACKS AND CONNECTORS for use in every field of electronics.

ing, and to retain the original push button station, a simulated push button station, relay-operated, w devised. This station consists of solenoid contactor in combinatio with a mercury switch. The me cury switch is fixed to the contact armature in such a position that t closing of the contactor causes t mercury to flow toward the end the tube into which the contacts a sealed; however, the closed pos tion of the contactor is such th the globule of mercury does not r main across the contacts. Closin of the circuit is dependent upon t inertia of the moving globule carr ing it past the equilibrium positi to make momentary contact befo returning to the position of re This action simulates the pushin of the "on" button. Release of t armature by a signal from the aut matic control unit is equivalent pushing the "off" button.

In addition to its use in the st system, the electronic relay d scribed has been found ideal for u with sensitive thermo-regulato whose precision depends upon t maintenance of clean contactor The exceedingly small curren drawn by the unit permit operatic for long periods of time with me cury thermoregulators.

• • •

ACTRESS DRAFTED FOR RADIO BY ARMY

Virginia Robinson, Broadway actress, broadcasts messages over a U. S. Army radio net in Italy to German soldiers. She went to Italy to entertain Yankee and Allied troops; instead her excellent German was used to make propaganda speeches between musical numbers

INCREDIBLE SALVAGE

The Case of the Flying Gull . . .

...ring the storm season of 1942, *The Fly-*... *ull* ran into heavy seas in the Gulf ...ico.* Running before a terrific wind, ... but made port. Then, just as she ...tting about near Hunter's Point, she ...d a gigantic wave and foundered. ...ds were saved. But *The Flying Gull* ... in eight fathoms of Gulf water.

...age operations were started. Later in ... when The Flying Gull was in the ... nd her electrical equipment ripped ... a amazing thing occurred. George ... of The Harris Salvage and Drydock ...ny of Galveston, put the Therma-... ansformer equipment on a shelf in ... nshine—mentally assigning it to the ... netal drive. Three days later, out of ... ty, he hooked the transformers onto ... ig bench and flipped on the current. ... amazement, they still showed signs ... He then ran standard tests. To his ... astonishment, all twelve of the ... ormers were not only working—they were working perfectly.

Harvy Stark, owner of the boat, had already ordered a complete new set of transformers from Thermador. He cancelled the re-order. And today The Flying Gull sails with her original Thermador transformers. Not designed for the briny deep—but they could take it!

Such stories of plus performance are not accidents, for Thermador transformers are built to perform beyond normal expectations. They are completely manufactured—not just assembled—under one roof on a vast array of modern precision equipment. They are made *only* from the finest materials, engineered by men of broad experience. The result is not alone quality but *quality in quantity*. If that meets your specifications, better discuss transformers with Thermador.

THERMADOR TRANSFORMERS

DEFEAT HEAT • COLD • HUMIDITY

"SEVEN LEAGUES AHEAD"

An actual case history from Thermador files; however names, dates, and location have been altered.* **Buy MORE War Bonds.

THERMADOR ELECTRICAL MANUFACTURING COMPANY
5119 SOUTH RIVERSIDE DRIVE • LOS ANGELES 22, CALIFORNIA

THE ELECTRON ART

New Rotating Slide Rule with 24 Scales on Slider

A ROTATING SLIDE RULE that permits a wide range of applications by electronic and electrical engineers has been invented by Lt. Jerry Ailinger, communications officer of the Boston Fire Alarm Headquarters. Called the "Rota-Vec-Trig," the new rule is designated as a log-log, vector and trigonometric slide rule.

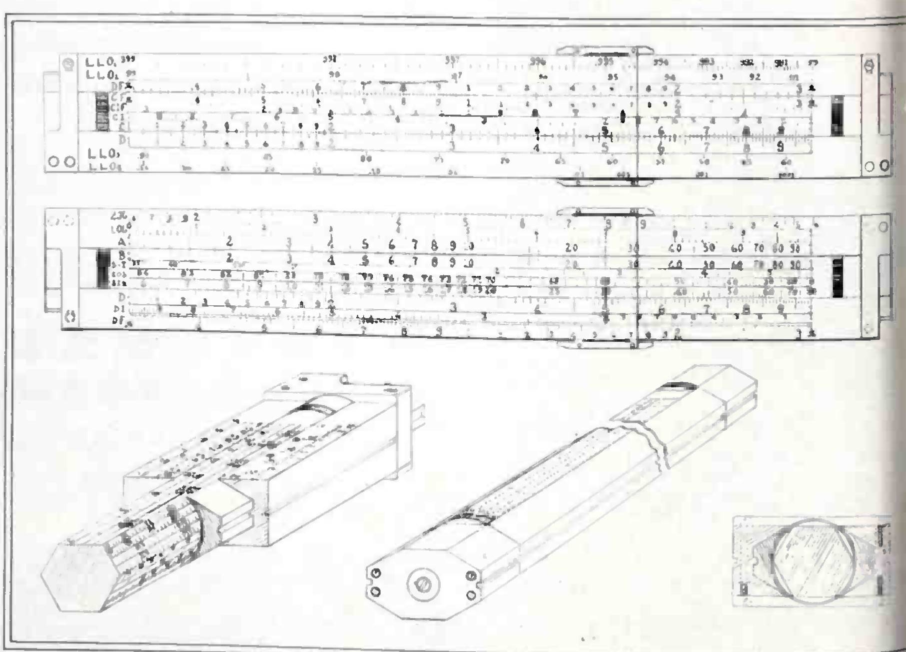
In appearance, the instrument resembles the ordinary slide rule, but contains 24 scales on its slider, compared to a maximum of eight on usual rules. All 24 scales operate against each side of the body. The 24 scales are grouped four to each face of a rotating hexagon axially mounted in the slider, and are instantly interchangeable by means of a milled wheel protruding slightly from the rule face. The selected scale locks in place when the plane of the scale is flush with the rule surface.

These scales are rotatable through 360 deg, which permits all 24 scales to slide against each side of the rule body without removing the slider to turn it over. The rotating hexagon, due to the great amount of space available, has scales representing the six leading functions of trigonometry, thus eliminating the need of converting certain functions by a primary solution involving identities, reciprocals, etc.

Rewriting a problem for slide rule solution is practically eliminated. The provision of scales of tangents greater than 45 deg and cotangents less than 45 deg allows the computation of tangents of any magnitude by the basic formula arc tan $\theta = a/b$, rather than by reciprocal form; where a/b is greater than 1. Complements are present when needed.

All scales except *A*,*B* and *KS* are of full unit length for greater accuracy and ease of operation. The *KS* scale is like the *K* scale on other slide rules, but is on the slider. It provides automatic cube root extraction regardless of the number of times the radical appears in either the numerator or denominator, and does away with the need of grouping "like radicals". Another interesting feature is a radian θ scale complementary to the *C* and *D* scales. This gives the angle subtended by *N* radians, or conversely, the equivalent radian value of *N* degrees.

A 2π scale provided is invaluable in calculating problems involving angular velocity. It gives the value of omega (ω) in a single setting. Radio engineers find this useful in problems of resonant frequency and inductive reactance, and when used with the *DI* scale, the computation of capacitive reactance. Another innovation is the introduction of log-log scales on the sliding section for greater flexibility. There are also new log-log scales of decimal quantities of full unit length for greater accuracy, referred to the *D* scale, which give the values of negative powers (e^{-n}) with a single setting. Besides folded and inverted scales on both body and slide, provision is made, when desired, for scales representing hyperbolic functions, also special scales for navigators, surveyors, chemists and other specialists.



Several views of the new slide rule and its assemblies. At lower left is a section of the body of the rule, rotatable slide and housing. A cross-section is at lower right

Automatic Amplitude Control for Variable-Frequency Oscillators

ADJUSTMENT OF THE FREQUENCY of oscillators by varying the capacitance or inductance of the tuned circuit is common practice but without some stabilizing means the amplitude of the oscillation usually varies, sometimes considerably, as the frequency is changed. Means of stabilization have been suggested in the past, such as the use of a diode shunted across the tuned circuit, but while such arrangements produce some improvement, the degree of stabilization obtained is insufficient for many purposes.

A review of the diode method and a new improved system are described by M. M. Levy in the *Journal of the British Institution of Radio Engineers* (9 Bedford Square, London, W. C. 1) for March-May, 1944.

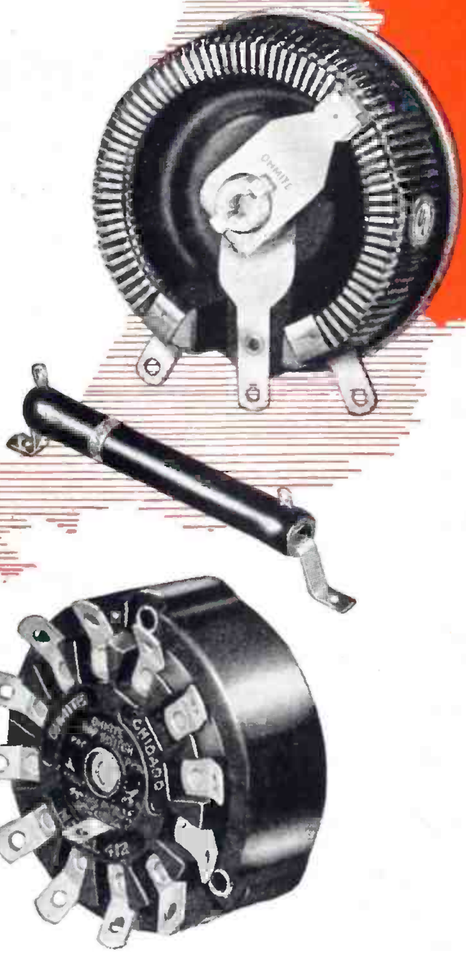
In Fig. 1 is shown the tuned circuit of an oscillator connected to a

OHMITE EXPERIENCE

in all types of Current Control Applications

Brings Time-Proved Benefits

1. The Right Rheostat, Resistor, or Tap Switch for Each Job
2. Consistently Accurate, Dependable Control
3. Long-Service Economy Under Varied Conditions



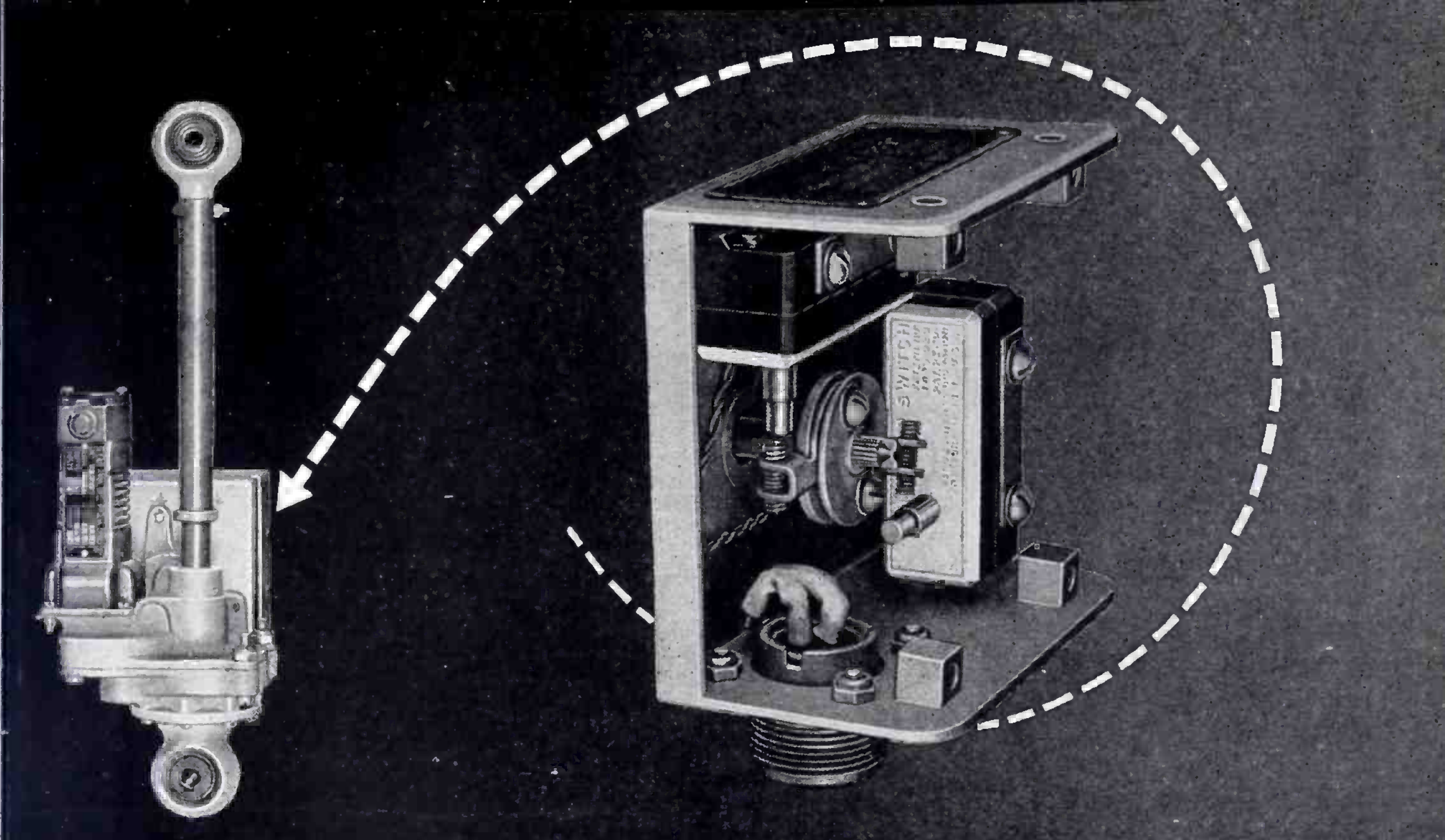
What better assurance of these important benefits than the record itself! . . . The record of Ohmite experience in pioneering new rheostat, resistor and tap switch developments—in producing the widest range of types and sizes—in meeting the varied requirements of innumerable applications with high quality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

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

OHMITE MANUFACTURING COMPANY
4818 FLOURNOY STREET • CHICAGO 44, U. S. A.
Foremost Manufacturers of Power Rheostats, Resistors, Tap Switches

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

Be Right with OHMITE
RHEOSTATS • RESISTORS • TAP SWITCHES



LEAR AVIA, INC. RELY ON MICRO SWITCHES
FOR INSTANT, PRECISE CONTROL OF ELECTRO-MECHANICAL ACTUATORS

Micro Switches are responsible for the accurate op[e]ration which has made Lear Actuators ideal components fo[r u]se in military aircraft.

Le[ar] Avia, Inc., Piqua, Ohio, who build these light, powerfu[l e]lectro-mechanical devices, find Micro Switches provide th[e p]recise, instant control required yet keep within the requ[ir]ed limits of small space and light weight.

Th[e] small Lear Actuator shown here weighs but 3.3 pounds. Ye[t i]t is capable of moving 1200 pounds. Rotary type Lear Ac[tu]ators are capable of operating torques from 400 inch-po[un]ds to 6500 inch-pounds.

Le[ar] Actuators must operate instantaneously. Micro Sw[it]ches, used in pairs, cause the unit to start or stop at the ex[act] point of predetermined setting in the control box. The first Micro Switch limits the actuator travel in one direction, the second Micro Switch serves as the limit to travel in the other direction. Lear Actuators may be controlled by manual switches, thermostats, pressure switches, etc.

Micro Switches were selected by Lear Avia, Inc. because a sensitive and precise limit switch was required to provide the accuracy of control necessary. The quick make-break action of Micro Switches was also found to assure long operation life on severe direct current loads. No unit failure due to faulty Micro Switches has ever been recorded.

Designers and production engineers who are letting pre-conceived ideas go by the boards . . . seeking a new way . . . will do well to investigate Micro Switch. This tiny, snap-action electric switch can be counted on for any application where a small, precise, sensitive switch is required that will respond accurately to actuating motion through millions of repeat operations.

Micro Switches provide over 2700 variations . . . combinations of housings, actuators and electrical characteristics. For complete information, send for Handbook-Catalog No. 60. If your application is for aircraft use, also send for Handbook-Catalog No. 70.

[Th]e basic Micro Switch is a thumb-size, feather-light, plas[tic] enclosed, precision, snap-action switch, Underwriters' [list]ed and rated at 1200 V.A., at 125 to 460 volts a-c. [Ca]pacity on d-c depends on load characteristics. Accurate [re]peat performance is experienced over millions of opera[tio]ns. Wide variety of basic switches and actuators meets [re]quirements varying from high vibration resistance to [se]nsitivity of operating force and motion as low as 2/1000 [ou]nce-inches. Many types of metal housings are available.

LET'S ALL BACK THE ATTACK— BUY EXTRA WAR BONDS

"Uses Unlimited"—a dramatic talking motion picture of Micro Switches, in color, is available to industrial groups, training classes, schools and colleges, through Y.M.C.A. Motion Picture Bureau, New York, Chicago, San Francisco. Size: 16 mm. Length: 40 minutes. Write us for details.

MICRO SWITCH TRADE MARK MS

A DIVISION OF FIRST INDUSTRIAL CORPORATION

FREEPORT, ILL., U.S.A., Sales Offices in New York, Chicago, Cleveland, Los Angeles, Boston, Dallas, Portland, (Ore.)

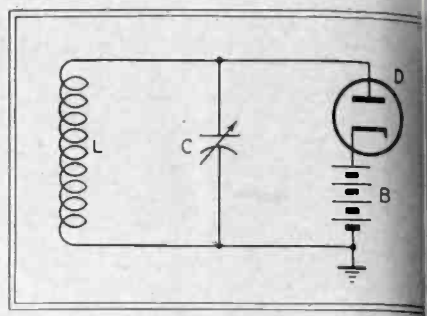


Fig. 1—Circuit illustrating the principle of stabilization of oscillator output amplitude by means of a diode

stabilizing diode D. The cathode of the diode is made positive by a battery B or other suitable means, and the biasing voltage is chosen to be slightly less than the desired maximum voltage to be generated in the tuned circuit. If the amplitude of the oscillations should tend to increase when the frequency is changed, the diode D will become conducting for the peaks of the positive half waves and will act as a load on the tuned circuits which increases as the amplitude increases. It therefore tends to limit the amplitude of the oscillations. However, experience shows that the stabilizing control is not very great and considerable amplitude variations still occur.

Use of Triode

The effectiveness of the control is greatly increased by using the circuit of Fig. 2 which uses a triode to shunt the tuned circuit instead of a diode and which applies to the control grid the amplified and rectified variations of the oscillating voltage by means of the detector amplifier connected as shown. This can be most easily appreciated in the following way. Let v be the variation in the amplitude of the oscillating voltage. This will be detected and amplified and will be

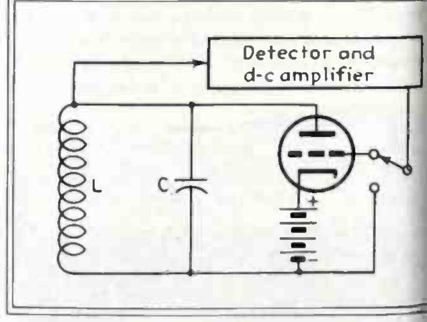


Fig. 2—Addition of an amplifier to a triode permits variations of the oscillator voltage to be detected, amplified and transmitted to the grid of the triode

PERMANENT MAGNET FIELD

DC VOLTAGE GENERATOR

We were called upon to manufacture this small voltage generator in which concentricity between shaft and mounting ring had to be within .001" while diameter of large mounting ring was held to ± .001". Output voltage was linear with speed to 1% and voltages were equal within 1% for each direction of rotation. A careful analysis of tooling requirements, together with the use of precision equipment, did the job.

Mounting ring diameter.......2 5/16"
Overall length.......3 1/8"

We Invite Inquiry

We are tooled up and in production on this small generator. Increased capacity enables us to accept additional orders for reasonable delivery. Write for details.

UNIQUE research, engineering, tool making and production skills combine, not only to build control devices that fulfill the most exacting requirements, but also to build special purpose devices for which no specifications exist. Our list of customers, the most exacting in government, aviation and manufacturing, attest to these skills.

Manufacturers of

Control Devices

and Components . . . for Electric, Electronic and Mechanical Applications

EAD

EASTERN AIR DEVICES, INC.

585 DEAN STREET • BROOKLYN, N. Y.

An Affiliate of THE FRED GOAT CO. INC., Special Machinery Specialists Since 1893 multiplied by some factor μ_1, b coming $\mu_1 v$. This voltage is appli to the grid of the tube and produc the same damping effect on t tuned circuit as another voltage applied to the plate and equal $\mu_1 v$ multiplied by another factor thus $P = \mu_1 \mu_2 v$. It is evident tha much greater load will be placed the tuned circuit for the same val of v with the arrangement of Fig than with that of Fig. 1, and accor ingly a much more effective stab izing control is obtained. Ma standard triode valves have an a plification factor μ_2 as high as and μ_1 may easily be made equal 10. A multiplication of 500 is th obtained. The result can provide circuit in which the variation o the whole frequency band is l than 0.05 db.

Practical Circuit

Figure 3 shows a simplified d gram of a practical stabilizing c cuit in which the variations of t high-frequency oscillating volta are detected by a conveniently b ased triode D, and amplified by direct-current amplifier VT-1.

The cathode of the diode is giv a positive bias by battery B_1, t voltage of which should be ju slightly less than the minim

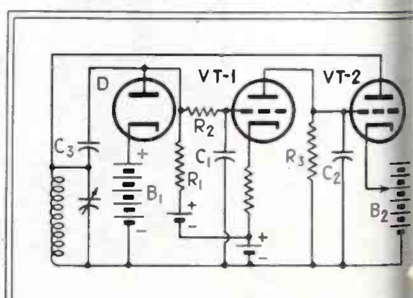
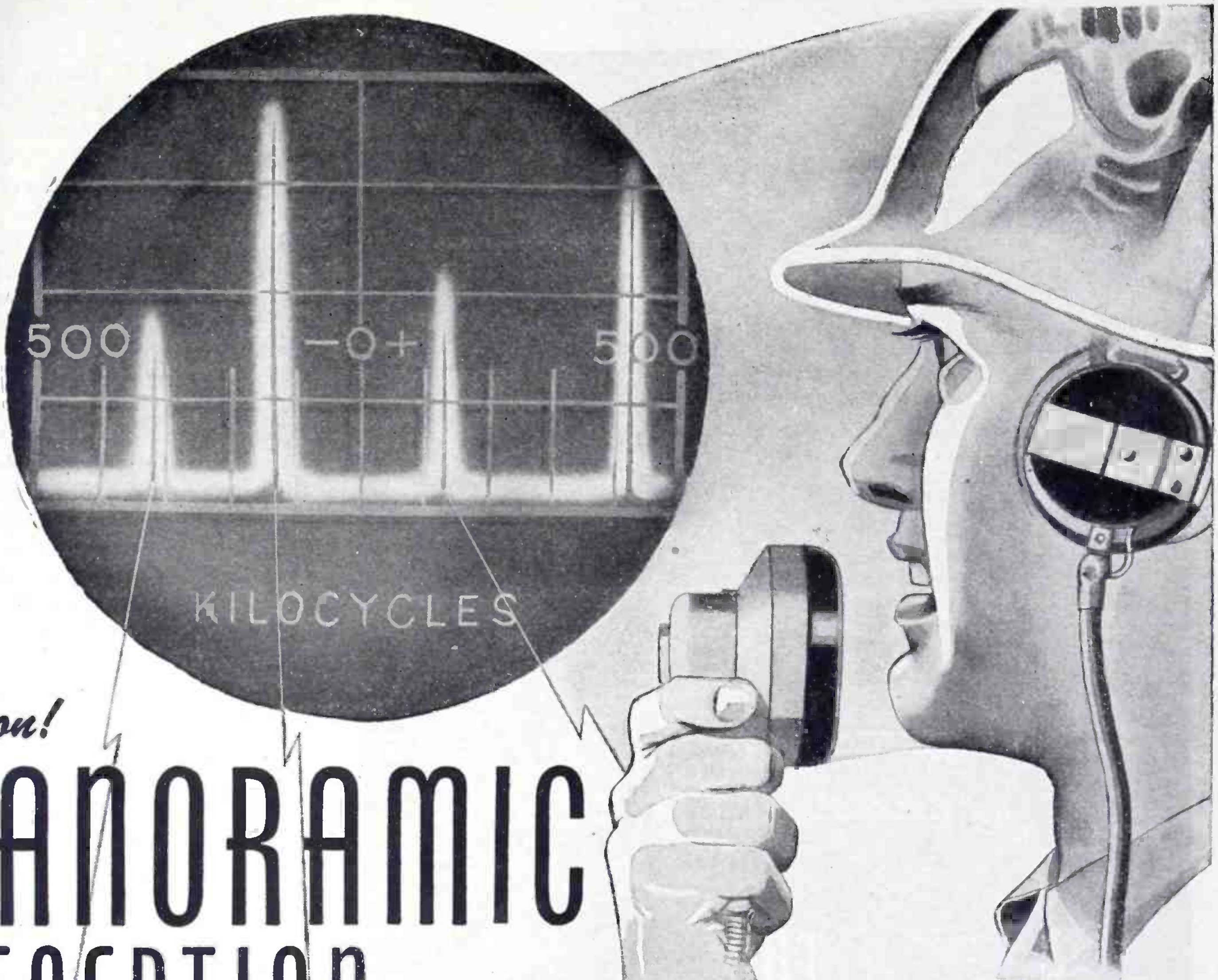


Fig. 3—Output voltage of the diode is amplified by VT-2 and applied to VT- operating as an amplitude limiter

amplitude of the uncontrolled osci lating voltage in the tuned circui taken over the whole frequen range of interest. The diode wi accordingly tend to produce a recti fied output voltage in the load re sistance, R_1, proportioned to th excess amplitude. This voltage i smoothed in the circuit comprisi the resistance R_2 and capacitor C and applied to tube VT-1 arrang as a direct current amplifier, pro ducing an amplified continuous vol age across the load resistance R shunted by the bypass capacitor C

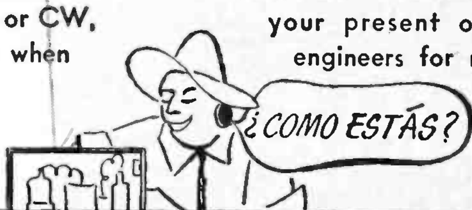


Soon!

PANORAMIC ECEPTION WILL BE USED BY GI JOE WITH HIS "HAM" RIG

hen GI Joe takes off his helmet, he will still member many of the things he is learning in tl Army. As a radio operator, he uses ***Pano- mic*** reception for effective monitoring and for ching tricks in enemy field communications. recognizes its value for peacetime as well as wartime. On the basis of military experience, will want to make use of ***Panoramic*** recep- for many more pleasant hours at his own , Because it ***SHOWS ALL SIGNALS ON A GIVEN ND OF THE RADIO FREQUENCY SPECTRUM ULTANEOUSLY,*** GI Joe knows that ***Pano- mic*** reception will tell him what stations are the air, whether they are phone or CW, what their signal strengths are when they reach him. Most important, he can be sure that he will miss very few calls in response to his CQ's.

Currently, ***Panoramic*** reception also is doing good work in laboratory development and industrial applications. Its ability to measure, interpret and compare variations in inductance, capacitance and resistance has created possibilities that are being utilized by far-sighted manufacturers. If ***Panoramic*** technique can be adapted to your present or future needs, ask our engineers for more detailed information.



PANORAMIC RADIO CORPORATION
242-250 WEST 55TH ST., *New York 19, N.Y.*

and is applied to the control tube VT-2 which then operates as a very sensitive amplitude limiter.

Any increase of the oscillating voltage across the tuned circuit produces an equal negative voltage across capacitor C_2 and C_1 and a much greater voltage increase at the grid of VT-2. This greatly increases the load across the tuned circuit and reduces the oscillating voltage to very nearly its initial value.

The cathode of tube VT-2 is biased positively by suitable means shown as a battery B_2, the voltage of which should be adjusted in order that the current flows in VT-2 only during the positive peaks of the oscillating voltage. When the adjustment is correct, the oscillating waveform becomes sinusoidal with a very small percentage of harmonics.

Another Circuit

The circuit of a practical arrangement with which the method has been tested is shown in Fig. 4. This circuit is slightly different from the circuit of Fig. 3. There is no diode, the grid-cathode portion of VT-1 being used as a diode, and there is no battery B_1. Only a small fraction of the oscillating voltage is transmitted to the grid of VT-2 by means of the potentiometer divider C_1C_2. The sensitivity is much smaller than the circuit of Fig. 3, but is still sufficient to give a perfect stabilization. Tube VT-3 is used also as an electronic voltmeter, and the oscillating voltage across C_2 is indicated on the meter M.

Adjustment for the best control is easy. The bias of the cathode of valve VT-3 should be adjusted until maximum stabilization is obtained. If the cathode should be given a positive potential greater than the maximum oscillating peak voltage, there will be no control at all as the tube will always have an infinite impedance. By making the cathode progressively more negative, the control increases until some point is reached at which the load on the tuned circuit, at the peaks, becomes so great that the control is maximum and the amplitude of the oscillating voltage start to decrease rapidly. The best operating point will be just before this occurs. With the circuit as described and as adjusted in the man-

You may have received this interesting series of booklets on Mica by Macallen.

THE IMC SERVICE MAN CAN HELP YOU MAKE THE MICA STORY VALUABLE IN YOUR PLANT

Macallen says "From the mines of India comes our mica . . . the mineral that possesses the vitally important properties for electrical insulation."

Macallen, by a special process, ingeniously cements extremely thin mica splittings into larger sheets of any desired thickness. From the sheets come numerous mica products to meet your needs.

Macallen mica has high dielectric strength, great inductive capacity, resists puncture, has low power loss, stands high temperatures, and is impervious to moisture, oil, and chemicals. In short, mica is immune to everything—but continued duty.

OTHER IMC PRODUCTS

Vartex Varnished Cloth and Tapes—Varslot Combination Slot Insulation—Varnished Silk and Paper—Fiberglas Electrical Insulation—Manning Insulating Papers and Press Boards—Pedigree Varnishes—Dieflex Varnished Tubings and Saturated Sleevings of Cotton and Fiberglas—National Hard Fibre and Fish Paper—Phenolite Bakelite—Adhesive Tapes—Asbestos Woven Tapes and Sleevings—Cotton Tapes, Webbings, and Sleevings, and other insulating materials.

Mica is the basic insulation material for you to use in Class B electrical units and other applications where continuous operation under the most severe conditions is encountered.

IMC warehouse and IMC service men are near-by to serve you well in your selection of Macallen mica products for electrical apparatus.

CALL US FOR MACALLEN MICA

India and Amber Segment Mica . . . India Moulding Mica Plate . . . Flexible Mica Plate—Mica Tapes . . . Mica Commutator Segments and Rings . . . Mica Tubes—Mica Specialties.

SERVICE FOR MANUFACTURERS IN THE MIDWEST

INSULATION MANUFACTURERS CORPORATION

★ CHICAGO 6 • 565 West Washington Blvd.
★ CLEVELAND 14 • 1005 Leader Building

Representatives in
MILWAUKEE 312 East Wisconsin Avenue
DETROIT: 11341 Woodward Avenue
MINNEAPOLIS: 316 Fourth Ave., South
PEORIA: 101 Heinz Court

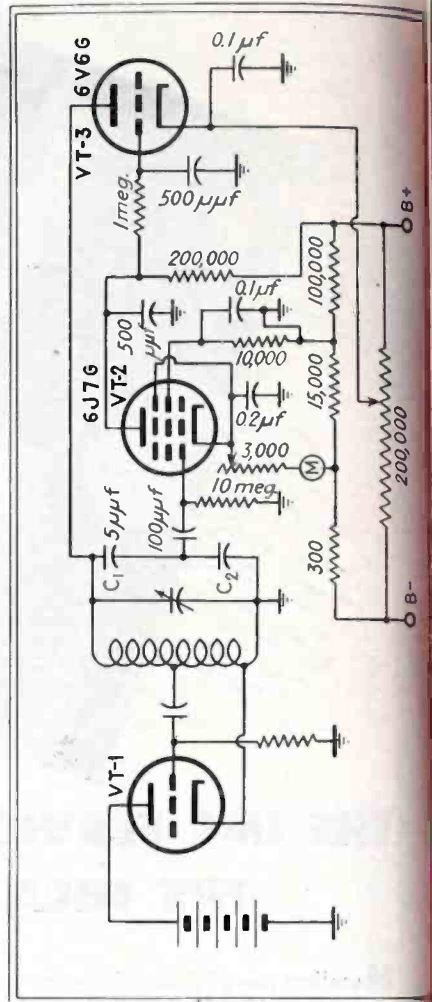


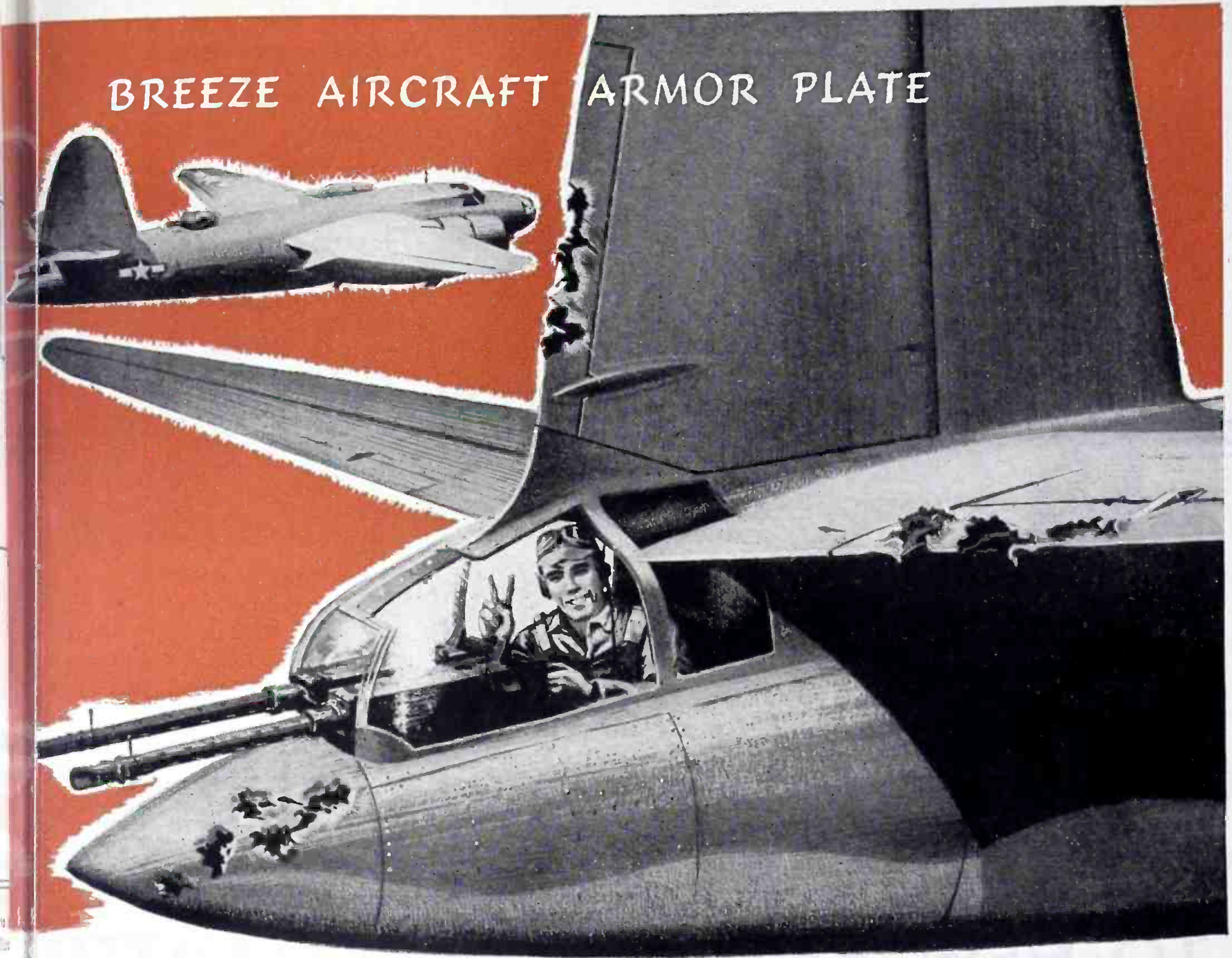
Fig. 4—Practical circuit used to hold output voltage constant on a multirange oscillator covering frequencies from 30 kc to 9 Mc. One grid and the cathode of VT-2 form the detector

ner just explained, it is possible to maintain the oscillating voltage constant within about one percent when it would vary by perhaps 200 percent without any control.

The circuit of Fig. 4 has been tried with five different coils in order to cover the frequency band from 30 kc to 9 Mc, and for each coil the stabilization was found perfect.

Although the control circuit employs three tubes, the total power necessary for operating them can actually be made small compared with the power necessary for the oscillator. For example, VT-2 could

BOWL COVERS used by housewives have been drafted by the Signal Corps to serve as covers for microphones in freezing temperatures. They prevent moisture from a speaker's breath from condensing and filling the small holes with ice.

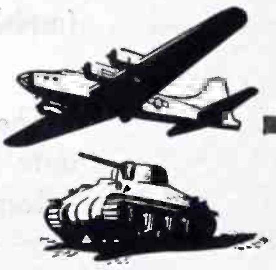


Homeward Bound

Breeze Aircraft Armor Plate Brings 'Em Back Alive In World-Wide Theatres of Warfare

eeze Aircraft Armor Plate is in ct n today on Allied invasion ro s, providing dependable protec- io or pilots and gunners of Amer- ca hard-hitting bombers and gh rs. Produced in quantity by he Breeze Electric Heat Treating ro ss, the fastest known for the ur se, this Armor Plate helps to ri home not only trained person- el t valuable equipment as well.

Breeze Armor is manufactured in two types: homogeneous and face-hardened. Although light in weight, it possesses the highest ballistic qualities and resistance to shatter. Complete assemblies to designers' special requirements are a specialty. Aircraft Armor Plate supplements the well-known Breeze line of equipment which is now in service on land, on the sea, and in the air.



A Few of the Many Breeze Products in the Nation's Service

Radio Ignition and Auxiliary Shielding • Multiple Circuit Electrical Connectors • Flexible Shielding Conduit and Fittings • Cartridge Engine Starters • Internal Tie Rods • Elevator and Rudder Tab Controls • Flexible Shaft and Case Assemblies • Aircraft Armor Plate

Breeze BREEZE MARK

CORPORATIONS, INC. NEWARK, N. J.

R DUCTION FOR VICTORY • PRODUCTS FOR PEACE

The New Home of Stewart Metal Stampings, outstanding in its architectural beauty, furnishes an appropriate setting for the Stewart "Quality" Line.

Announcing

THE REMOVAL OF OUR FACTORY AND OFFICES TO NEW AND LARGER QUARTERS

THE steady and consistent growth of our business has made it imperative for us to expand our manufacturing facilities. This fine modern fireproof structure, to which we hold title, furnishes the answer.

•

The new home of Stewart Stampings embraces every up-to-date construction feature—daylight windows and skylights—automatic heat regulation—high ceilings and scientific ventilation—and large loading platforms to facilitate shipping.

•

With greatly increased floor space now available, we have added many new units to our mechanical equipment, resulting in faster production—increased volume—and an all-around better service to our customers.

STEWART STAMPING COMPANY

TERMINALS • LUGS • BRACKETS • CLIPS

630 CENTRAL PARK AVENUE • YONKERS 5, N. Y.

be a very low-power tube whose maximum current is not more than, say, 2 milliamperes; and tube VT-3, owing to the manner in which it operates, will generally draw a plate current of less than 1 ma, even if a power tube such as a 6V6 or 6L6 is used. The voltage divider arrangement can also be arranged so that the total current drain is not more than about 7 ma.

• • •

Electronics in AIEE

MORE PAPERS on electronic subjects were presented at the summer technical meeting of AIEE in St. Louis during June than have been given at meetings in the past. Among those with electronic significance, one by N. D. Kenney and Perry H. Ware referred to design and testing of coaxial cables.

The first part of the paper presented a discussion of the variation of transmission line parameters, both basic and working, as a function of construction and frequency. The and approximate formulas were given for computing cable properties, with notes on applicability and limitations as well as practical methods of test.

Simplification of the analytical expressions for rectifier behavior was the objective of a paper by E. F. Christensen and C. C. Herskind of General Electric and C. H. Willis of Princeton University. The paper gives the methods used in analyzing rectifier circuits, illustrates the application of new circuit concepts, provides standard procedure for analysis of rectifier circuits, gives a standard form for the presentation of rectifier characteristics, and presents a comprehensive set of characteristic curves for the delta double-y rectifier.

Design and tests of a mercury-vapor rectifier with exciter anodes was summarized by H. Winograd of Allis-Chalmers Mfg. Co. He described the application to electrochemical service of a 12-tank Excitron unit rated at 5,000 amp., 650 volts d.c.

Control for Welding

Improved electronic control for capacitor-discharge resistance welding was presented by H. J. Bichsel and E. T. Hughes of Westinghouse. This paper describes a capacitor-discharge welding control designed to give high-speed operation and low maintenance.

Basic elements include: (1) a capacitor bank in which energy for the resistance weld is stored; (2) a rectifier system with its charge control and blocking circuit for converting a-c to d-c power and for automatically supplying an exact quantity of energy to the capacitor bank; (3) a discharge system to convert the stored electrostatic energy into welding current; (4) a flux reset circuit to restore the welding transformer flux to the same value between welds, and (5) a sequence control system including a forge timer to coordinate the operation of (2) and (3), above, with the mechanical system.

Fundamentals of hearing-aid design were covered by W. D. Penn. He showed that frequency-selective amplification is usually beneficial and described a method of obtaining this type of action, with mathematical analysis to support the conclusion. Means of computing acoustical amplification were also described.

By combining the advantages of electronic tubes and symmetrical component filters, a new carrier relay results in a marked simplification over previous systems. It was described by T. R. Halman and A. F. Drompp of Detroit Edison Co. and S. L. Goldsboro and H. W. Lensner of Westinghouse. Not only has the number of relays been reduced but the number of operating elements per relay as well.

In an aircraft engine torque meter described by F. W. Godsey, Jr. and C. F. Langer of Westinghouse, resistance straingage elements and vacuum tube amplifiers are combined. The paper included an extensive survey of methods for measuring torque.

Electronic Frequency Conversion

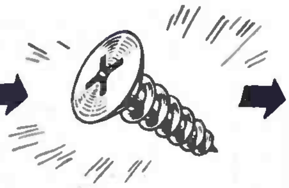
In a symposium devoted to the subject of electronic power conversion, one paper referred to the installation of a 20,000-kw electronic converter to exchange power between 25 and 60 cycles. The converter was described by F. W. Cramer of Carnegie-Illinois Steel Corp. and L. W. Morton and A. G. Darling of GE.

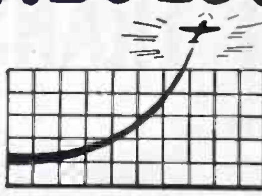
Distribution of currents in various transformer winding and recti-

WHEN THIS →  DREW A BLANK

THE BOSS TORE HIS HAIR 

UNTIL SOMEONE WISED HIM UP TO

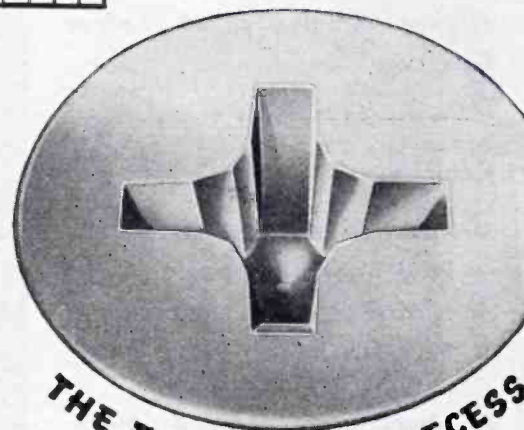
THIS →  → THE RECESSED HEAD

SCREW THAT UPS  DRIVING

SPEED AS MUCH AS

50%

IT'S PHILLIPS



THE ENGINEERED RECESS

S mied because you've just got
ost assembly department out-
and you can't hire more
rers to do it? No need to be!
u can boost output another
y - by switching to Phillips Re-
d Head Screws. They will in-
e driving speed as much as 50
nt. They have done it for
reds of plants!

ith Phillips Recessed Head
rs, your workers encounter none of the troubles that cause slow driving. Spiral and power driving can be used where speed tools have always been impractical. And, the work becomes so much easier that assemblers can maintain a fast pace throughout a shift.

Switch to Phillips Recessed Head Screws. You'll find they'll give you faster driving, easier driving, greatly increased output. You'll also find they *cost less to use!*

TO MAKE WARTIME QUOTAS AND PEACETIME PROFITS

Faster Starting: Driver point automatically centers in the Phillips Recess . . . fits snugly. Fumbling, wobbly starts, slant driving are eliminated. Work is made trouble-proof for green hands.

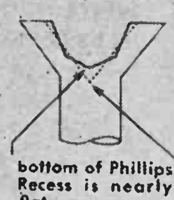
Faster Driving: Spiral and power driving are made practical. Driver won't slip from recess to spoil material or injure worker. (Average time saving is 50%.)

Easier Driving: Turning power is fully utilized. Workers maintain speed without tiring.

Better Fastening: Screws are set-up uniformly tight, without burring or breaking of screw heads. The job is stronger, and the ornamental recess adds to appearance.

IDENTIFY IT!

Center corners of Phillips Recess are rounded . . . NOT square.



bottom of Phillips Recess is nearly flat . . . NOT tapered to a sharp point.

PHILLIPS *Recessed Head* SCREWS

S · SCREWS · MACHINE SCREWS · SELF-TAPPING SCREWS · STOVE BOLTS

24 SOURCES

American Screw Co., Providence, R. I.
Atlantic Screw Works, Hartford, Conn.
The Bristol Co., Waterbury, Conn.
Central Screw Co., Chicago, Ill.
Chandler Products Corp., Cleveland, Ohio
Continental Screw Co., New Bedford, Mass.
The Corbin Screw Corp., New Britain, Conn.
General Screw Mfg. Co., Chicago, Ill.
The H. M. Harper Co., Chicago, Ill.
International Screw Co., Detroit, Mich.
The Lamson & Sessions Co., Cleveland, Ohio
Manufacturers Screw Products, Chicago, Ill.
Milford Rivet and Machine Co., Milford, Conn.
The National Screw & Mfg. Co., Cleveland, Ohio
New England Screw Co., Keene, N. H.
Parker-Kalon Corp., New York, N. Y.
Pawtucket Screw Co., Pawtucket, R. I.
Pheoll Manufacturing Co., Chicago, Ill.
Reading Screw Co., Norristown, Pa.
Russell Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y.
Scovill Manufacturing Co., Waterville, Conn.
Shakeproof Inc., Chicago, Ill.
The Southington Hardware Mfg. Co., Southington, Conn.
Wolverine Bolt Co., Detroit, Mich.

fying elements under conditions of unbalance were considered by E. F. Christensen and M. M. Morack of GE. Effects of such unbalances on circuit duty and rectifier capacity were indicated.

Measurement of dielectric properties at uhf by the resonant cavity method was considered by C. N. Works, T. W. Dakin, and F. G. Boggs of Westinghouse. In this method a reentrant cylindrical cavity is adapted to measure the dielectric constant and power factor of small disks, samples, and insulating material. Methods of measurements, mechanical details, and electric coupling and detecting circuits employ technique common to uhf. Because the cavity has a value of Q higher than 2,000, it is much more sensitive to low power-factors of samples than any conventional coil- and capacitor-resonant circuit.

Furnace Regulation

Electronic motor control for regulating arc furnaces was covered in a paper by J. E. Reilly and C. E. Valentine of Westinghouse. The method has proved successful on many applications where a wide range of speed control and quick response are desired. Many combinations of acceleration and speed range can be obtained with a minimum of apparatus and almost instantaneous response. In the electronic system, the field is held constant and the armature voltage is varied to give the desired speed. Moving parts are eliminated from gear ahead of the motor.

• • •

D-F IN FCC CAR

A mobile direction finder used by the FCC to trace outlaw stations is explained to Congressmen Hart and Wigglesworth by J. B. Lewis (right), monitoring officer in charge of the mobile unit

HOW ELECTRONIC HEAT INCREASED SPAR OUTPUT 700%

Here's How Tolerton Lumber Co. Met Increased Production Demands

BEFORE December, 1941, wood aircraft manufacturers were using spars cut from solid wood planks. But the supply of Grade A spruce for such spars was also limited. Thus spars laminated from thin plies came into the picture; next, to further conserve lumber, short lengths were scarf-jointed; and finally narrow widths had to be edge-glued in order to meet demands.

As a result of these many operations, costs and production time increased sharply.

The Tolerton Lumber Company, applying electronic heating to speed the setting of the glue, found that edge-glued joints could be "set" in 2 minutes; that 8 scarf joints could be "set" simultaneously—in about 10 minutes; and that a 6" x 6" x 16½' beam could be laminated from several planks in about 20 minutes by electronic heat (former time in hot-platen press was 4 hours).

The aircraft spars are cut from these 16 foot beams.

Tolerton uses an RCA 15-kw electronic generator.

Results:

Because electronic heating shortened press time so greatly, the Tolerton plant output was increased from 25 spars per day to 200!

The setting of the glue is complete because electronic heating produces uniform temperature throughout the glue line.

Lumber costs were cut about 40% by using odd pieces!

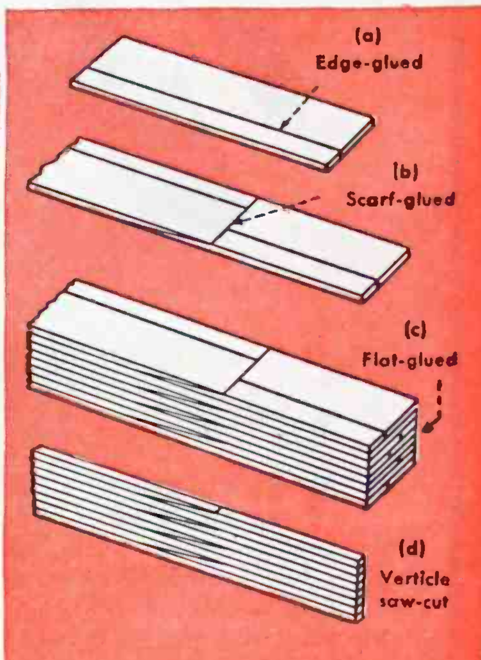
In tests of these glue joints, wood failure runs 100%—considerably above the 80% acceptable under Government specifications.

For more complete information on this application, send the coupon below.

Other Applications by Tolerton: "In addition to manufacturing spars and other aircraft parts such as ailerons, fairings, fins, capstrips, etc., at a big saving in time, lumber, and expense," wrote Mr. R. I. Tolerton, vice-president of the Tolerton Company, "we are also using this electronic method of gluing in the manufacture of lithograph backing blocks and steelmill hammer boards.

"The manufacturing rate has increased greatly, and the products are more accurately made because of the added glue adhesion obtained by electronic heat. We also laminate 6-inch square maple blocks which are later turned to make wheel-bearings for bombers. Electronic heat has made these blocks the most satisfactory material yet found for the purpose."

Want More Details? The complete story of the Tolerton operation—together with pictures, drawings, diagrams, and curves—is contained in a free 8-page article "Electronic Heating Sets Glue in Laminated Aircraft Spars." Write for it, or send the convenient coupon. If you have a problem electronic heating might solve, write us the details; our engineers may be able to help you. Address Radio Corporation of America, Electronic Apparatus Section, (70-40H), Camden, N. J.



Steps in the construction of the spars: (a) edge-gluing to obtain 6-inch width, (b) scarf-gluing to obtain 16½-foot length, (c) laminating to obtain 6-inch by 6-inch by 16½-foot beam, (d) beam cut to obtain edge-grain laminated spars ¾ inch by 6 inches by 16½ feet.

RCA 15-B Electronic Power Generator which supplies about 50,000 B.T.U. per hour. (Send coupon for bulletin.)

RCA ELECTRONIC HEAT

BUY WAR BONDS

RADIO CORPORATION OF AMERICA

RCA VICTOR DIVISION • CAMDEN, N. J.

SEND FOR DETAILS! RCA, Electronic Apparatus Section, Camden, N. J.

Gentlemen: I want more information on how Tolerton Lumber Co. increased output 700% with electronic heat. Please send me "Electronic Heating Sets Glue in Laminated Aircraft Spars." Also booklet on the "RCA 15-B Electronic Power Generator."

☐ I would like an RCA sales representative to call.

Name..........

Address..........

Company..........

City.......... State..........

70-40H-

Remote Amplifie

(*Continued from page* 131)

visible indication of field intensit in the null point of the radiatio pattern. In contrast to a metho in which a reading must be take periodically by a comparison balancing method, this contin ous indication will give immedia warning of an increase in th signal in the unwanted directio and could of course be readi adapted to operate a relay soun ing an alarm.

Regulation of Voltages

Development of the remote mo itor system involved dealing wi several variables which affect its indications. Voltage variatio were taken care of by a regulat in the line, and by gas-tube vol age-regulators in the receiv high-voltage supply.

Fluctuations in the receiver self caused most of the troub encountered. These were found be due to frequency drift of th local oscillator of the superheter dyne type receiver originally use which caused it to become d tuned sufficiently to reduce th detector current. Attempts to de with this particular variation means of temperature-compensa ing capacitors were less succes ful than the adoption of a t-r type receiver such as the or shown schematically.

Extreme changes in ambien temperature occur in the sem desert valley location of the tran mitter. Because of the d-c indica tion method used, changes in re sistance of the telephone lin were anticipated as a facto which might have to be dealt wit On a typical hot summer da temperature ranges from 64 t 102 deg F, between 4 a.m. and p.m. Measurements of the resist ance of the line, totaling as a loo 11,485 ft, showed a change wi this temperature range of abou 14 ohms in the total resistance o 413 ohms at the low temperatur point. This variation in line re sistance is sufficient to cause onl a barely noticeable change in th reading of the microammeter. Th system is otherwise stable enoug

to permit this deviation to be observed on a hot day.

Accuracy of the System

The 6H6 rectifier current which goes over the telephone line is about 220 microamperes, and is read on a 500-microampere full-scale meter. This current remains within plus or minus five microamperes, which is roughly equivalent to a field intensity change of 0.75 mv/m in the normal 31 mv/m area at the center of the null point at the remote monitoring location 1½ miles from the antenna of the transmitter. The stability and hence accuracy of indication on a relative basis, which is all that is important for this type of application, is thus within approximately 1 part in 30, or about 3 percent.

At another field measurement point 4½ miles from the antenna, the signal in the null point is equivalent to only 28 watts of transmitter power. In the direction of maximum radiation, approximately southward over Los Angeles and its environs, the field intensity is equivalent to a power of 38 kw.

This remote monitor was devised by Major Lloyd C. Sigmon, formerly chief engineer of KMPC, who also installed the transmitter and directional antenna system.

• • •

ELECTRONICS FOR CHINA

Two Chinese engineers remove the anode coil from a high-power broadcast transmitter made in England for China, while the third examines a band-change unit mounted on a turntable. Young Chinese are being trained in Britain for postwar reconstruction in their own country


G-E MYCALEX
The development of G-E mycalex, the superior insulator possessing low dielectric power losses at high temperature, is of particular interest to the radio, electronic, industrial control and heating industries.
G-E mycalex has superior electrical characteristics and good mechanical strength. It has a low power factor, high arc resistance, chemical and dimensional stability and a low coefficient of thermal expansion. It is impervious to water, oil and gas and is unaffected by sudden temperature changes. Metallic inserts can be readily molded into the parts.
General Electric is molding mycalex for rectifier seals, brush holder studs, tube bases, switch insulation, structural parts in radio transmitters, arc chutes, relay insulators, terminal insulators and as inserts in die castings and organic plastics. For further information write Section N-252, Plastics Divisions, General Electric Company, 1 Plastics Avenue, Pittsfield, Mass.
Hear the General Electric radio programs: "The G-E All-girl Orchestra" Sunday 10 P.M. EWT, NBC. "The World Today" news, every weekday 6:45 P.M. EWT, CBS.
FIFTY YEARS IN THE PLASTICS INDUSTRY
GENERAL ELECTRIC
PD-252
BUY WAR BONDS

NEWS OF THE INDUSTRY

Conventions to come; Canadian radio; Electronic Conference program; D. C. Bias, words from Washington; television and electronic instruction; transmission facilities; military communications

Radio on Maneuvers with the Airborne Artillery

THROWING OUT RADIOS and other equipment to float down on color-coded parachutes, 500 men of the 541st Parachute Infantry Regiment and the 467th Parachute Field Artillery Battalion dropped near Camp MacArthur, Long Island, recently to show visiting Army and Navy dignitaries and reporters how an air strip is captured by airborne forces.

From bomb-racks on the C-47 transports which brought the paratroopers in, so-called daisy chains of 75-mm pack howitzer parts were released. Each demountable piece of the gun is provided with its own parachute but all the parts of a single gun are tied together with a long streamer of cord which keeps them from separating on the descent and facilitates finding the individual bundles on the ground. Colored lights on the bundles also aid in detection and identification of dropped equipment after dark.

Each battery of artillery includes four transmitter-receivers, each with two standard channels, crystal-controlled. Channel A is the basic use channel with B as a standby. Battery commanders are kept in touch with battalion command through a separate radio net which is tuned to a K channel. Besides the crystals in the transceivers, a large supply of additional units are carried along for frequency change-over.

In actual combat, one-man sets in the 300 series are used but for these exercises, type BC-659-A combinations made by Galvin Mfg. Corp., were dropped. Requiring a two-man team, they consist of radio and batteries in separate containers which are coupled together mechanically with trunk-type hasps and electrically with plugs and cables. The telescopic antenna is demountable and carried in clips on top of the radio cabinet.

Although normal communication is carried on with a push-to-talk, hand-held microphone and a speaker in the panel, provisions exist for earphones at points close to enemy lines where silence must be maintained. For use at a forward observation post where the operator wishes to conceal the antenna mast by placing the set on lower ground, microphone and earphone extensions permit remote operation.

Equipment bundles include form-fitting protective pads of mattress-like construction, but one zealous crew had borrowed the sofa cushions from their day room for extra security against damage. In spite of the standard precautions, one of the units suffered considerable physical distortion but operated perfectly. Another, with no outward sign of injury, went dead after a few minutes of use.

Book of Electronic Standards

IN A BOUND COMPILATION of results of the standardization program in WPB's radio and radar division, 21 American war standards for electronic components are brought together in a single, convenient reference.

Because the standards were developed in cooperation between the armed forces and industry, they satisfy the extremely critical requirements of the armed forces without going beyond the capabilities of industry regarding large scale production. Thus it is anticipated that besides constituting a sound basis for war standardization, they may also serve as a nucleus for postwar development.

Contents include ceramic insulating materials, fixed mica-dielectric capacitors, meter resistors, glass-bonded mica insulators, fixed composition resistors, glass insulators, wire-wound resistors, crystal units, fixed ceramic-dielectric capacitors, dynamotors, porcelain radio insulators, toggle switches, fixed paper-dielectric capacitors, method of noise-testing fixed composition resistors, electrical indicating instruments, shock-testing mechanism for indicating instruments, external r-f thermocouple converters, external ammeter shunts, and fixed molded paper-dielectric capacitors.

Search for Scientists

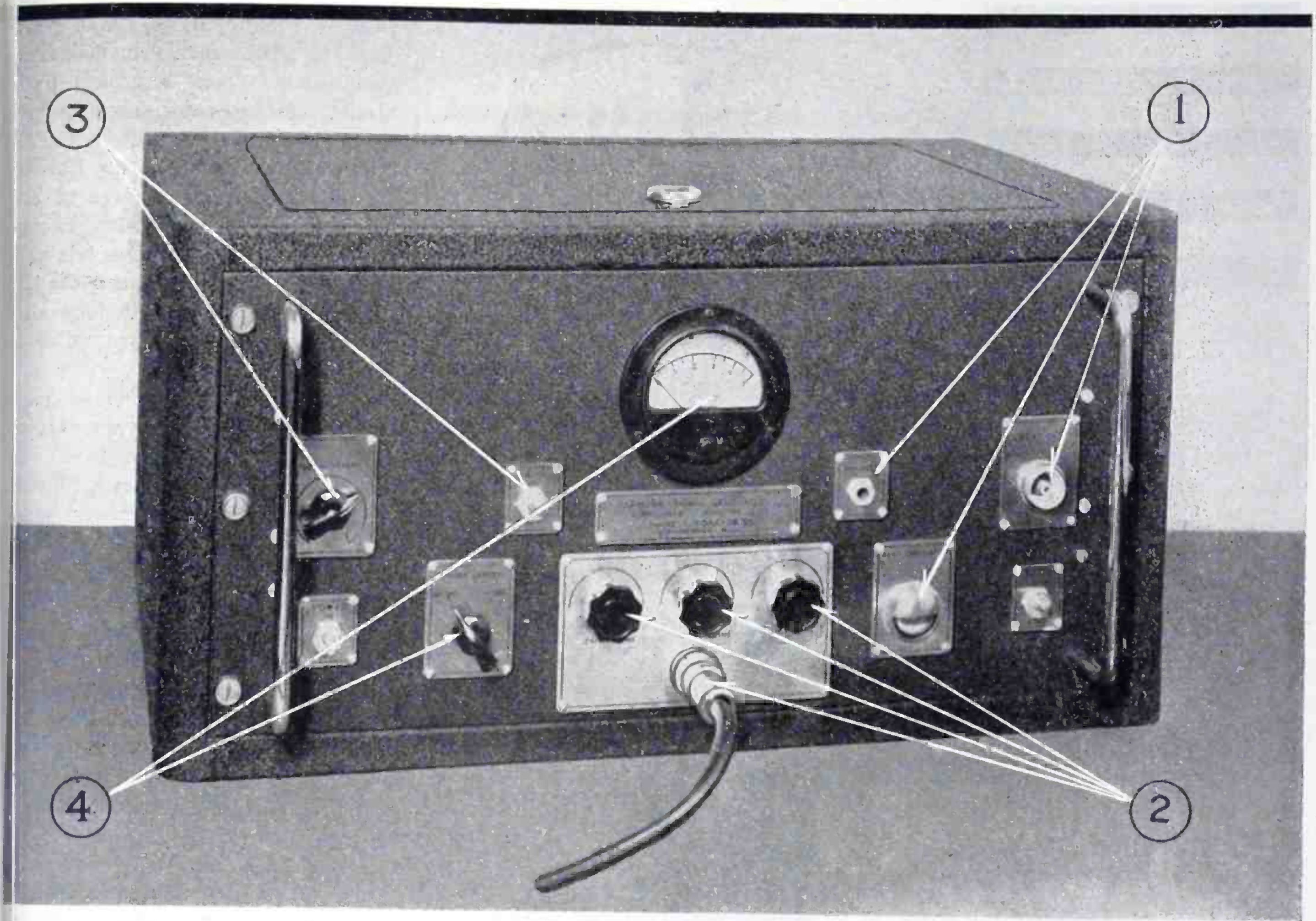
REQUESTS FROM INDUSTRIAL and government laboratories, for research personnel; from colleges, for teachers; and from industrial establishments, for miscellaneous scientifically trained persons, are reaching the office of scientific personnel of the National Research Council in large numbers. The supply of able scientists has never seemed so small in relation to the demand.

One of the functions of this office is to assist in the recruitment of scientists for positions in war-supporting activities. Since it is in touch with demands from all types of activities, it is in a position to refer an able scientist to employers engaged in urgent work. Demand is particularly heavy for people trained in electronic and communication engineering, in physics, and in mathematics. Individuals who are or may become available should write to Dr. M. H. Trytten, director, 2101 Constitution Ave., Washington 25, D. C.

Convention Coverage by Television

SCENES FROM the recent Chicago conventions were put on the air from film within 18 hours of their actual happening. Television set owners in 5,000 homes in New York, Philadelphia, and Schenectady were able to see important interviews and actual deliberations on the convention floor through television network facilities. Films for exclusive television use have never before been produced on so extensive a scale.

Production at the Stadium in Chi-



4 REASONS WHY . . .

the *New* LAVOIE C-200 Calibrator

EASILY Establishes CRYSTAL - CONTROLLED Frequencies at UHF Up to 2000 Megacycles!

1. BEAT DETECTOR UNIT provides easy calibration of signal generators or oscillators with either aural or visual indication of zero beat.
2. OUTPUT and ADJUSTMENTS give crystal-controlled harmonic frequencies up to 2000 megacycles.
3. MODULATION CONTROLS permit selection of either modulated or unmodulated output as well as degree of modulation.
4. MILLIAMMETER and SELECTOR SWITCH facilitates easy adjustment of output controls.

Write for detailed information.

L U H F

Lavoie Laboratories

RADIO ENGINEERS AND MANUFACTURERS

MORGANVILLE, N. J.

Specialists in the Development of UHF Equipment cago was handled by Pathe News. Due to differences in television technique, it was necessary to instruct the veterans newsreel cameramen to make certain changes in their normal procedure. For one thing, far greater footage of each scene was required. Also, because of the small size of the television screen, a greater percentage of closeups was used, with long shots serving only for background or atmosphere.

The shooting supervisor maintained a schedule of every airplane flight from Chicago for New York. As each zero hour neared, film was unloaded from the camera magazines, labelled, and rushed to the plane with police escort. At New York, the films were rushed to the laboratory and developed. National Broadcasting Company, from whose WNBT the presentation originated, televises negative instead of positive film. This saved considerable time in finishing and made it possible to edit the reels quickly.

CONVENTIONS TO COME

Sept. 11. Symposium on Fluorescence and Luminescence, New York, N. Y. **American Chemical Society,** James T. Grady, 609 Journalism Bldg., Columbia University, New York 27, N. Y.

Sept. 11–16. **American Association for the Advancement of Science,** Cleveland, Ohio. F. R. Moulton, secretary, Smithsonian Institution Bldg., Washington 25, D. C.

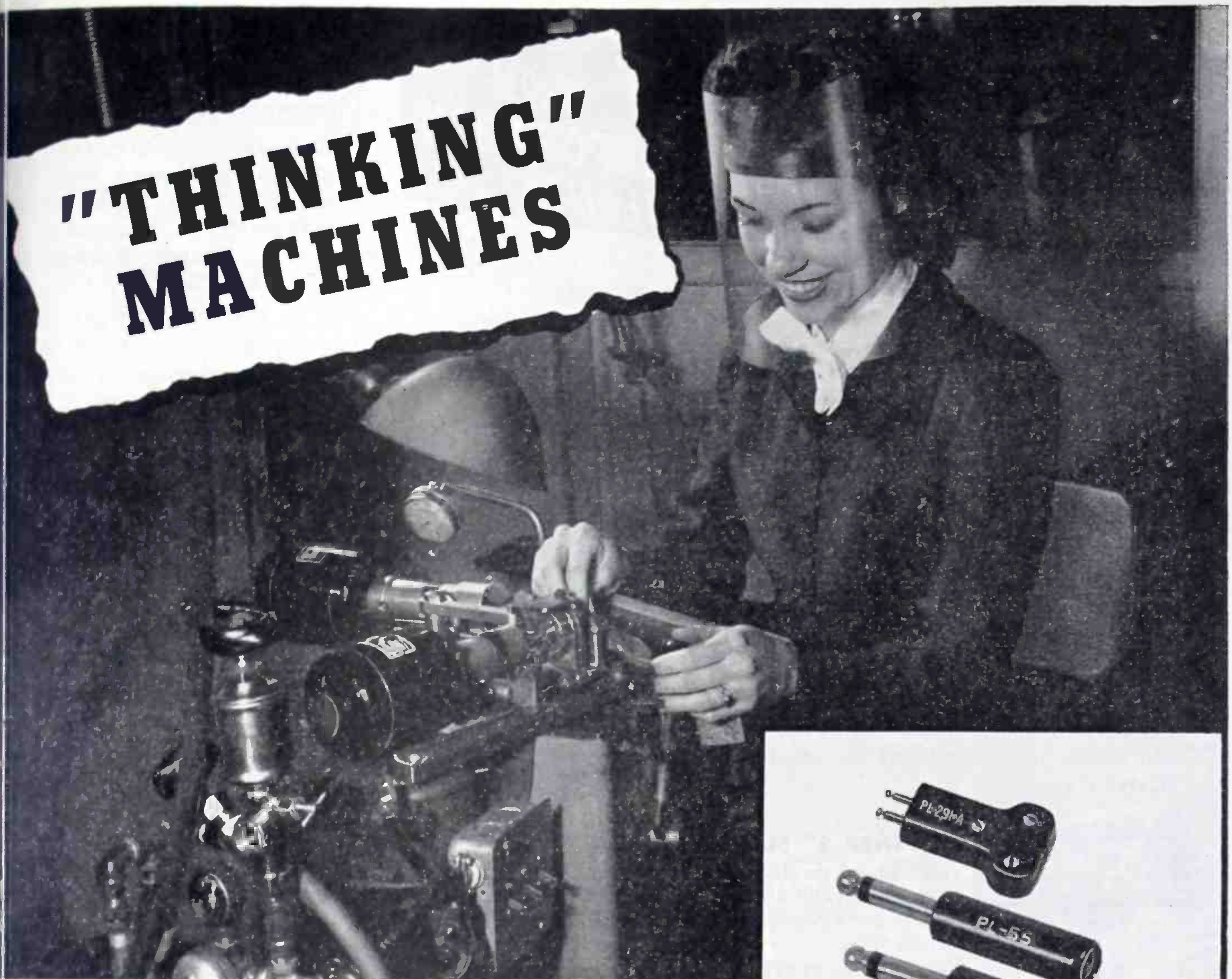
Sept. 14. Regular Meeting, New York, N. Y. **Radio Club of America,** Milton B. Sleeper, corresponding secretary, 11 West 42 St., New York 18, N. Y.

Sept. 18–20. Eleventh Annual National Conference, Toledo, Ohio. **Associated Police Communication Officers, Sgt. C. H. Knudel,** chairman, 720 Jefferson Ave., Toledo 2, Ohio.

Oct. 2–5. Forty-Ninth Annual meeting, Boston, Mass. **International Municipal Signal Association,** Irwin Shulsinger, secretary, 8 East 41 St., New York, N. Y.

Oct. 5–7. **National Electronics Conference,** Chicago, Ill. B. Dudley, secretary, 520 N. Michigan Ave., Chicago, Ill.

"THINKING" MACHINES



Machine designed by Remler to perform multiple operations: automatic slotting; indexing; drilling; milling and reaming.

REMLER ENGINEERS design and build robots with "brains" to improve production techniques. Ingenious jigs and dies, and in many instances entire machines are constructed to combine intricate operations. These innovations contribute to the precision accuracy of Remler products; release man-power for other tasks; reduce costs and speed up deliveries. For complete sound transmitting systems; radio; plugs and connectors and other electronic components in metal and plastic, consult . . .

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

Oct. 12–14. Fall Meeting, Buffalo, N. Y. **Electrochemical Society,** Colin G. Fink, secretary, Columbia University, New York 27, N. Y.

Oct. 16–18. Fifty-Sixth Semi-Annual Fall Conference, New York, N. Y. **Society of Motion Picture Engineers,** W. C. Kunzmann, vice president, Hotel Pennsylvania, New York, N. Y.

Oct. 16–19. Twenty-Fifth Annual Meeting, Cleveland, Ohio. **American Welding Society,** M. M. Kelly, secretary, 33 West 39 St., New York 18, N. Y.

Oct. 19–21. Electronic Parts and Equipment Industry Conference, Chicago, Ill. **Association of Electronic Parts and Equipment Manufacturers; Eastern Div., Sales Managers Club;** and **National Electronics Distributors Association.** H. W. Clough, chairman, PO Box 5070-A, Chicago 80, Ill.

Nov. 2–3. National Time and Motion Study Clinic Chicago, Ill. **Industrial Management Society,** C. S. Becker, vice president, 205 West Wacker Drive, Chicago 6, Ill.

Nov. 13–14. Annual Receiver- and Tube-design Meeting, Rochester, N. Y. **Radio Manufacturers Association and Institute of Radio Engineers;** Bond Geddes, secretary RMA, 1317 F St. N.W., Washington, D. C.; Haraden Pratt, secretary IRE, 330 West 42 St., New York 18, N. Y.

Nov. 9–10. Fall Meeting, Dayton, Ohio. **Institute of the Aeronautical Sciences,** Robert R. Dexter, secretary, 1505 RCA Bldg. West, Rockefeller Center, New York 20, N. Y.

Naval Electronic Production

DELIVERIES OF RADIO and other electronic equipment for the Navy are currently reported to be well in excess of $100,000,000 monthly. This figure is five times the total production for all purposes in 1940.

Electronic Conference Program

SCIENTIFIC DEVELOPMENTS in electronics and electronic applications in industry and medicine are to be emphasized at the National Elec-

ERMANENT MAGNETS MAY DO IT BETTER

tronics Conference in Chicago, October 5 to 7. The program has been prepared by Professor Arthur B. Bronwell of Northwestern University and a tentative list of subjects is classified as follows.

Television

Color and U-H-F Television by Dr. P. C. Goldmark, CBS.

Reflective Optics in Television by I. G. Maloff and D. W. Epstein, RCA.

Radio Relay Systems by C. W. Hansell, RCA Labs.

Ultrahigh Frequencies

A Lighthouse Tube; a Pioneer Development by E. F. Peterson and E. D. McArthur, G. E.

Principles of Klystron Amplifiers by Dr. Robert Haxby, Sperry.

Developments of Electronic Tubes by I. E. Mourontseff, Westinghouse.

Wide-Frequency-Range Tuned Circuits for High Frequencies by Dr. D. B. Sinclair, General Radio Co.

U-H-F Converters and Conversion Diagrams by Dr. Harry Stockman, Harvard.

Radio

Generation of Quasi-Continuous Frequency Spectra by Dr. Harold Goldberg and Richard G. Talpey, Stromberg-Carlson.

A Frequency-Dividing Lock-In-Oscillator F-M Receiver by G. L. Beers, RCA.

Incremental Permeability Tuning by W. J. Polydoroff, Consulting Engineer.

Audible Audio Distortion by H. H. Scott, General Radio Co.

Broadband Carrier and Coaxial Cable Networks by P. A. Cowan, AT&T.

Industrial Measurements and Special Devices

Supersonic Reflectoscope for Inspecting the Interior of Metal Parts by Dr. F. A. Firestone, University of Michigan.

Dynamic Strain Gages by C. A. Dohrenwend, Armour Research Foundation.

The Mass Spectrometer and Its Practical Applications by J. A. Hipple, Westinghouse.

Two-Million-Volt X-Ray Unit by Dr. E. E. Charlton and W. F. Westendorp, G. E.

Industrial Fluoroscopy of Light Materials by Dr. Scott W. Smith, Kelley-Koett Mfg.

Application of Amplifier Theory to Mechanical Stability Problems by John M. Cage, Allis-Chalmers.

Industrial Electronic Controls

Electronic Mechanisms in Process Plants and Industrial Laboratory by T. A. Cohen, Wheelco Instrument Co.

Electronic Measurements of Non-Electrical Quantities by H. D. Middell, G. E.

Cathode Ray Tubes and Their Application by Dr. P. S. Christaldi, Allen B. Du-Mont Laboratories.

Electronics in Instrumentation by Walter P. Wills, Brown Instrument Co.

Design Factors in the Application of Relays by R. H. Herrick, Automatic Electric Co.

Induction Heating

High Frequency Induction Heating by C. J. Madsen and R. M. Baker, Westinghouse.

New Methods and Techniques in High Frequency Heating by Dr. Eugene Mittelmann, Illinois Tool Works.

High Frequency Electronic Generators for Industrial Heating by Dr. Wesley Roberds, RCA.

Electronic Applications in the Power Field

Power Applications of Electronics by A. C. Montieth, Westinghouse.

Power Rectifiers and Inverters by J. A. Cox and G. F. Jones, Westinghouse.

Electronic Power Converters by Dr. E. F. W. Alexanderson, G. E.

Medical Applications of Electronics

Electronic Equipment in the Medical

Profession by Dr. A. H. Carter, American Medical Association.
Electroencephalography by Dr. Ralph Gerard, University of Chicago.

Recent Theoretical Developments in Electronics

Theory of Microwave Oscillation Generators Using Velocity-Modulated Electron Beams by Dr. E. U. Condon, Westinghouse.
Theorem of Lorentz for Electrons in Magnetic Fields by Dr. Leon Brillouin, Columbia University.
Transient Response of Wide-Band Amplifiers by Dr. W. W. Hansen, Sperry.

Underground Communications Center

IN ENGLAND, two years before D-Day, work was started on a combined signal headquarters for American, British, and Canadian forces. One hundred feet beneath the English countryside, this center is a town in itself. Radio facilities are such that complete direction of the battle in France could be exercised from this point.

Television Course for Radio Engineers

DURING OCTOBER, NBC will sponsor in New York, a special four-week course in television for the engineering personnel of its affiliated stations. Given under the direction of the RCA Institute, the course will be composed of field trips alternating with lecture classes. Subjects will include major elements of television systems; remote television pickups, cathode-ray tubes and oscilloscopes, kinescope deflection methods, analysis of television receivers, studio design and arrangement, iconoscopes and orthicons, analysis of control pulses, wide-band line amplifiers, television transmitters, and television developments and trends. Other features will include inspections of live-talent studios in Radio City and of the transmitter in the Empire State Building.

Unionists Learn Electronics

FEELING THAT ELECTRONICS is about to become the dominant part of the electrical industry and run into four billion-dollar proportions, the International Brotherhood of Electrical Workers (AFL) is working with the Engineering College of Marquette University to establish a national electronics school for its membership.

Intensive six-week courses are to be given to 700 men a year, each of


AC OR DC
Any Size
2" — 3" — 4" — 5" — 6" — 7"
Any Style
Shipment within 30 days
ON any AA Priority
The Triplett Line of Instruments—a complete line from one source and better than ever before—is now ready for the demands of "regular" business. Naturally, standard catalog numbers ready in the stock room can be shipped promptest, but all our instruments, through increased production facilities, are being delivered with gratifying speed. You can count on quick deliveries so place your orders now.
Triplett
ELECTRICAL INSTRUMENT CO.
BLUFFTON OHIO
STANDARDS ARE SET BY TRIPLETT
MILLIAMPERES D.C.
AMPERES R.F.

whom will return to his local union as an instructor to pass the information along to some 25,000 members per year. Tuition costs of the electronics school amount to about $30,000 a year, which will be taken care of by the international union. Locals will bear the expense of transporting and lodging their member students.

Tubes for Civilians

AT LEAST ONE HUNDRED and possibly 200 percent more civilian radio tubes will be delivered in the last half of 1944 than in the first half, according to an estimate of Arthur Stringer, director of circulation for the National Association of Broadcasters. Increased production is actually in effect and between 35 and 40 percent of the increase is expected to be shipped during the third quarter of the year.

Listing of Licensees

NAMES OF 600 HOLDERS of first- and second-class radiotelephone licenses comprise a list released by FCC in a third report on its survey of manpower. These licensees have indicated availability for employment in the communications industry.

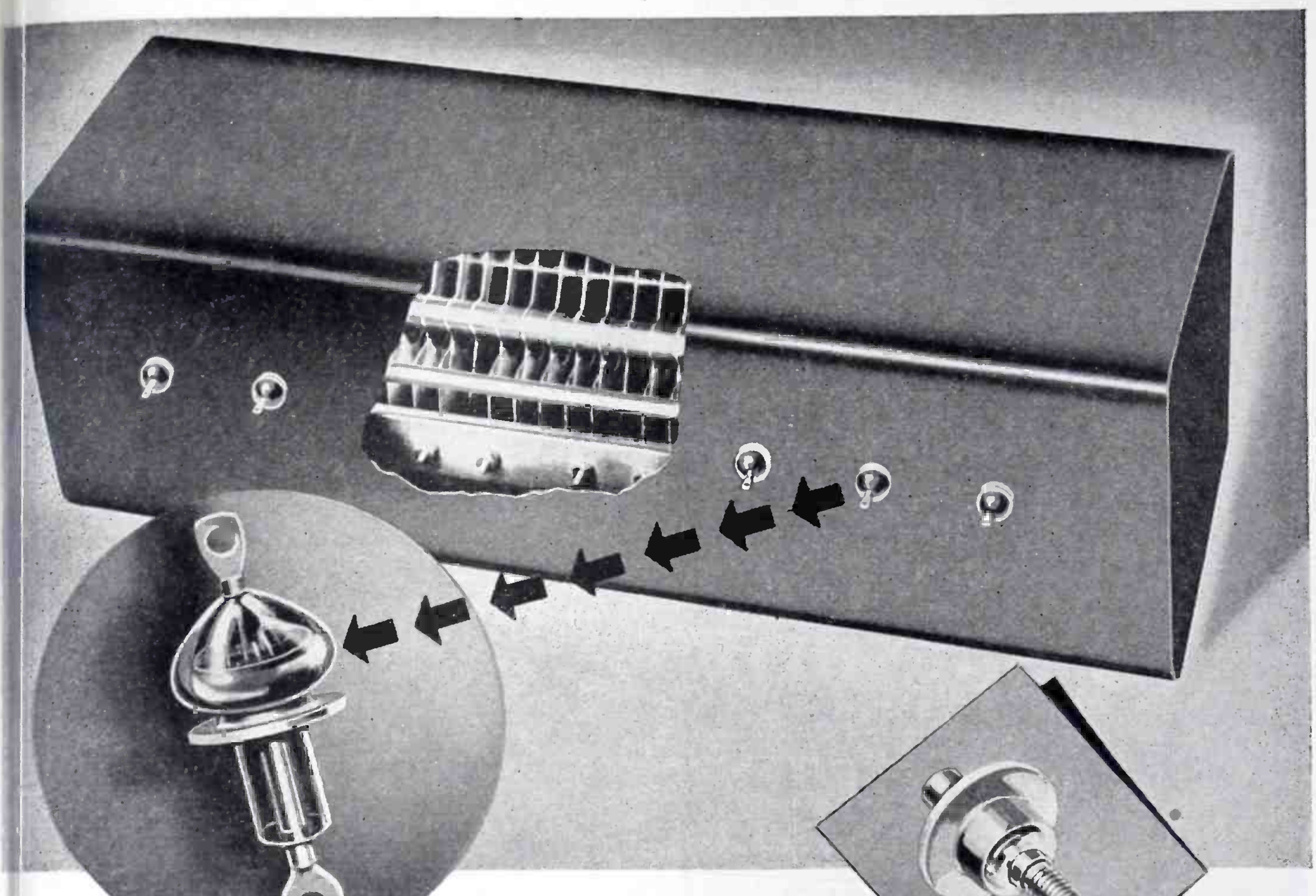
Besides the names and addresses of the individuals, their present draft status, the nature of their present employment, the class of license held, and other particulars are listed. The compilation is broken down by state of residence and by census regions.

Radio Telephone for Emergency Airport Vehicles

CONSTRUCTION PERMITS for low-power experimental radiotelephone stations in crash trucks, ambulances, and fire trucks have been granted by FCC to Lockheed Air Terminal, Inc. Authorized for transmission above 100 Mc, the installation will be in the vicinity of the company's airport at Burbank, Calif.

Communications on Attu

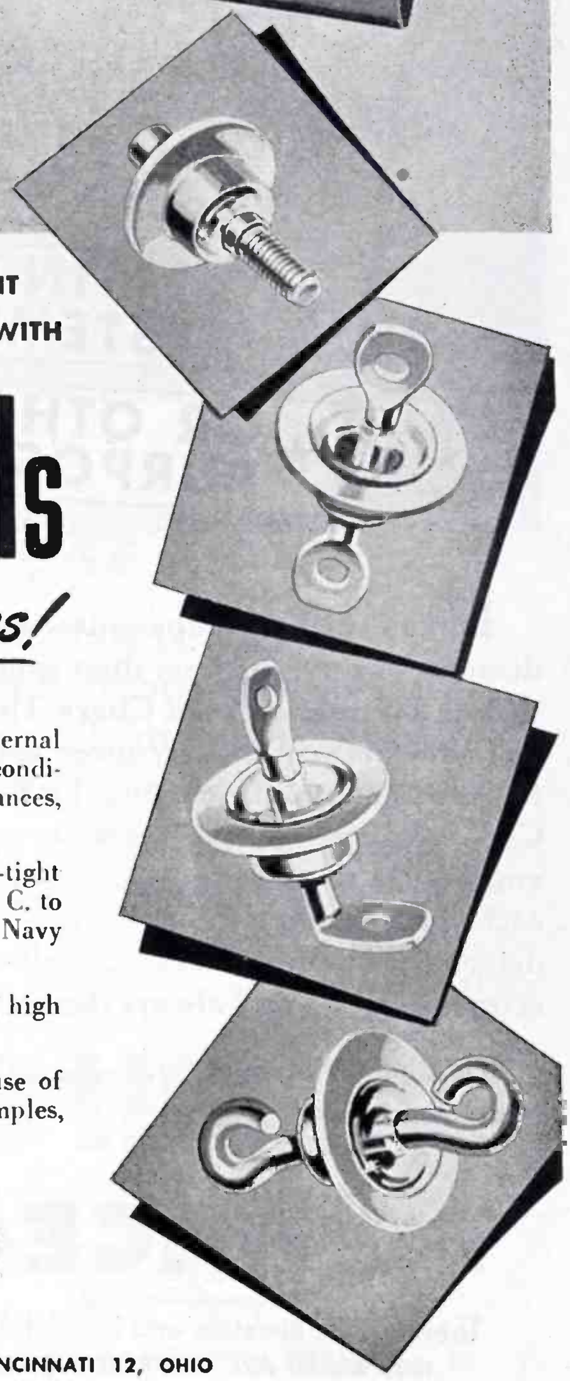
U. S. FORCES OCCUPYING the Aleutian Island of Attu found no evidence of the use of radio there by the Japanese. Stories to the effect that the Japs used high-pitched bird-call whistles to give signals



GIVE SENSITIVE EQUIPMENT
AN IMPENETRABLE DEFENSE WITH

Sperti Hermetic Seals

Volume production! Prompt deliveries!



Block the only points of entry for dust, fungus, moisture and other external elements that threaten the efficiency of equipment under tough military conditions. Adopt Sperti Hermetic Seals for capacitors, condensers, inductances, relays, vibrators, transformers and other component parts.

ONE PIECE. Glass and metal are fused into one piece to form a vacuum-tight hermetic bond. Resist corrosion. Have a thermal operating range of −70° C. to 200° C. Insulation leakage resistance, 30,000 megohms, minimum, after Navy immersion test.

SOLDERING TEMPERATURE NOT CRITICAL. Simple, easy to attach by means of high frequency, oven-soldering or standard soldering iron.

WIRE, WRITE OR PHONE TODAY for information. Full details of planned use of Sperti Hermetic Seals will bring proper recommendations and desired samples, promptly.

Sperti INCORPORATED

SPERTI ELECTRONICS

Electronic Division, Dept. E-4

RESEARCH · DEVELOPMENT · MANUFACTURING · CINCINNATI 12, OHIO have not been substantiated an[d] such sounds are now thought t[o] have been actual bird calls whic[h] are still heard daily. These fact[s] were contained in a report recentl[y] received by Major General H. C[.] Ingles, Chief Signal Officer.

New Coaxial Run

AMONG FACILITIES which may b[e] available for a postwar televisio[n] network is a new coaxial cable link authorized by FCC between Terr[e] Haute, Ind. and St. Louis, Mo. Pe[r]mission was granted to AT&T fo[r] construction of this new circu[it] which will contain six coaxial con[]ductors. Cost of the overall proje[ct] is $4,032,000, including carrie[r] equipment to be installed at point[s] between Kansas City and Ne[w] York. The installation wil provid[e] 226 additional telephone channel[s] which are now urgently needed fo[r] war messages.

Supplementary Service Survey

ALL DOMESTIC BROADCAST station[s] including fm and television are be[]ing circularized by NAB (Nationa[l] Association of Broadcasters) to ob[]tain information which will aid i[n] estimating present and future need[s] for frequencies devoted to relay[,] studio-transmitter link, experimen[]tal, and emergency use. Resultin[g] information will be tabulated an[d] made available to the various RTP[B] panels dealing with allocation prob[]lems. Individual information wil[l] be kept confidential.

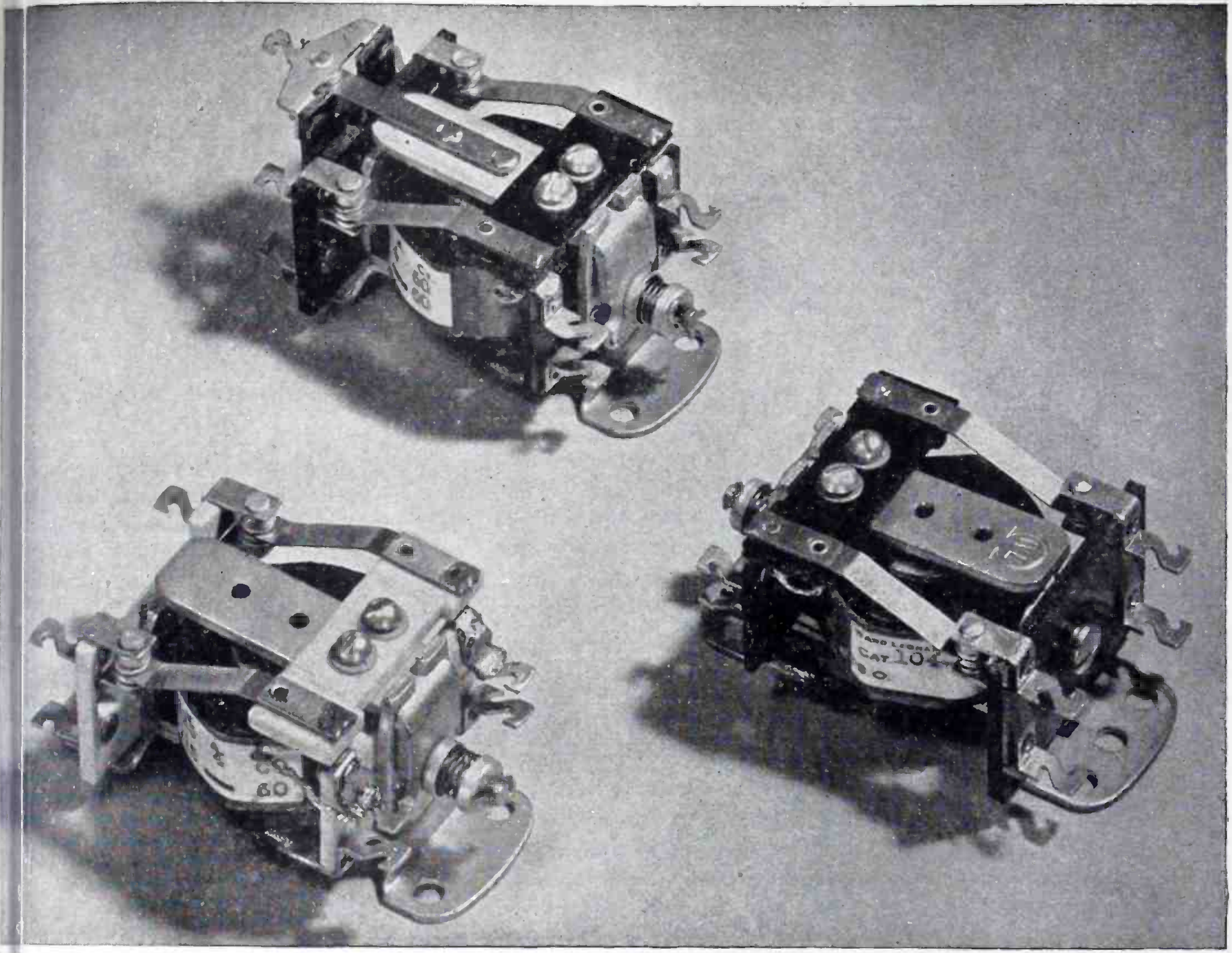
Radiation Patents

AT THE RADIATION LABORATORY o[f] Massachusetts Institute of Tech[]nology, the Signal Corps has estab[]lished the Cambridge Signal Paten[t] Agency with responsibility for th[e] preparation of patent application[s] related to work at the Radiatio[n] Laboratory and at the Radio Re[]search Laboratory of Harvard Uni[]versity.

Canadian Radio

POWER INCREASES have recently been approved by Canadian Broad[]casting Corp. for a dozen or so transmitters. Lack of material is delaying the approved changes.

Other applications have been made and approved for a number of



ADAPTABLE...

FOR MANY PURPOSES

The Ward Leonard Midget Metal Base Relay has proven so satisfactory and dependable that several adaptations have been made in it to give it even wider application. The relays shown above are the original relay, one with auxiliary contact and one with porcelain insulation. These relays may be furnished with studs in place of metal bases.

Only 1¼ inches in height. For continuous operation on AC and DC voltages up to 110-115. Double pole double throw. This Relay described in data Bulletin 104. Send for a copy.

WARD LEONARD

RELAYS • RESISTORS • RHEOSTATS

Electric control (WL) devices since 1892.

WARD LEONARD ELECTRIC COMPANY, 32 SOUTH STREET, MOUNT VERNON, N. Y.

local private stations and a ne CBC station.

Two 50-kw shortwave transmit ters are announced as being in stalled in New Brunswick for trans mission to South America, Afric Australia, and the Far East. Ove these stations, which represen Canada's first venture into ove seas broadcasting, programs wi be brought from Montreal, 60 miles away.

Jeep-Mounted Mobile Cinema

FOR SHOWING MOTION PICTURES battle areas, Warrant Officer Albe A. Hinchey established a worksho in New Guinea where projectio equipment could be serviced. H also combined equipment with th necessary power supply so it coul be mounted or a jeep for transpo by plane to troop concentrations i areas inaccessible by road.

As a result of this activity, jee mounted RCA equipment was show ing movies on Lae 48 hours aft the island had been captured fro the Japanese.

D.C. BIAS

Communications Construction. A amendment has been issued b FCC extending the time limit pr scribed for facilities which hav been authorized. Section 63.05 o the rules and regulations no state that "Unless otherwise d termined by the Commission upo proper showing in any particula case in the event constructio shall not have been begun upon project involving an expenditur of more than $50,000 within 1 months from the date of the Com mission's authorization, or all o part of the proposed facilities sha not have been placed in operatio within 36 months after such dat such authorization shall termina at the end of such 12 or 36 month period . . .". For projects involv ing $50,000 or less, the time period are 9 months or 18 months.

Production Deficit. Since the prin cipal deficits in deliveries of mili tary products are in those item most urgently needed in comba areas, the Army has asked for in creased efforts by management an labor to bolster up lagging pro

An Army that Travels on its Ears

CERTAINLY, today's armies have Stomachs, but they have something Napoleon's armies *did not* have . . . Ears. Ears that can hear, not for just a few feet, but over any distance on Land, in the Air and on the Sea. Electronic ears that link every unit of our fighting forces in instant and complete Communication . . . that spell the difference between success and failure.

As a pioneer designer and manufacturer of Sound Reproducing Equipment, it is only natural that Rola should be in the forefront of the effort to supply our Military with the delicate, dependable components for Communications Systems... Headsets, Transformers, Coils and other Electronic parts. Knowing the power of Communication on the Home Front, it is only natural that Rola suggests, "Consider everything you SAY; check the source of everything you HEAR."

THE ROLA COMPANY, INC. • 2530 SUPERIOR AVENUE • CLEVELAND 14, OHIO

ROLA

Let's do more in forty-four!

MAKERS OF THE FINEST IN SOUND REPRODUCING AND ELECTRONIC EQUIPMENT duction. Radio and electronic equipment is in this category. Materials in production today are required to meet expenditures on the battle front, and failures now to meet schedules mean delays in military operations which may be costly in loss of lives and in prolonging the struggle.

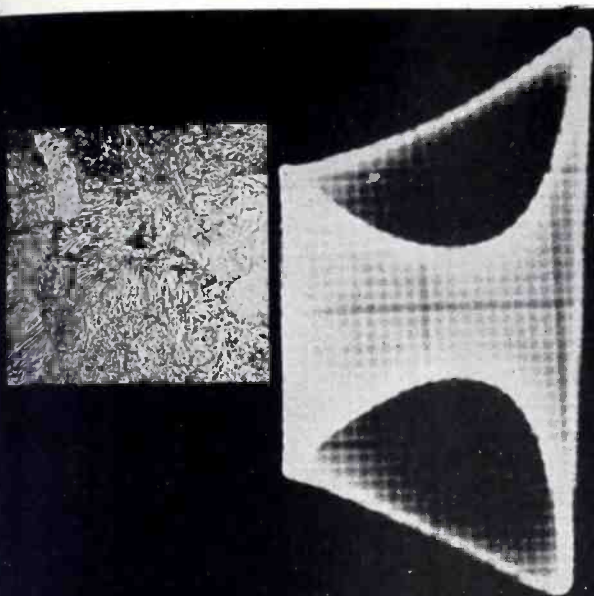
Meanwhile, WPB has made increased efforts to channel idle and excess electronic components back into the production stream. Forms have been sent to all radio prime contractors and component manufacturers, so that they can report excess and idle stock. The component recovery section of WPB will maintain distribution of published idle-and-excess-component listings.

Surplus Disposal. An orderly method of handling future huge quantities of electronic surpluses is expected to result from present tests on ways of handling currently small amounts of products by Defense Supplies Corp. Among specific problems anticipated are those surrounding the disposition of obsolete walkie-talkies and similar equipment which, unless care were exercised, might end up in the hands of criminals or other subversive elements.

Mica. At recent meetings of the raw mica fabricating industry advisory committee, methods were discussed for obtaining and conserving the better qualities of mica, for manufacture of block mica into film, and for establishment of standards. Questions covered included the advisability of changing the dividing line between strategic and non-strategic block mica, while relaxation of unnecessary controls was advocated by industry representatives.

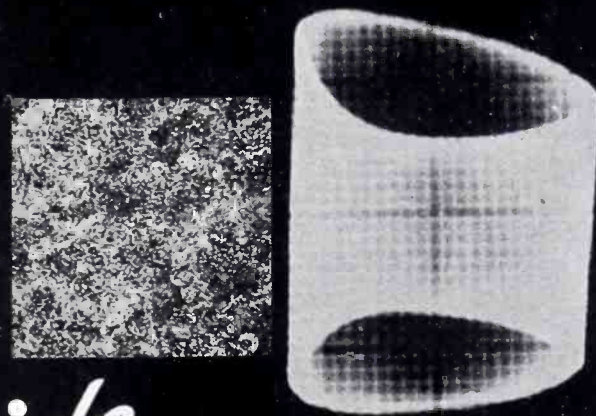
It was reported that large stocks of No. 6 mica of better qualities (good stained, fair stained, clear, and slightly stained) are now available for all purposes. Radio tube manufacturers were urged to use the better quality even though prices of finished tube parts might increase. Greater consumption of No. 6 mica would be beneficial in relieving pressure on No. 5 and 5½ for radio and radar capacitors.

To help the industry acquaint itself with the various micas available, tentative plans call for 100-lb samples of each quality to be main-

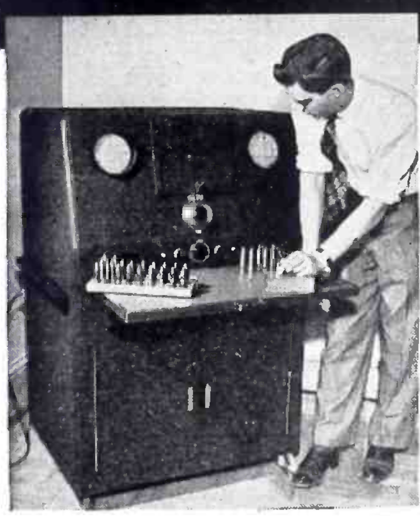


(Left) Photomicrograph of bottom of 57 mm. shot, Brinell hardness 247, with corresponding cyclogram.

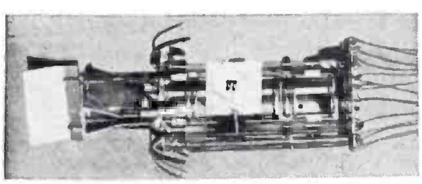
(Below) Photomicrograph of top of same shot, Brinell hardness 451. Cyclogram shows corresponding change in structure.



They wanted to LOOK *inside* METALS



GOOD *bad* GOOD GOOD *bad*... 6,500,000 bullets, rejected because of a mix-up in copper cladding measurements, were re-sorted by the DuMont Cyclograph... 99% of them salvaged!



ALL METAL PARTS OF CYCLOGRAPH TUBES ARE *NICKEL & NICKEL ALLOYS*

... Nickel is de-gassed readily ... has strength to endure de-gassing bombardment at 1850° F.

It resists warpage and distortion... has high stiffness and damping capacity to minimize vibrations of delicate parts.

It does not rust... is highly resistant to corrosion.

When carbonized, it supplies ductile easily-formed strip of very high thermal emissivity.

The high work function of Nickel minimizes back emission.

It is unsurpassed as a base for stable, oxide coated cathodes of high electron emissivity and long life.

It resists deformation in handling during manufacture... makes strong spot welds and resists oxidation during welding.

... and DuMont Laboratories found that pure Nickel and Nickel alloys provided all the properties they sought to make the electronic eyes of their Cyclograph

The Cyclograph gives an immediate electronic view of the inner make-up of metals.

Its cathode-ray tube reveals differences in magnetic and electrical properties of metals which may be correlated with differences in one of the following: chemical composition, hardness, toughness, internal stresses, case depth, thickness of plating or cladding, and other characteristics.

These readings, to be accurate, require cathode-ray tubes free from tube-caused errors which might affect the Cyclogram.

Naturally the cathodes of DuMont cathode-ray tubes—as in the majority of modern tubes—are pure Nickel.

For Nickel provides the combined mechanical, electrical and electronic properties which give the DuMont cathode-ray tube its long life.

This use of pure Nickel and other Nickel alloys in the DuMont cathode-ray tube is typical of the unique service given by Nickel and its alloys, for Nickel alloys offer the electrical, expansion, magnetic and non-magnetic characteristics required in electronic devices.

If you have a problem involving the selection of the right metal for an electronic application, you are invited to consult INCO Technical Service. Address: The International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.

NICKEL INCO ALLOYS

MONEL • "K" MONEL • "S" MONEL • "R" MONEL • "KR" MONEL • INCONEL • NICKEL • "Z" NICKEL

Sheet... Strip... Rod... Tubing... Wire... Castings tained for inspection at New York and Washington. Capacitor manufacturers were urged to call the attention of their customers to the desirability of using capacitors of low-quality mica in place of paper-dielectric units. Only one-third of available mica-capacitor facilities are being utilized at present.

Dry Cell Batteries. Consumers durable goods division of WPB is pointing out to distributors of farm radio batteries that such products have, within the past year, become one of the most urgent and critical products in our war production program. Military requirements were described as exceeding production by an estimated 30 percent. Because fifty or more military items such as radios, buoys, submarine detectors, direction finders, bazookas, and field telephones require dry batteries, it is unlikely that the industry will be able to do any more than maintain the present inadequate civilian production. The production bottleneck was indicated as being a shortage of workers rather than a shortage of materials or machines.

BUSINESS NEWS

In the theater equipment business, RCA Victor Div., **Radio Corp. of America,** plans postwar distribution on a worldwide basis not only of sound reproducing equipment but also related theatrical apparatus.

Illinois Condenser Co. increases its production to a point 300 percent above activities a year ago by addition of a floor to its Chicago plant.

Two department heads at **Kollsman Instrument Co.,** Flushing, N. Y., found themselves in court recently for breaking an obscure ordinance which prohibits working on Sunday—even for an Army-Navy E.

Labor-management committee members at **Hallicrafters Co.,** Chicago, Ill., turned over to the Army's new Vaughan General Hospital the $2500 that employees would have been paid for working

extra time on D-day, plus $2500 they would have spent on a company picnic they cancelled.

Madison Electrical Products Corp. is a new company in Madison, N. J., devoted to manufacture of resistors, electronic assemblies, coil windings, and special components.

By producing in a single plant more than 4,178,000,000 single-conductor-feet of wire, during the last 2½ years, **United States Rubber Co.** exceeds the combined industry figure for building wire in 1941.

West Coast Electronic Manufacturers Association accepts for membership six new concerns, bringing the roster above the fifty mark. The companies are **Brittain Sound Equipment Co.,** Los Angeles; **Merle F. Faber,** San Francisco; **Harvey Machine Co.,** Los Angeles; **Howard Pacific Corp.,** Los Angeles; **The Lake Mfg. Co.,** Oakland; and **Special Electric Laboratories,** Los Angeles.

Electronic equipment for the armed forces will be manufactured by approximately 2000 workers of **Western Electric Co.,** in newly leased space at 529 West 42 St., the company's fourth manufacturing plant in metropolitan New York.

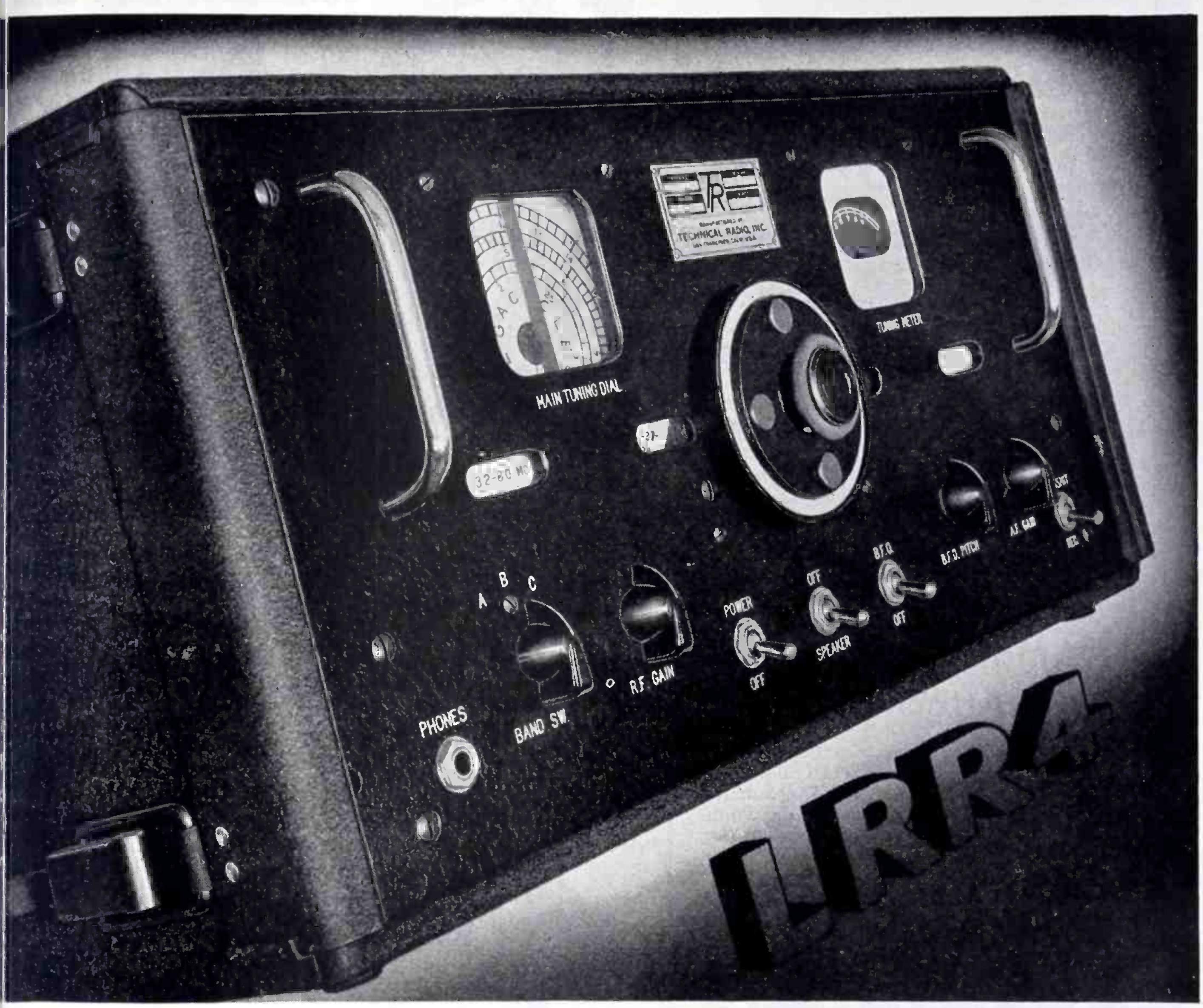
Universal Microphone Co., Inglewood, Calif., purchases the entire plant in which it has been operating under rental for the past 12 years. Included are two two-story buildings, an annex, and two stores.

Home receivers are reported to be planned as part of the postwar line of the radio division of **Bendix Aviation Corp.**

Under a system referred to as the PDQ plan, **Emerson Radio & Phonograph Corp.** is establishing preference delivery quotas for home receiver sales after production is resumed. Priority certificates are issued without cash deposit to would-be consumers who register with dealers throughout the country.

National Broadcasting Co. is starting a 50-week course in television for the engineers in its central division. Instruction will be in charge of Clarence Radius, and will parallel that previously made

Built to take it . . . *anywhere* . . . *anytime!*



● ● ● Techrad LRR-4 is built to take it under ny and all conditions. This Techrad receiver has F.C.C. pproval for low radiation, but there are many more asons why it is winning such general acceptance.

Techrad LRR-4 is built to insure uninterrupted perrmance under the most drastic conditons of service . . . *anywhere in the world.* ecause of its massive and rugged conruction, it can be counted on to get ere, and to get there intact. It will stand ansshipment on the bang-slam carriers und in remote places and be ready to go ito service upon arrival at its destination.

Techrad LRR-4 will work in any climate. It offers a high degree of resistance to tropical humidity and to tropical organisms because *LRR-4 transformers are hermetically sealed*... and *LRR-4 wiring and terminal boards are completely Anti-Fungus treated.* It will also stand up under severe duty at sea, because *LRR-4 is capable of withstanding the Salt Spray Test.* Techrad LRR-4 is available in a number of different models which cover a variety of frequency ranges.

• • • •

MASTER ENGINEERING TAKES NOTHING FOR GRANTED.

TECHRAD

Technical Radio Company

Over ten years of continuous experience

275 Ninth Street · San Francisco 3, California

Export Agents: Frazar & Hansen, 301 Clay St., San Francisco 11, California, U. S. A.

extra time on D-day, plus $2500 they would have spent on a company picnic they cancelled.

Madison Electrical Products Corp. is a new company in Madison, N. J., devoted to manufacture of resistors, electronic assemblies, coil windings, and special components.

By producing in a single plant more than 4,178,000,000 single-conductor-feet of wire, during the last 2½ years, **United States Rubber Co.** exceeds the combined industry figure for building wire in 1941.

West Coast Electronic Manufacturers Association accepts for membership six new concerns, bringing the roster above the fifty mark. The companies are **Brittain Sound Equipment Co.**, Los Angeles; **Merle F. Faber**, San Francisco; **Harvey Machine Co.**, Los Angeles; **Howard Pacific Corp.**, Los Angeles; **The Lake Mfg. Co.**, Oakland; and **Special Electric Laboratories**, Los Angeles.

Electronic equipment for the armed forces will be manufactured by approximately 2000 workers of **Western Electric Co.**, in newly leased space at 529 West 42 St., the company's fourth manufacturing plant in metropolitan New York.

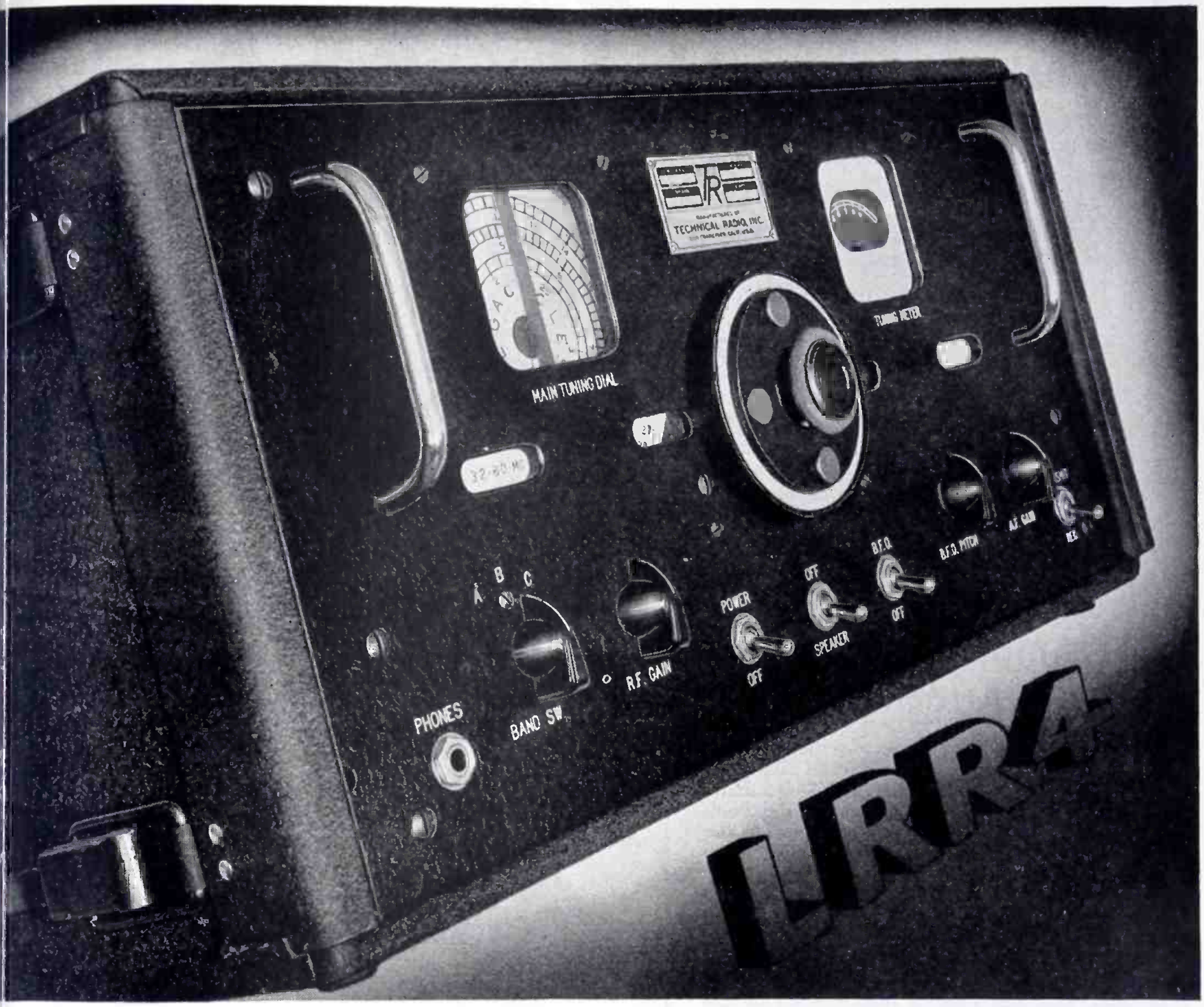
Universal Microphone Co., Inglewood, Calif., purchases the entire plant in which it has been operating under rental for the past 12 years. Included are two two-story buildings, an annex, and two stores.

Home receivers are reported to be planned as part of the postwar line of the radio division of **Bendix Aviation Corp.**

Under a system referred to as the PDQ plan, **Emerson Radio & Phonograph Corp.** is establishing preference delivery quotas for home receiver sales after production is resumed. Priority certificates are issued without cash deposit to would-be consumers who register with dealers throughout the country.

National Broadcasting Co. is starting a 50-week course in television for the engineers in its central division. Instruction will be in charge of Clarence Radius, and will parallel that previously made

Built to take it . . . anywhere . . . anytime!



● ● ● ● Techrad LRR-4 is built to take it under any and all conditions. This Techrad receiver has F.C.C. approval for low radiation, but there are many more reasons why it is winning such general acceptance.

Techrad LRR-4 is built to insure uninterrupted performance under the most drastic conditions of service . . . *anywhere in the world.* Because of its massive and rugged construction, it can be counted on to get there, and to get there intact. It will stand transshipment on the bang-slam carriers found in remote places and be ready to go into service upon arrival at its destination.

Techrad LRR-4 will work in any climate. It offers a high degree of resistance to tropical humidity and to tropical organisms because *LRR-4 transformers are hermetically sealed* . . . and *LRR-4 wiring and terminal boards are completely Anti-Fungus treated.* It will also stand up under severe duty at sea, because *LRR-4 is capable of withstanding the Salt Spray Test.* Techrad LRR-4 is available in a number of different models which cover a variety of frequency ranges.

● ● ● ●

MASTER ENGINEERING TAKES NOTHING FOR GRANTED.

TECHRAD

Technical Radio Company

Over ten years of continuous experience

275 Ninth Street · San Francisco 3, California

Export Agents: Frazar & Hansen, 301 Clay St., San Francisco 11, California, U. S. A.

available to the company's eastern personnel.

Reorganization changes **Amperex Electronic Products** to a Delaware corporation, **Amperex Electronic Corp.**, gives it an affiliation with **North American Philips Co.** Personnel, management, and policies are unchanged except that former senior partner N. Goldman has retired.

A limited partnership, **Pioneer Gen-E-Motor** transfers all its assets and liabilities to a Delaware corporation, **Pioneer Gen-E-Motor Corp.**

RCA Victor Div., **Radio Corp. of America** is using 17,000 new procedures suggested by efficiency-conscious workers since Pearl Harbor. This represents 35 percent of all ideas submitted.

In a new building at Minneapolis, Minn., **Audio Development Co.** now houses its general and engineering offices, experimental and design laboratory, and model shop. Space formerly occupied by these units is assigned to production for a 25 percent increase.

PERSONNEL

Director of communications **J. R. Cunningham** rejoins United Airlines after more than two years of active duty with the AAF.

At newly-organized Grayhill, Chicago, Ill., **W. S. Lewis** fills the post of chief mechanical engineer, while **Arnold Wassell** heads up plastic design engineering.

W. C. Walsh, formerly electrical design engineer for the Department of Agriculture, becomes district representative of the General Electric electronics department in San Francisco, Calif.

Within RMA, 12 parts group are organized under the chairmanship of **Robert C. Sprague** of Sprague Electric Co. Heads of the various sections are: **Paul Hetenyi**, capacitors, Solar Mfg. Co.; **Leslie F. Muter**, coils, Muter Co.; **J. H. Stackpole**, fixed resistors, Stackpole Carbon Co.; **R. L. Triplett**, instruments, Readrite Meter Works; **Hugh H. Eby**, sockets, Hugh H. Eby, Inc.; **W. R. MacLeod**, special products, King Laboratories, Inc.;

"The high quality of their product, which comprises telephones, switchboards and electrical supplies, has placed them in the position of the largest manufacturer of their goods in this section of the country."

... from
A CENTURY OF MERIDEN
published in 1906

If "skill to do comes of doing," this thirty-eight year old commentary explains the record of Connecticut Telephone and Electric in manufacturing telephones, switchboards, and electrical supplies for the military needs of this war.

We look forward to the *next* thirty-eight years, confident that this is the dawn of the most important era yet, in the development of communications, and every other branch of electrical science.

If our seasoned, but progressive, experience can be of help to you in connection with your communications requirements or the development and manufacture of electrical or electronic devices, we shall be glad indeed to talk with you.

CONNECTICUT TELEPHONE & ELECTRIC DIVISION

GREAT AMERICAN INDUSTRIES, INC.

MERIDEN, CONNECTICUT

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

Robert A. O'Reilly, switches, Oak Mfg. Co.; **James M. Bennan,** transformers, Jefferson Electric Co.; **Russell E. Cramer,** variable capacitors, Radio Condenser Co.; **H. E. Osmun,** variable resistors, Centralab; **Ray F. Sparrow,** vibrators, P. R. Mallory & Co.; and **R. G. Zender,** wire, Lenz Electric Mfg. Co.

At Webster Products, Chicago, Ill., **R. J. Keogh** joins the engineering staff. He has been with Colonial Radio Corp. in a similar capacity.

A. Warren Norton, new president and general manager of Press Wireless, Inc., was previously manager of the Christian Science Publishing Co. He succeeds **Joseph Pierson,** founder and former president.

Sylvania Electric Products Inc. puts **Curtis A. Haines** in charge of plants at Mill Hall and Altoona, Pa.; Huntington, W. Va.; and Lexington, Ky., as general manufacturing manager.

American Institute of Electrical Engineers elects to presidency

Charles A. Powel, manager of headquarters engineering at Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. His predecessor was **Dr. Nevin E. Funk.**

T. H. Mitchell, lieutenant colonel in the Army Communications Service, is to succeed **William A. Winterbottom,** deceased vice president and general manager of RCA Communications Inc.

At Operadio Mfg. Co., St. Charles, Ill., **Harold H. Kingsbury** is made production-control manager over the company's three plants there.

Formerly chief of the audio and industrial section of the radio and radar division of WPB, **Glenn C. Henry** joins the sound equipment

A the field of Electronics broadens and new, more complex ecipment goes into service the need for more accurate test an measuring instruments becomes greater. The war has lent gat impetus to the progress of Electronics and has accordinly accellerated the development of Electronic instruments. In the past two years have been crowded a normal ten years otechnological progress.

Tlay the most advance developments are not being released fc general use. However, today is not too soon for you to rke your plans for post-war activity. And, along that line, you shuld make note of the fact that *-hp-* engineering is in the vaguard of electronic instrument developments.

Oscillators to test wide range television channels, new high frequency signal generators, special signal generators for F. M. use, new vacuum tube voltmeters . . . all providing split-hair accuracy for more exacting measurements and ruggedly constructed to perform in the field under circumstances of war, are examples which merely hint of the better things to come.

-hp- engineering is at your service, whether your problem is immediate or for post-war. Write today, there is no cost or obligation. Direct Canadian inquiries to Atlas Radio Corporation, 560 King Street West, Toronto 2, Canada.

HEWLETT-PACKARD COMPANY

Box 927A Station A · Palo Alto, California section of Radio Corp. of Ameri where he will have responsibili for the development of produc and services.

Dr. Edward U. Condon, associa director of the Westinghouse r search laboratories is elected membership in the National Aca emy of Sciences for his work

theoretical physics. His best know contribution to this field is tl interpretation of spontaneo emission of alpha particles fro materials like radium.

John Meck Industries, Plymout Ind., has for chief engine **Charles R. Wexler**, former assis ant chief engineer at Emerso Radio & Phonograph Corp., an

C. R. Wexler

H. R. Denius

for plant manager of the elec tronic division, **Homer R. Deniu** previously chief production engi neer for the radio division o Crosley Corp.

Communications consultant to th Iranian government is the ne post of **James A. Mendenhall**, for mer consultant and liaison officia with AAF. He will have head quarters at Teheran.

Edmund A. Laport becomes staf engineer for international com munications systems and specia apparatus at RCA Victor Div Radio Corp. of America, Camden N. J. His former position of chie engineer for engineering products at Canadian RCA Victor Ltd. is filled by **James B. Knox**, previously senior engineer.

For distinguished service in the application of electricity to air-

craft, **Richard E. Stowe,** manager of the Dayton, Ohio, office, is given the Order of Merit by his company Westinghouse Electric & Mfg.

From International Resistance Corp., where he was vice president and works manager, **Leslie G**

Thomas goes to Bayonne, N. J., to be works manager of Solar Mfg Corp.

John J. Farrell is appointed engineer of the transmitter division in the electronic department of General Electric Co., Schenectady N. Y. He used to be designing engineer for the division.

Vice president and chief engineer of newly-formed Madison Electrical Products Corp., Madison, N. J. is **John G. Ruckelshaus,** who has been doing development work for the Signal Corps. Plant supervision goes to **A. L. Livera,** previously assistant chief engineer at Hardwick-Hindle Co.

John B. Huarisa becomes executive vice president in charge of production and engineering for all divisions of Admiral Corp. Chicago, Ill. Vice president in charge of the radio division is former midwest manager, **Richard A. Graver**

From the WPB office of civilian requirements, **Charles L. Saunders** goes to Wheelco Instruments Co. to be vice president. He was previously with Minneapolis-Honeywell Regulator Co. in a corresponding post.

Elections of new chairmen in the divisions of RMA include: **E. A. Nicholas** of Farnsworth Television & Radio Corp. to replace **R. C. Cosgrove** in the set division; **David T. Schultz** of Raytheon Mfg. Co. to replace **M. F. Balcom** in the tube division; and **C. J. Burnside** of Westinghouse to replace **George W. Henyan** in the transmitter division.

A PRECISION LABORATORY INSTRUMENT

EDERAL

J. H. F.
IGNAL
GENERATOR
MODELS
304-CSI

lso 804-CS2

*IR MORE DETAILED INFOR-
IATION WRITE TO DEPT. E-9*

RICE
350.00
O.B. FACTORY

Carefully and difficultly acquired experience enabled ***Federal*** to produce more Ultra High Frequency Test Signal Generators than were ever thought possible—and quickly, too.

Breaking the tightness of demand by the Army and Navy, these high quality laboratory precision instruments are available to research laboratories and industrial manufacturers engaged in the production of electronic equipment.

Your inquiries are invited.

CARRIER FREQUENCY RANGE: 7.6 to 330 megacycles plus or minus 2%, direct-reading in 5 bands, 6th band available for use with blank coil form supplied.

OUTPUT VOLTAGE RANGE: Calibrated Attenuator continuously variable from 1 to 20,000 microvolts, accuracy plus or minus 10%.

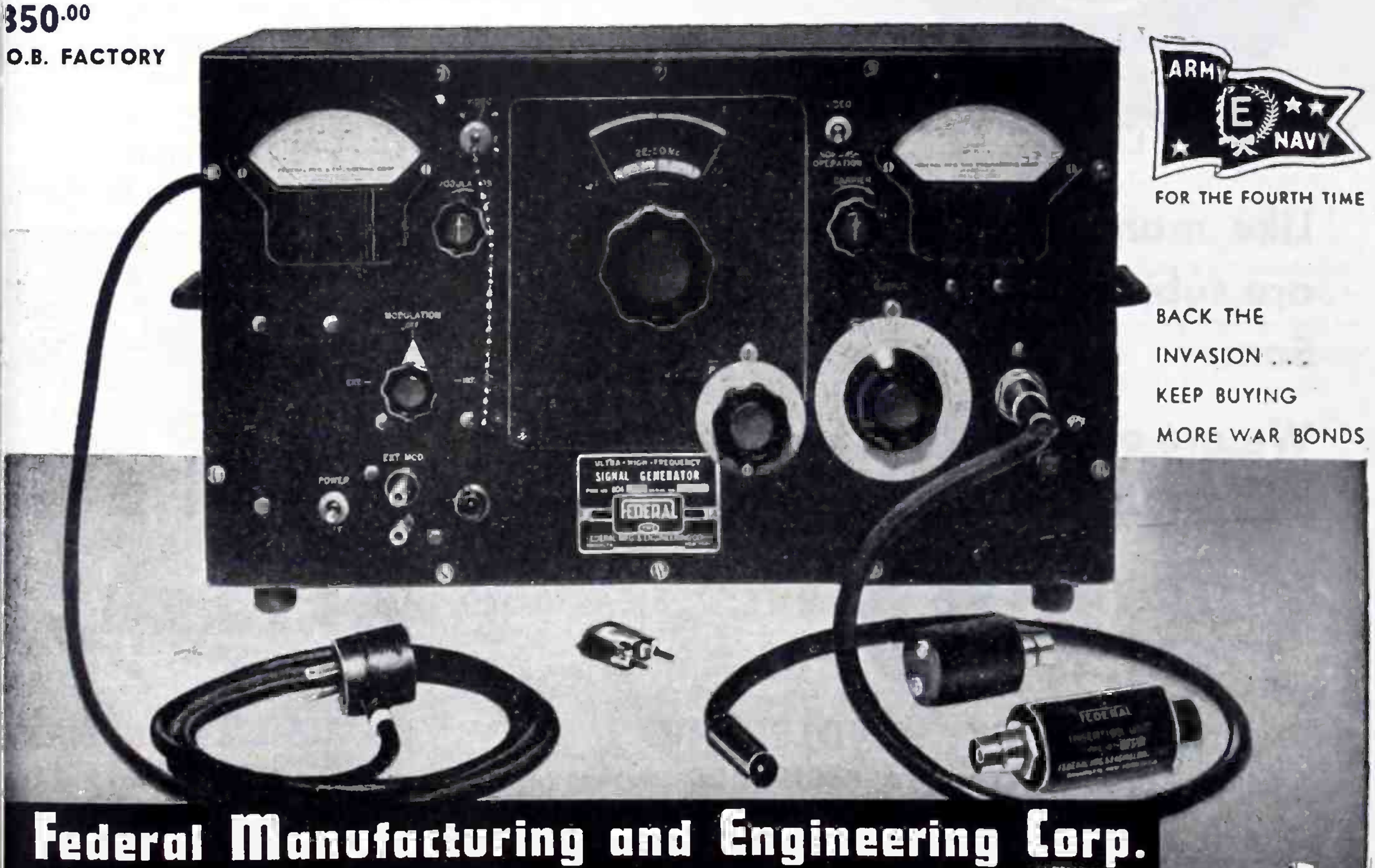
MODULATION: Internal Modulation 1,000 cycles; external modulation up to 20,000 cycles; 0 to 60% direct-reading modulation meter.

STRAY FIELD LEAKAGE: Held to a minimum by Improved shielding and R.F. Filters.

VIDEO OR PULSE MODULATION: Can be pulse modulated externally with signals having very steep wave fronts.

VOLTAGE REGULATED POWER SUPPLY: 115 or 230 volts, 40 to 60 cycles, single-phase.

Manufactured by arrangement with the General Radio Company of Cambridge, Massachusetts, and in accordance with their designs.



ARMY E NAVY

FOR THE FOURTH TIME

BACK THE INVASION . . .
KEEP BUYING
MORE WAR BONDS

Federal Manufacturing and Engineering Corp.

Manufacturers of Federal Photographic Equipment and Federal Electronic Devices

BROOKLYN 5 NEW YORK

Broadcast Relay System

(*Continued from page* 97)

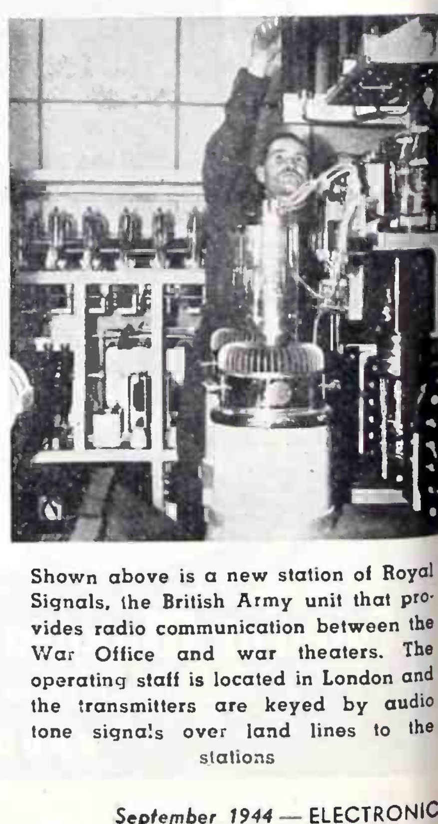
future units will be equipped with a readily removable loudspeaker unit and an additional volume-indicator meter. This extension unit could then be mounted at a point somewhat remote from the transmitter and convenient to the operator where he could control the level of the monitor speaker or switch over to the meter alone if answering the telephone, handling telegrams or conducting other business.

The twelve units now in operation have exceeded expectations in regard to coverage and very little time has been lost due to tube and equipment failure. When the suggested conversions have been made the time lost due to equipment and tube failures will be further reduced and should not exceed two to three hours per unit per year.

The idea of serving remote listeners by means of a number of small transmitters was originally conceived by the CBC's chief engineer, Mr. G. W. Olive. Co-operating with the author in the development of the project were Messrs. J. A. Ouimet, H. M. Smith, W. G. Richardson and R. D. Cahoon of the CBC's Engineering Division.

• • •

BRITISH COMMUNICATIONS



Shown above is a new station of Royal Signals, the British Army unit that provides radio communication between the War Office and war theaters. The operating staff is located in London and the transmitters are keyed by audio tone signals over land lines to the stations

For mobile two-way communication specify KAAR RADIOTELEPHONES

KAAR PTL-10X TRANSMITTER

10 WATTS · 1600-2900 KC*

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

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

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

◀ KAAR AUTO-LOAD ANTENNA

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

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

KAAR 11X RECEIVER

6 TUBES · 1600-2900 KC*

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

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

KAAR

ENGINEERING CO.

PALO ALTO, CALIFORNIA

KAAR ENGINEERING CO.

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

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

Generator of Microwaves

(*Continued from page* 115)

on the transplantable sarcoma of the mouse.

Out of a total of 43 white mice of mixed strain, inoculated with A. 80, 28 mice were treated against 15 kept as control. The mice were irradiated on the whole body as they moved freely inside a jar positioned under the radiant unit. Out of the 28, 18 mice recovered, indicating after the third application of the rays a reduced activity with increasing hardness and dryness of the sarcoma, which at the end always fell from the body of the mouse as an ordinary scab. The balance of 10 mice died.

Interesting is the fact that the dessication occurred without any apparent thermal effect outside or inside the mouse's body. Out of the 15 control mice, 13 died and 2 recovered although, in the latter one, the tumor, growing smaller and smaller, continued to remain soft and active until reabsorbed. Due to the war emergency in June, 194 the experiments had to be discontinued.

The author wants to thank Dr. Walter Toscanini and his friends who financed the construction of the apparatus; Dr. Lenz, former Chief of the Division of Cancer, New York City, who supplied the mice and the laboratory facilities; Dr. DeGregorio, also formerly with the Cancer Division, for his continuous interest and presence during the performance of the experiments and Prof. W. C. Ballard, Jr., of Cornell University who revised the present paper.

Bibliography

Arcadiewa, A. Glagelowa, *Physik Zeitschr.* 24, p. 153, 1924.

Bose, J., *Jour. Asiatic Soc. of Bengal*, Calcutta, **LXIV**, Part II, p. 231, 1895.

Bousse, H., "Ondes Hertziennes," E. Delagreve, Paris, 1925.

Hertz, H., *Wied. Ann. der Physik und Chemie*, p. 181, 1887.

Hollmann, H. E., "Physik und Technik der Ultrakurzen Wellen," Ed. Julius Springer, Berlin, 1, 2, 1936.

Lewitsky, M. A., *Physik Zeitschr.*, 2 p. 107, 1924; 27, p. 177, 1926; 28, p. 82 1927; 35, p. 361, 1934.

Ludenia, W., *Elektrik. Nachr. Technik*, p. 248, 1929.

Righi, A., *Rendiconti Regia Accad. di Lincei*, 5, p. 505, 1893.

IN 1943, the Signal Corps purchased ten times the dollar value of communications equipment sold in this country in 1940.

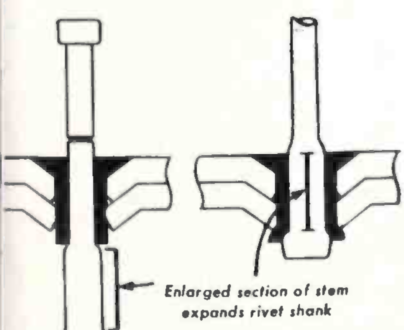
that makes CHERRY RIVETING *so tight, so strong, so durable*

The high resistance to shear and fatigue found in the self-plugging Cherry Rivet is due to the Cherry principle of application—shank expansion.

The stem pulled into shank in the upsetting action, forces the sides of the rivet into the material that is fastened. This, for practical purposes, forms a tight, solid rivet that stays firm even under excessive strain and vibration.

No special locking device is required.

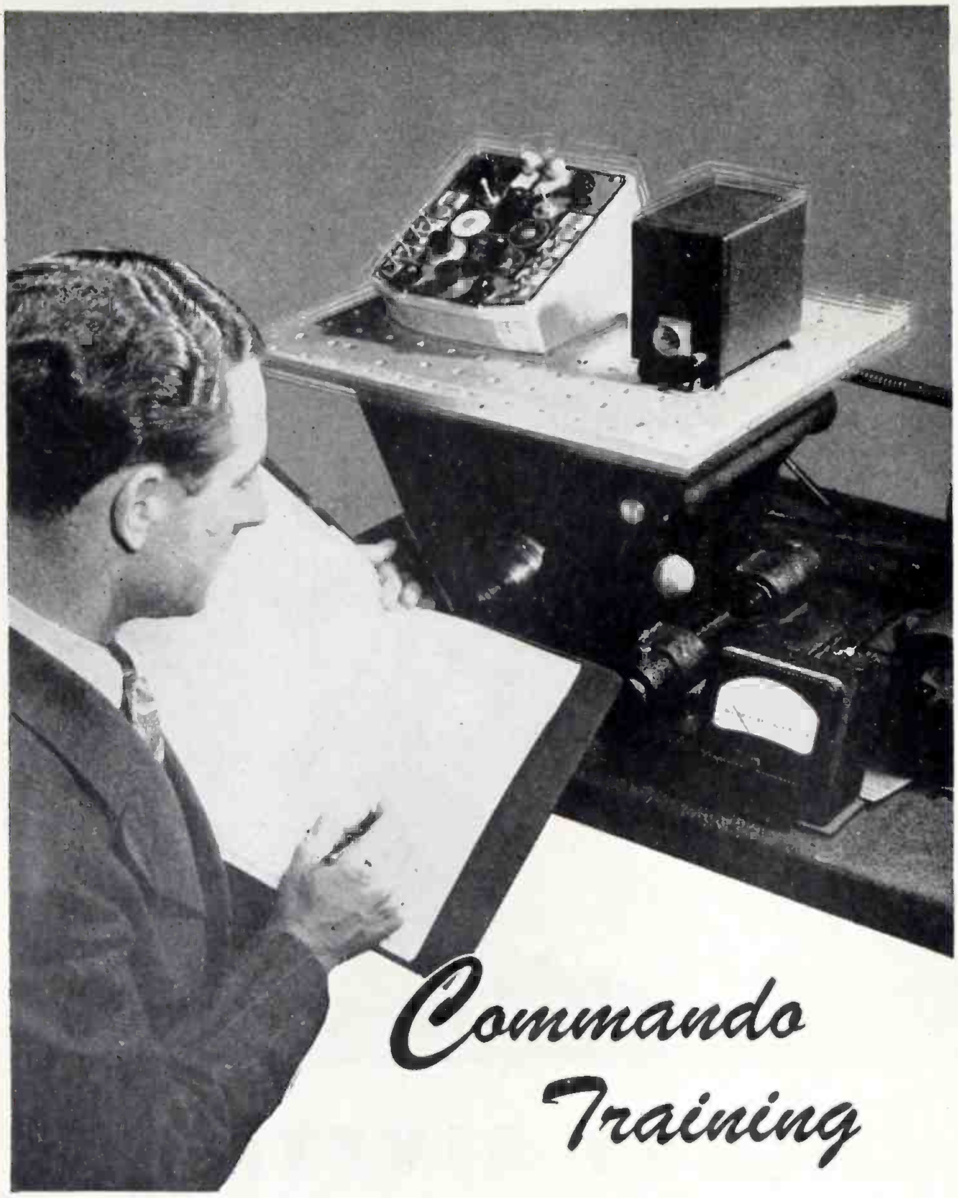
Cherry rivets have, for blind rivets, wide tolerance in hole size and grip length. The patented "pull head" on the Cherry Rivet stem gives a positive grip for the tool, makes it fast and easy to insert, keeps the rivet parts correctly assembled at all times.



CHERRY RIVETS, THEIR MANUFACTURE AND APPLICATION ARE COVERED BY U. S. PATENTS ISSUED AND PENDING

you are interested in making tough jobs easier the Cherry Rivet Handbook. (Ask for A-43.) may point the way to time and money saving your plant. Address your request to Department 120, Cherry Rivet Company, 231 Winston Street, Angeles 13, California.

Cherry Rivet *Company*
LOS ANGELES, CALIFORNIA



Petroleum Research

(*Continued from page* 140)

recently it has been shown that i styrene or conjugated diolefins ar removed, the analysis can be mad on the total octane cut (250–29 deg F).

Absorptions in this wavelengt region are caused by electron transitions related to the resona ing groups within the molecule. I aromatic compounds with aliphat side chains these resonating grou are in the nucleus or ring portio of the molecule. Thus, altering th position of the side chain on th ring (o-, m- and p-xylenes) adding side chains (toluene is be zene plus a methyl group) usual causes a marked difference in th ultraviolet absorption spectru But increasing the length of th side chain has less effect upon th spectrum.

For analysis, a weighted qua tity of sample is diluted with a no absorbing solvent such as isoocta and placed in an absorption c with quartz windows. Ultraviol light, preferably from a continuo source such as a hydrogen lamp, passed through the sample cell, di persed by a quartz prism, and th resulting spectrum examined to d termine regions of absorption.[13]

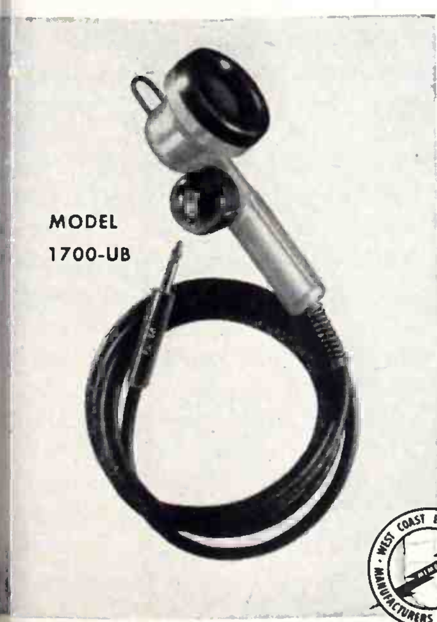
The spectrum may be phot graphed, but small ultraviolet mo ochromators are available whic detect and measure the spectru by means of phototubes. These a preferred for routine analysis f several reasons. First, photograp and all its accompanying equi ment and trouble is eliminated. Th phototubes measure the intensit of the ultraviolet light directl Secondly, once a method is devise for a given analysis, it is usuall not necessary to examine the who spectrum but merely necessary t measure the transmission at a fe specific wavelengths. The phot electric instrument may be faste in such cases.

Emission Spectroscopy

The region from about 10 t 2,000 Angstroms in the electromag netic spectrum is not of industri importance at present largely be cause of experimental difficultie In this region air, quartz, and eve

History of Communications Number Seven of a Series

EARLY COMMUNICATIONS BY AIR



While electronics use the ether and other media, one of the most speedy methods of communications in the early days was through the air by carrier pigeon. With a finely printed note fastened to the leg, these birds faithfully reached home to bring in the latest news events and stock market reports.

Today news commentary reaches into your homes in a flash of a second via electronic voice communications making use of the various types of Universal broadcast microphones. This being a modern age, the battle front is brought into the homes of the informed peoples of the democracies via military microphones such as those now being manufactured by Universal for the Allied Armed Forces.

< Model 1700-UB, illustrated at left, is but one of several military type microphones now available to priority users through local radio jobbers.

WEST COAST ELECTRONIC MANUFACTURERS ASSOCIATION

UNIVERSAL MICROPHONE COMPANY

INGLEWOOD, CALIFORNIA

FOREIGN DIVISION: 301 CLAY STREET, SAN FRANCISCO 11, CALIFORNIA ·· CANADIAN DIVISION: 560 KING STREET WEST, TORONTO 1, ONTARIO, CANADA

the gelatin in photographic plat absorbs the radiation. Howev the spectrum from 2,000 Angstro through the visible region (rougt 4,000 to 8,000 A) up to 12,000 An stroms can be recorded on pho graphic plates. Many years a phenomena observed in this regi formed the basis for the interp tation of modern atomic theory

Everyone is familiar with t rainbow. This visible spectr (the separation of white light i its component colors), which in t case of the rainbow is produced water droplets in the sky, is mc readily produced in the laborato by means of prisms or finely rul gratings. The spectrum also c tains light invisible to the eye.

One commercial emission spect graph, in use in the Socony-Vacu laboratories, uses a prism to se arate the ultraviolet, visible a near infrared (2,000 to 10,000 into component wavelengths. T prism used most frequently is quartz and gives high dispers (wavelength separation) in the traviolet. A glass prism may substituted for the quartz to i crease the dispersion in the visit and near-infrared regions. So investigators prefer instrumen which use finely ruled gratings the diffracting medium. The di persion of grating instruments do not vary with wavelength.

If an unknown sample is burn and the light given off analyzed a spectrograph, the elements pre ent in the sample can be determine Under proper conditions, atoms any element will emit characterist light. Such light is emitted wh the outer electrons of an atom a disturbed or made to change e ergy levels. The metallic and meta loid elements can be readily excit by thermal energy supplied by flame, arc, or spark. The no metallic elements are more difficu to excite. Spectra or characterist light of the non-metals is usuall excited by ionization in a gaseo discharge.

Industrially, then, emission spe trography is primarily useful fo the exact and infallible identifica tion of the metals and metalloid (phosphorus, arsenic, antimon and bismuth). It is especially use ful in the determination of thes elements where they may be presen in very low concentrations. Most o

unlimited frequency selection

No. 540 AMPLIFIER EQUALIZER

·over two critical ranges: 20 to 100 cycles; 4,000 to 10,000 ·cles with an available boost of 0 to 20 db.

Unlimited frequency selection — an unusual operational ·vantage offered by the equalizer unit of the Fairchild ·nplifier-Equalizer — compensates for brilliance-loss at the ·ower 33.3 speed and for response-deficiencies of cutterhead, ·sc material, pickup, or speaker by electronically boosting the ·gher frequencies from 4,000 on up to 10,000 cycles — with ·negligible effect on volume and without loss in the bass.

With a Fairchild Amplifier-Equalizer and two No. 539 ·airchild Recorders, it is possible to record or play back ·ntinuously; to make duplicate records; or to "dub" from one table to the other. Wherever extreme flexibility, low noise level, low distortion content and fine frequency response are professional requirements, the one answer is the Fairchild Amplifier-Equalizer.

All Fairchild sound instruments are built to meet the exacting professional requirements of the radio and communications fields. To electronic skill Fairchild has added the plus of exceptional mechanical skill — skill long practised in .0002" tolerance production of aerial and gun cameras, and aircraft computing gunsights.

Descriptive and priority data are available.

SOUND EQUIPMENT

FCI

Fairchild **CAMERA**
AND INSTRUMENT CORPORATION

·8-06 Van Wyck Boulevard, Jamaica 1, N. Y. • *New York Office:* 475 Tenth Avenue, New York 18, N. Y.

·OUND EQUIPMENT—*PRECISIONIZED*—mechanically and electronically—*FOR FINER PERFORMANCE*

the metallic elements can be positively and readily detected when present at only a few parts per million of the total sample. Elements which are difficult to identify uniquely by chemical means, as for example the alkali elements, are easily distinguished spectographically. It has been stated that no metal has ever been made so pure that the spectrograph could not find impurities present.

Quantitative analyses for the metals and metalloids can be made by spectrographic methods[14, 15, 16]. The sample is burned, the spectrum recorded, and the photograph developed under rigorously controlled conditions. The optical density of chosen lines is measured on a microphotometer and compared with those from known samples of approximately the same composition.

To summarize, if samples are of a kind that must be burned in a direct-current arc, then the quantitative accuracy will probably not exceed ± 10 percent of the amount of the element present. For example, if magnesium were present in a clay catalyst at 10 percent, spectrographic methods would report it as 10 ± 1 percent at best. However, if it were present at 0.01 percent it might be reported as 0.010 ± 0.001 percent.

Quantitative spectrographic methods are especially useful to determine metallic elements in low concentration, where the accuracy of the spectrographic method usually exceeds other analytical methods. If a large number of analyses of a given kind are to be made, then spectrographic methods are rapid and time saving.

Certain metallurgical analyses are made spectrographically wherein the sample is burned in a carefully controlled spark source. The analytical results often equal, or are better than, those obtained by wet chemical methods and the time saved by the spectrographic method is almost unbelievable. Alloy steels have been analyzed to determine the concentration of some six elements and the results reported within a quarter of an hour after the sample is received.

X-Ray Diffraction

X-ray diffraction provides a means for the unique identification of crystalline materials. Just as a

THIS PIVOT PROVES A POINT

THIS unretouched photomicrograph, approximately 50 times actual size, shows pretty clearly what we ean by the value of experience, when it comes to the aking of electrical instruments and testing equipment.

Pivots play an important part in determining an in-rument's life and accuracy. In the Simpson-made pivot ove, you have what is truly a masterpiece of its kind . perfect in contour . . . all surfaces brilliantly pol-hed to prevent rusting . . . rounded end properly cor-lated with radius of jewel to minimize friction and ithstand vibration and shock . . . heat-treated for an iusual combination of strength and hardness.

The obvious explanation for this excellence rests in ie fact that Simpson employs some processes others do ot, and safeguards every step of manufacture by the nest and most complete control modern science can rovide. But in the final analysis, it is only Simpson's ng experience which makes such a pivot possible.

That experience reaches back more than 30 years. rom it has come new shortcuts in manufacture, new finements in design, which today permit Simpson to ake "instruments that stay accurate" in greater volume ian ever before. From this long specialization has come o a sound basis for further advance; in your postwar impson Instruments you will see still more forcefully ie value of this experience.

SIMPSON ELECTRIC CO.
5200-5218 Kinzie St., Chicago 44, Ill.

Simpson

INSTRUMENTS THAT STAY ACCURATE

Buy War Bonds and Stamps for Victory

human fingerprint serves to identify a particular person, an x-ray diffraction pattern is a fingerprint of a crystalline material. This is possible because the distance between the atomic building blocks in crystalline materials is of the same order of magnitude as the distance between wave crests in an x-ray beam. Thus the atomic building blocks can act as diffraction centers and the crystalline material as a diffraction grating for an x-ray beam.

Specific examples of the use of x-ray diffraction in a petroleum laboratory include the identification of inorganic deposits found on valves, bearings, oil filters and other engine parts. Approximately 95 percent of the inorganic materials encountered will yield an x-ray diffraction pattern by means of which it may be possible to identify them. Other industries find the x-ray method extremely valuable in determining the structure of metals and alloys.

Electron Diffraction

The electron diffraction method as applied to industrial petroleum problems is very similar to the x-ray diffraction method. As the name implies, electron waves are diffracted rather than x-rays. Electron waves are slightly shorter in wavelength than x-rays but, unlike electromagnetic radiation of similar wavelength, electron waves do not have the intense penetrating power of x-rays or gamma rays. Electron diffraction supplements x-ray diffraction when it is desired to study surface phenomena which may be too thin to be detected by means of x-ray diffraction.

Electron Microscopy

In the past several years electron microscopes have become available which make it possible to see objects far smaller than can be resolved in ordinary microscopy. In electron micrography, electron waves travel similarly to light rays in an ordinary microscope except that in place of glass or quartz lenses the electron microscope substitutes electrostatic or magnetic fields. The maximum resolution possible at present probably does not exceed 0.01 microns (0.000,001 cm or 100 A). However, another feature of the electron microscope


JAMES KNIGHTS
Crystals
THE JAMES KNIGHTS CO.
FREQ. 1000KC
TYPE T-9-A
SANDWICH, ILLINOIS
A Habit With Us--
HERMETICALLY SEALED
ETCHED Crystals
The engineers of the James Knights Company pioneered in the development and manufacture of *Etched* quartz crystals. For some time now, we have been supplying quantities of these definitely better type crystals in hermetically sealed holders. James Knights *Etched* Crystals are available to improve the performance of your equipment. Catalog on request.
BUY WAR BONDS FOR VICTORY!
The JAMES KNIGHTS Co.
SANDWICH, ILLINOIS
JK
CRYSTALS
CRYSTALS FOR THE CRITICAL

which is very important is the remarkable depth of focus found in electron micrographs, which thus reveal more detail than could be seen heretofore under similar magnification by other methods.

X-Ray Microradiography

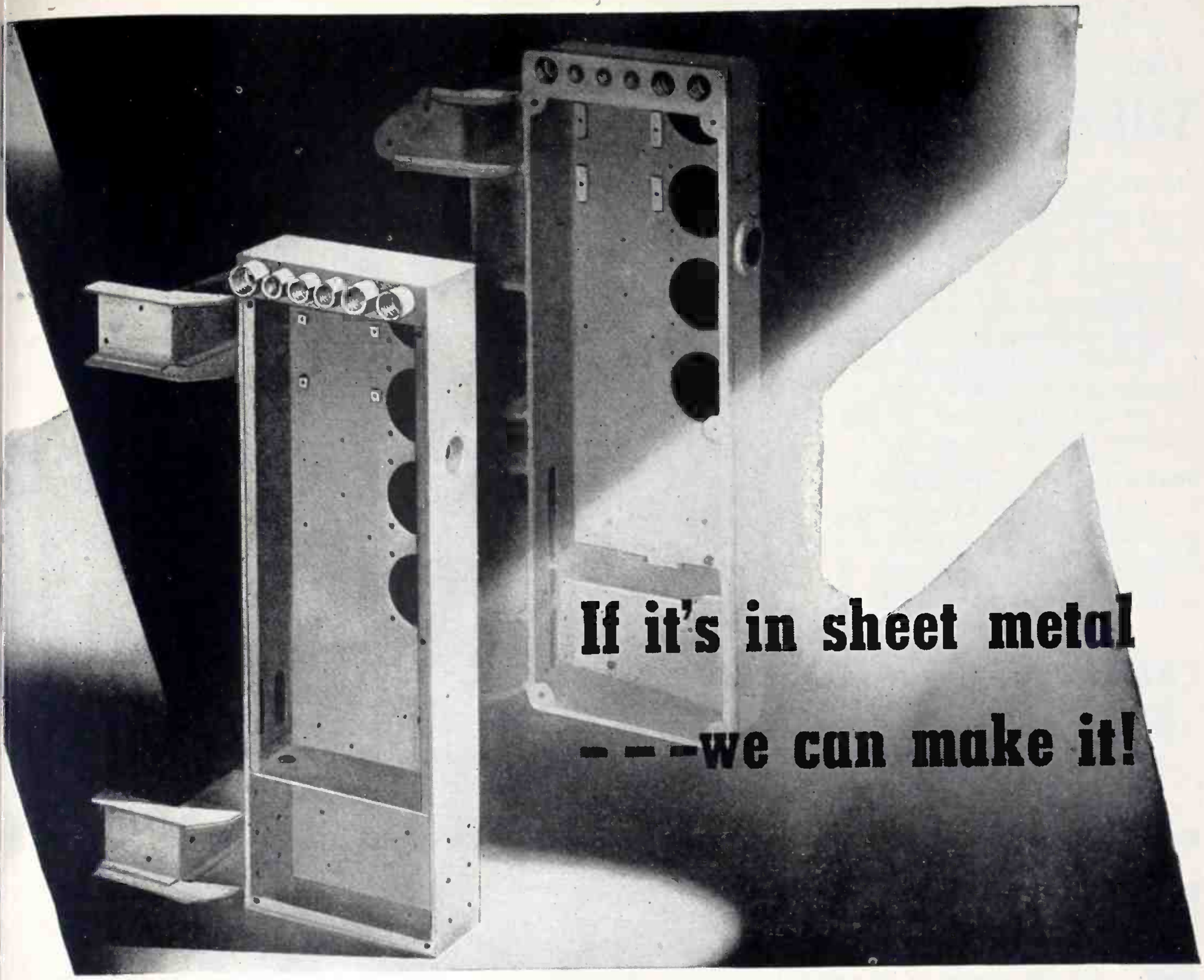
A relatively little known but potentially useful technique is that of x-ray microradiography. Microradiographs of thin sections of any material may be obtained using techniques similar to that of inspecting castings, welds, etc. except that the specimen is very thin and the film is capable of extreme enlargement. The pictures obtained are truly microradiographs, for the original is usually ½ inch or less in diameter and sections of this are then enlarged about 300 times.

This microradiographic technique supplements the optical microscope in metallurgical and other industrial applications, with several advantages; it gives a three-dimensional view of the specimen; does not depend on differential action of etchants but only on the variations in absorbing power of constituents, including internal voids and cracks; requires no special polishing of the specimen; and can be incontrovertibly interpreted. The

• • •

BRITISH RADAR

Somewhere in England, Craftswoman Doris Birt overhauls part of a radiolocation receiver for the AA Command



For Example . . . KARP was assigned the task of converting from cast aluminum to sheet steel a junction box in which are connected all wires operating an anti-aircraft searchlight. These are the results:

Manufacturing . . .
a sheet metal product was produced with standard equipment without any special dies.

Quality . . .
the KARP-produced junction box has greater strength, is lighter in weight, and is better looking.

Conservation . . .
critical material and vital machine tool time were saved, with no loss in the efficiency of the unit.

Savings . . .
in production costs and actual man hours, in addition to speeding up deliveries.

If it's in sheet metal, KARP can make it. The scope of KARP's service can be fully appreciated only when you see KARP on your production problem.

ARTISANS IN SHEET METAL

KARP METAL PRODUCTS CO., INC.

CABINETS CHASSIS RACKS PANELS

124 30th STREET • BROOKLYN 31, N. Y.

Wastepaper is America's No. 1 Critical Material . . . Save Every Scrap

major difficulty lies in obtaining a specimen section 0.010 inch or less in thickness from the material to be inspected.

References

(1) Radio Power for Processing Chemical Materials, *Ind. Eng. Chem.*, 36, p. 440-7, 1944.

(2) Planning Tomorrow's Electronic Highways, *General Electric Review*, 47, p. 15-21, 1944.

(3) Mass Spectrometer Aids Research, ELECTRONICS, p. 120-4, Nov. 1943.

(4) Mass Spectrometer as an Analytical Tool, *Ind. Eng. Chem.*, Anal. Ed., 15, p. 541-8, 1943.

(5) The Raman Effect, *Rev. Modern Phys.*, 15, p. 111-73, 1943.

(6) Identification of Paraffins, Analysis of Paraffinic Mixtures by Means of Raman Spectra, *Ind. Eng. Chem.*, Anal. Ed., 12, p. 191-4, 1940.

(7) Photoelectric Detection and Intensity Measurement in Raman Spectra, *J. Optical Soc. Am.*, 32, p. 390-6, 1942.

(8) Barnes, Gore, Liddel and Williams, "Infrared Spectroscopy", Reinhold Publishing, N. Y., 1944.

(9) Synthetic Rubber, A Spectroscopic Method for Analysis and Control, *Ind. Eng. Chem.*, Anal. Ed., 15, p. 83-90, 1943.

(10) A Spectrophotometric Method for the Analysis of Multicomponent Mixtures and Its Infrared Application, *J. Applied Physics*, 14, p. 418-28, 1943.

(11) The Ultraviolet Absorption Spectra of Aromatic Hydrocarbons, *Chem. Rev.*, 32, p. 1-47, 1943.

(12) Drying Oils and Resins, Ultraviolet Absorption Study of Esters of the Acids of Drying Oils, *Ind. Eng. Chem.*, 32, p. 963-9, 1940.

(13) A Quartz Photoelectric Spectrophotometer, *J. Optical Soc. Am.*, 31, p. 682-9, 1941.

(14) Brode, W. R., "Chemical Spectroscopy," John Wiley & Sons, N. Y., Second Edition 1943.

(15) Gibb, Jr., T. R. P., "Optical Methods of Chemical Analysis," McGraw-Hill, N. Y., 1942.

(16) Sawyer, R. A., "Experimental Spectroscopy," Prentice-Hall, N. Y., 1944.

(17) Clark, G. L., "Applied X-rays," McGraw-Hill, N. Y., 3rd edition, 1940.

(18) Symposium on Optical Methods for the Study of Molecular Structure, X-ray Diffraction Method, *J. Optical Soc. Am.*, 30, p. 369-73, 1940.

(19) Technique and Applications of Industrial Microradiography, *Ind. Eng. Chem.*, Anal. Ed., 14, p. 676-83, 1942.

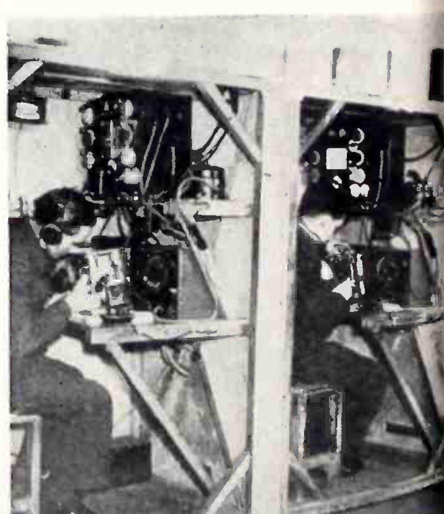
(20) The Electron Microscope, I. Principles; *Petroleum*, London 7, p. 41, 1944.

(21) Bibliography of Electron Microscopy, *J. Applied Physics*, 14, p. 522-35, 1943.

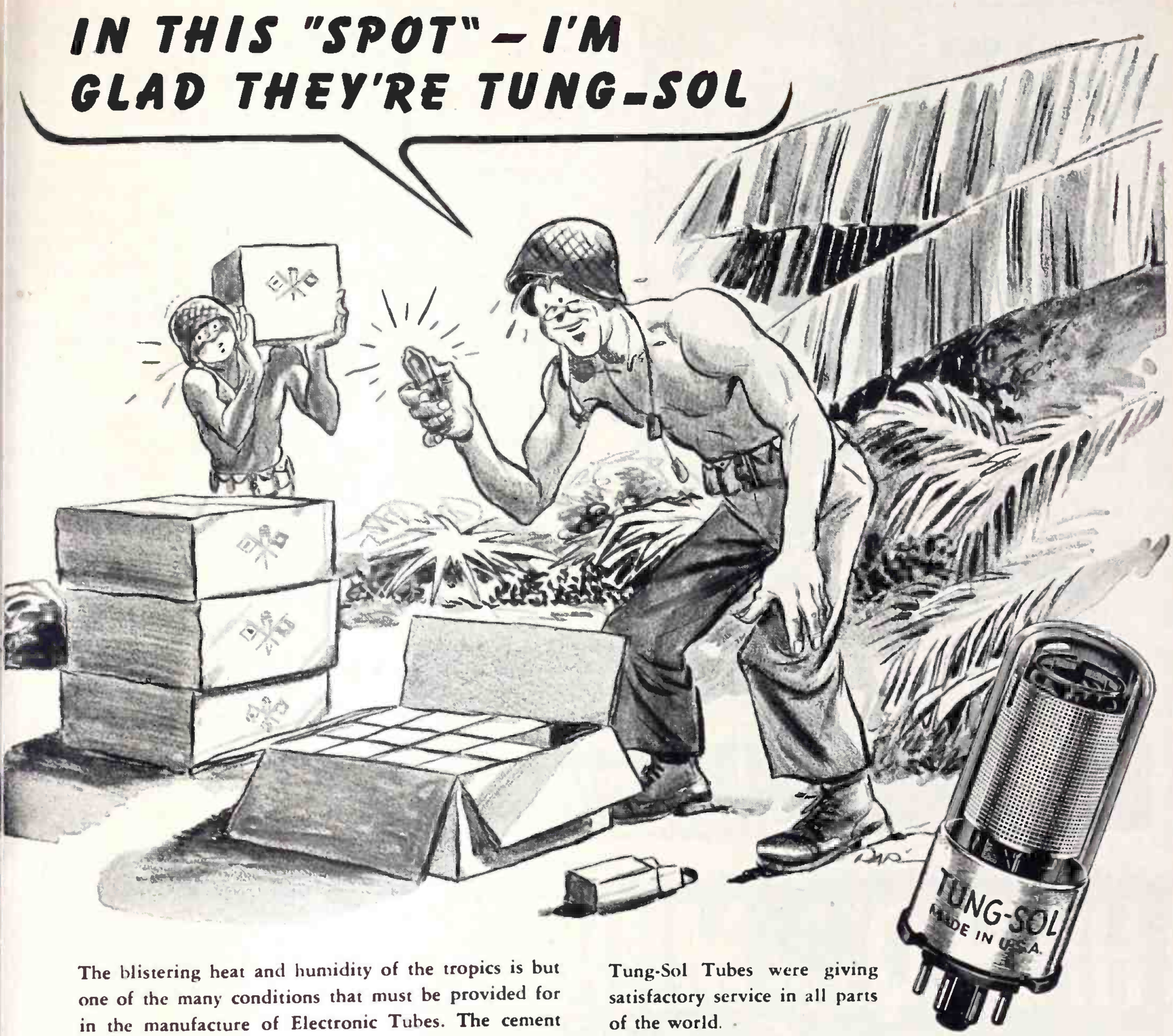
(22) Electron Microscopy in Chemistry, *Ind. Eng. Chem.*, 35, p. 450-8, 1943.

• • •

RAF RADIOMEN



Separate cubicles simulate the radio room of a plane and help train RAF signal cadets to find troubles in radio equipment under crowded conditions



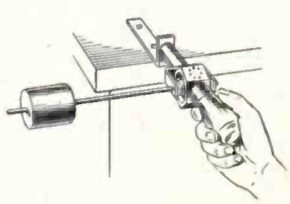
The blistering heat and humidity of the tropics is but one of the many conditions that must be provided for in the manufacture of Electronic Tubes. The cement used to secure the bases to the glass must not loosen under the high temperatures and humidity. This is why the Army and Navy insist on a rigid "torsion-test" of all bases and top caps.

A tough test . . . sure it's tough . . .

The importance of the resistance of the cement, to heat and humidity, has always been recognized by Tung-Sol quality control engineers. Before the war, Tung-Sol Tubes were giving satisfactory service in all parts of the world.

Many new types of tubes for sending, receiving and amplifying have been developed that will be available to civilians. War has proved the dependability and efficiency of TUNG-SOL Electronic Tubes. While present facilities are now devoted entirely to war work, our engineers are interested in your plans for post-war products that will use Electronic Tubes.

THE "TORSION-TEST" FOR SECURITY OF BASES



The tube is subjected to tropic-like heat and humidity for 18 hours, then room temperature for one hour. It is then inserted in a swivel base with a weighted arm. The tube must withstand this terrific twisting strain without the base becoming loose from the glass.

TUNG-SOL

vibration-tested

ELECTRONIC TUBES

ARMY E NAVY

TUNG-SOL LAMP WORKS INC., NEWARK 4, NEW JERSEY

ALSO MANUFACTURERS OF MINIATURE INCANDESCENT LAMPS, ALL-GLASS SEALED BEAM HEADLIGHT LAMPS AND CURRENT INTERMITTORS

Vacuum Capacitors

(*Continued from page 127*)

air device, with a low-frequency capacitance of 100 $\mu\mu$f may exhibit a rise in effective capacitance of about 30 percent at 50 Mc.[7] For a given capacitance and voltage rating, a vacuum capacitor is much smaller in size than an air unit and has far less self-inductance. Therefore, its net change of capacitance with frequency—even at very high frequencies—is very slight.

Effects of humidity and fungus growths are critical in tropical regions. Plates of variable air capacitors often require daily cleaning for removal of corrosion and fungus both of which can cause transmitter failure. Some types of fungi secrete a corrosive fluid which not only attacks metal, but also unglazed ceramics and most other types of insulating materials. The vacuum capacitor may eventually find wide application in tropical climates because it requires a minimum of maintenance.

Vacuum Capacitor Applications

Vacuum capacitors are particularly suitable for transmitter tank applications where high voltages are involved and where space is at a premium. Resonant frequency of the tank circuit can be varied in the inductive component.

Where a short transmitting antenna is used at medium or high power input, the vacuum capacitor can be employed to good advantage for antenna coupling, because of the unusually large rf potential developed. Series-parallel combinations make up an unusually compact, stable capacitor bank where high potentials are involved.

In aircraft equipment, vibration-proof construction, small size and stable voltage ratings are a considerable asset. This type of capacitor may also be of value in uhf installations where precise, unchanging capacitance is essential. They may find further application in many kinds of precision apparatus, in which frequency stability is particularly important.

Pressurizing With Gas

Gas-filled capacitors, feature high voltage ratings by utilizing

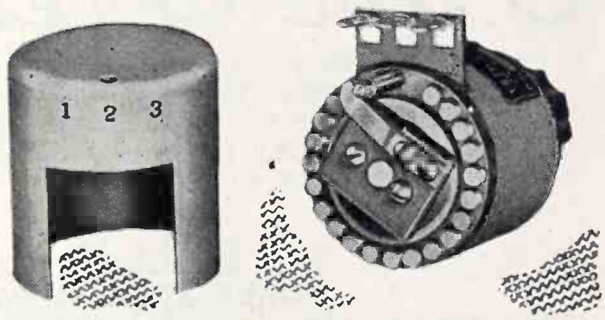
To meet your most exacting requirements . . .

ATTENUATORS by TECH LABS . . .

T-PAD ATTENUATORS

TYPE 700 Attenuators embody all improvements made during the war on our former Type 95 units. These improvements include silver contacts; improved die cast detent housing and detent gear which will stand up for a half million revolutions and more; special wiper springs of stainless silver which keep contacts clean and eliminate the necessity of periodic cleaning, and also greatly improves the noise level. In addition, the rotor hub is pinned to the shaft, preventing unauthorized tampering and keeping the wiper springs in perfect adjustment. Write for Bulletin No. 431.

MIDGET ATTENUATORS



TYPE 600 Midget Attenuators represent a crystallization of all the improvements and experiments made during the war. These units also have silver contacts and special silver alloy wiping springs which stay bright and clean and reduce maintenance and noise level. The hubs are also pinned to the shaft and all other parts are as rugged and mechanically perfect as is possible in this small size. Write for Bulletin No. 431.

These units can also be furnished as Ladders, Potentiometers, Dual Potentiometers and Tandem units.

CONSULTATION SERVICE . . .
You are invited to consult with our Engineering Department on your "special design" problems.

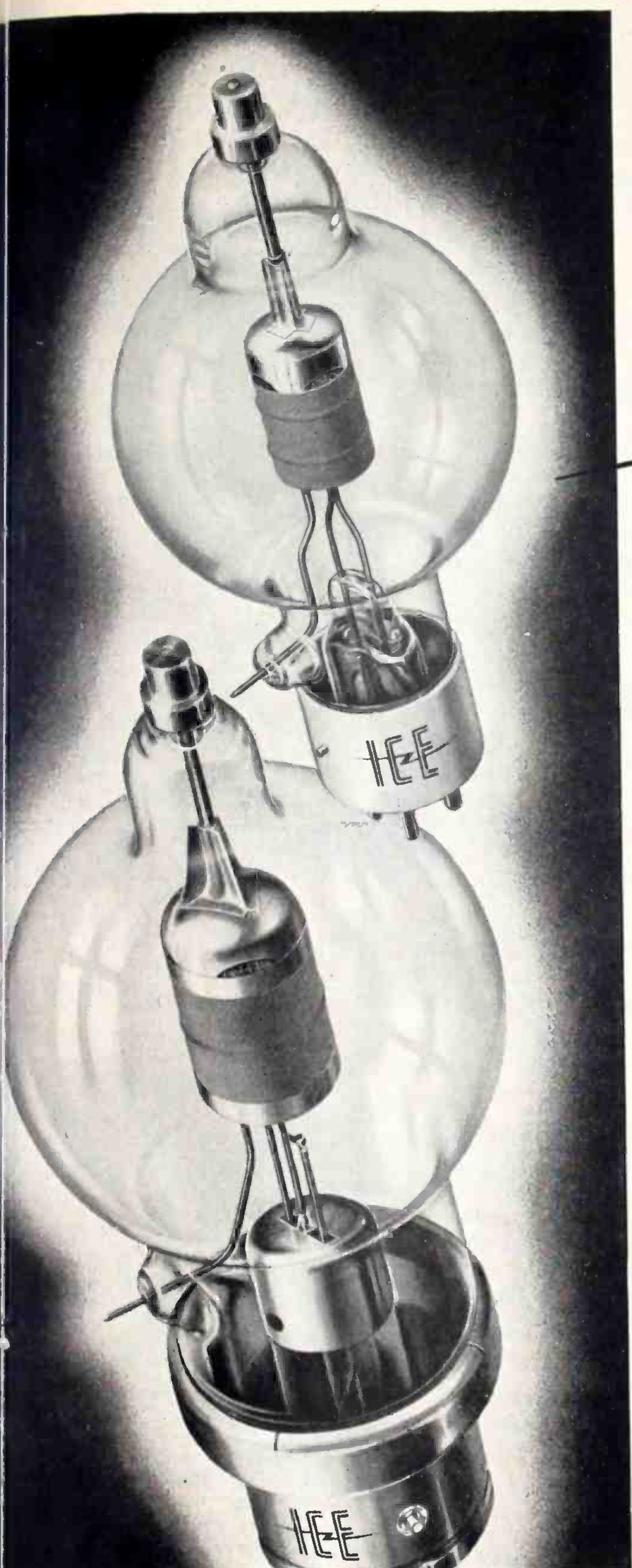
PATS. APP. FOR

TECH LAB. MICROHMMETER . . .
gives direct and instantaneous readings of resistance values down to 5 microhms and up to 1,000,000 megohms. Furnished in two models. Accuracy in all measurements to better than 2%. Entirely AC operated. Write for Bulletin No. 432.

TECH LABORATORIES

7 LINCOLN STREET, JERSEY CITY 7, N. J.

MANUFACTURERS OF PRECISION ELECTRICAL RESISTANCE INSTRUMENTS



I. C. E. 250th • I. C. E. 100th

ICE
...the Symbol of PRECISION manufacturing

MORE DEPENDABLE TUBE PERFORMANCE

"Precision" is something more than a motto at I. C. E. "Precision" I. C. E. tubes must be *right*... consistently *right*... long-lived and dependable. I. C. E. engineers don't believe in "good enough"... they're constantly searching... experimenting... striving for even better tube performance.

Right now the war effort is claiming most of our production facilities... but we do have a limited number of precision-engineered electronic tubes, ready for delivery. Whether your problem be radio transmitting or industrial application... we invite your inquiries.

ICE
ELECTRONIC TUBES

INDUSTRIAL & COMMERCIAL ELECTRONICS
BELMONT, CALIFORNIA

certain desirable properties of gas dielectrics.

Where an electrostatic field exists between two electrodes in a gas, the voltage gradients are not distributed evenly. There is no constant proportion between current and field strength, as in metals. Therefore, a gas is not referred to as having resistance. The discharge of electricity in gases is extremely complex, and is dependent on many factors, one of these being density of the gas.

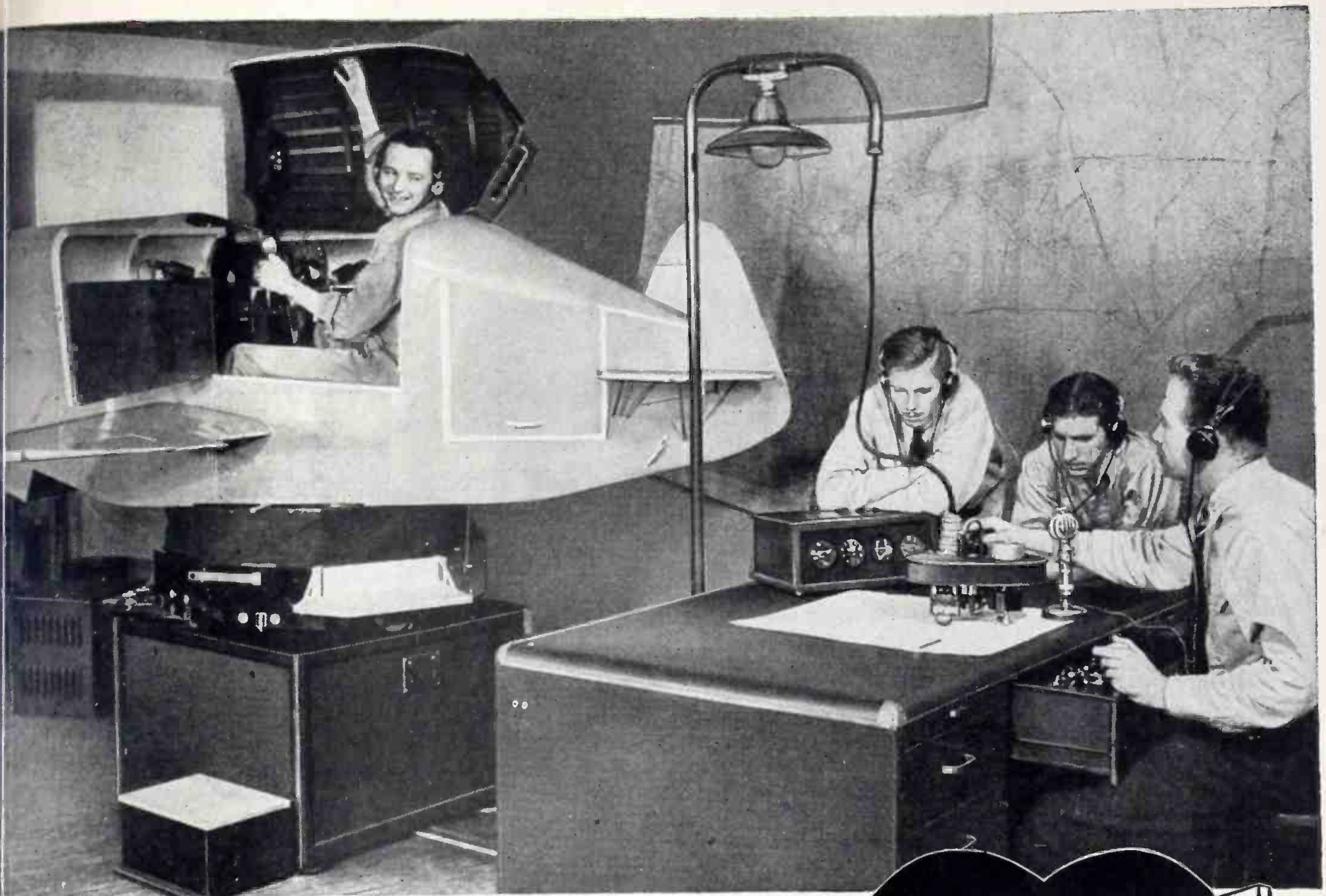
Referring back to Fig. 1, we find that after the pressure is raised above minimum sparking potential of any given gas, for a given electrode spacing, the sparkover voltage increases in approximate proportion to the pressure. Pressures of the order of 350 lb per sq in. will decrease the mean free electron path to a great extent, as demonstrated by Fig. 3, so that an electron moving from one plate toward the other would undergo a huge number of collisions. This minimizes the tendency toward ionization. Field strength necessary to produce an electrical discharge becomes proportionately high, imparting to the pressure capacitor a large flashover rating. Other features are rugged construction, very low losses, low temperature coefficient, stable dielectric constant, variable capacitance, and provision for external flash-over.

Rigid mechanical construction of the pressure capacitor is a considerable asset. The gas-filled chamber is usually of aluminum or copper-plated steel while the actual capacitor elements have sturdy, precision-made plates, with edges accurately rounded to increase breakdown potential and eliminate corona.

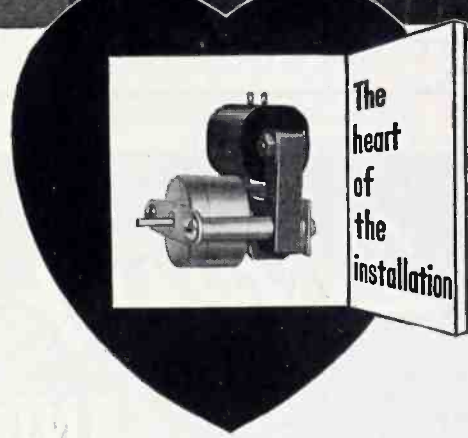
Variable Models

Some models are of the variable type, where the capacitance can be changed while in operation from about 40 percent to maximum rating. The rotor shaft is brought out through special pressure seals. A worm gear is utilized to give ratios from 15-to-1 up to 900-to-1. These units can be supplied with motor-driven remote control, including automatic stops, so that pressing a button provides a quick and accurate change of value.

Fixed units can be set at the fac-



"How'm I doing?"— and Telechron tells him



Synchronous, self-starting Telechron motors provide a written record of blind "flights" made in the Link Trainer—the "plane" used to teach pilots to fly on instruments.

Two of these strong but sensitive little motors drive the recorder on the instructor's desk. Another powers the wind drift mechanism. The smooth, constant-speed Telechron motors automatically write for pilot and instructor accurate charts of flight performance.

Charting the course of the fledgling flier, controlling processes in the refinery making his high-octane gasoline—you'll find Telechron motors in all kinds of timing, controlling and recording jobs, speeding the war effort.

Adaptable and dependable, these motors are available in sizes from 12 to 250 volts for all commercial frequencies—and from 1 to 1800 rpm. Their industrial applications include:

Timing	**Cycling operations**	**Measuring**
Controlling	**Signaling**	**Gaging**
Metering	**Fixed process controlling**	**Regulation**
Recording		**Communications**
Switching		

We have been supplying industry with self-starting, synchronous motors for all kinds of timing, recording and control jobs for 25 years. Our experience is at your service. Just write Motor Advisory Service, Dept. C.

Telechron

REG. U. S. PAT. OFF.

WARREN TELECHRON COMPANY, ASHLAND, MASSACHUSETTS

MAKERS OF TELECHRON ELECTRIC CLOCKS AND SYNCHRONOUS ELECTRIC MOTORS

IN *Crystals* IT'S THE *Cutting* THAT *Counts*

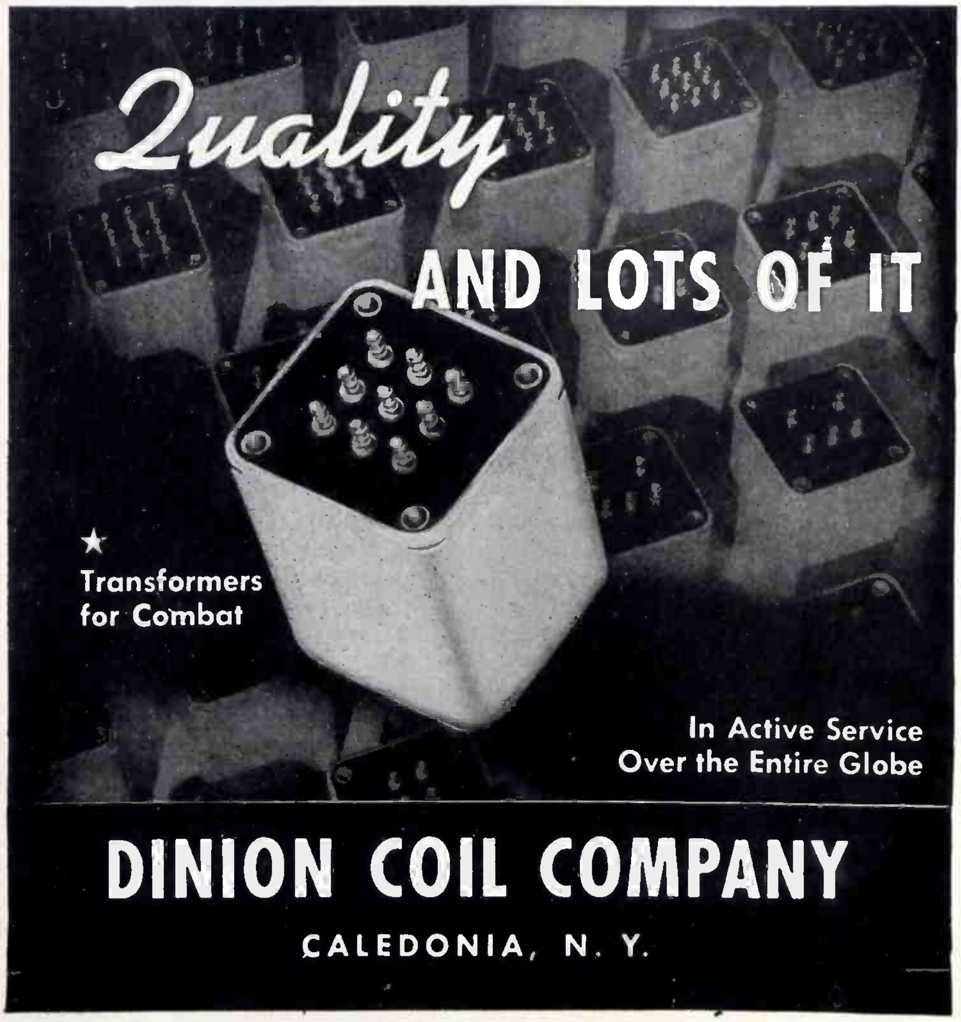
To insure constant frequency and high activity, Crystals must be cut at the correct angles to the crystallographic axes. That's why C.T.C. Crystals are X-RAY ORIENTED. This process predetermines the axes of the Crystals, making it possible to cut each slice with extreme accuracy.

Next time you need Crystals send your specifications to us. You'll find C.T.C.'s "correctly cut" Crystals will meet your most exacting standards of quality and performance.

For delivery estimates, quotations, etc., get in touch with

CAMBRIDGE *Thermionic* CORPORATION

439 CONCORD AVE. • CAMBRIDGE 38, MASS.



Inspection on Location with DoALL Mobile Unit

A complete inspection departme on wheels, to check parts right the machine or bench. Errors a caught where they start and hu dreds of dollars in wasted m hours and material are saved.

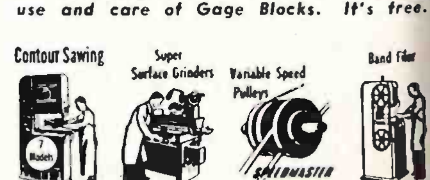
The Unit consists of an 83-pie set of DoAll Gage Blocks, 20 au iliary instruments, surface pla Metron Comparator Gage, a fi for records, desk space and colla sible seat. Occupies only 24 x 4 floor space.

Doing a Great Big Job

These 83 little jewels of indust can turn an ordinary machi shop into a manufacturer of pre sion parts accurate to with ±.000002" (2 millionths of an inch

Decide right now to make your fa cilities more valuable to our w effort and for later peacetim needs.

Send for 64-page Handbook on the modern use and care of Gage Blocks. It's free.



CONTINENTAL MACHINES, INC

Manufacturers of DoAll Contour Machines and Surface Grinders. Offices in Principal Cities

1366 S. Washington Ave., Minneapolis 4, Minn

tory to any desired value, and are rated at ±1 percent accuracy. The dielectric is a dry, inert gas, (usually nitrogen) maintained at a pressure up to 350 lb, and a pressure gage is supplied with each unit. The insulating bowl which supports the rotor is the only loss-producing dielectric. Its physical contact with the terminals is comparatively small, and its ratio of area to thickness is large, resulting in very little effect on over-all efficiency. This insulator is usually porcelain, Pyrex, steatite, or other ceramic materials.

About Availabilities

Voltage and capacitance ratings of gas-filled units cover a wide range. The variable type is made in values of 100 to 3,500 $\mu\mu$f, while units have been constructed with fixed values up to 20,000 $\mu\mu$f. A typical capacitor of the variable type is rated at 42,000 v peak and 100 amp at 1000 kc, having a maximum capacitance of 500 $\mu\mu$f, a diameter of 10¾ in., and a total height of 24¾ in. Special units have been put into service with peak ratings of 60,000 v or higher, and certain types are available for special high-frequency or high-current applications. Among companies making gas-filled capacitors are: Barker & Williamson, Good-All Electric, E. F. Johnson, and Lapp Insulator.

Power loss in a gas-filled capacitor is quite low, because of the

• • •

RADAR ON BENCH

Formerly a Lloyd's broker's secretary, Craftswoman Beryl Reed solders a capacitor into a unit of radiolocation equipment at an AA Command workshop

today's emphasis on electronics, WESTON developments in the field of sensitive Relays assume utmost interest to design engineers. Even prior to the war, these relays provided positive control at input values low as microamperes or 1 millivolt. Employing WESTONS exclusive *magnetic contact* principle, they handled 5 watts at 110 volts, with complete freedom from contact troubles.

ut relay development at WESTON has kept pace with the more exacting control needs of this war. Relays with sensitivity *far exceeding* that of prewar days already have proved their reliability on critical equipment, under the most rigorous conditions!

lore than likely, these relays provide the answer for many of tomorrow's products; for they provide the simplest, most compact means of controlling minute energy levels.

lave the full story on "what's ahead" in sensitive relays and instruments at your fingertips. Check WESTON, too, on all *war instrument* needs!

aboratory Standards . . . Precision DC and AC Portables . . . Instrument Transformers . . . Sensitive Relays . . . DC, AC, and Thermo Switchboard and Panel Instruments.

WESTON

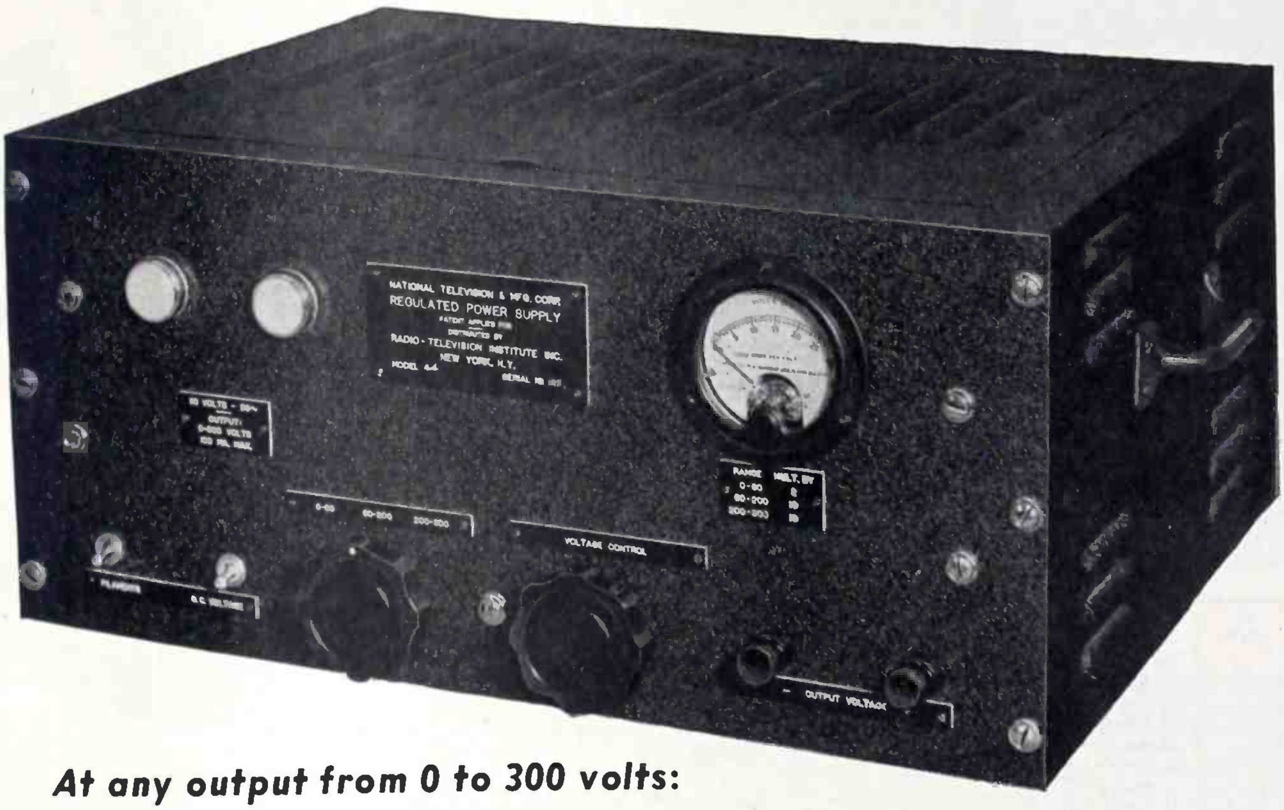
Specialized Test Equipment . . . Light Measurement and Control Devices . . . Exposure Meters...Aircraft Instruments... Electric Tachometers...Dial Thermometers.

Weston Electrical Instrument Corporation, 618 Frelinghuysen Ave., Newark 5, N. J.

0-300 Volts D.C.

Wide Range Regulated Power Supply

Excellent Regulation and Stability— Very Low Hum Level



At any output from 0 to 300 volts:

1. Output voltage changes less than 0.5 volts with ± 10% line change.
2. Internal resistance less than 2 ohms at low frequencies.
3. Hum is less than 12 millivolts, R.M.S.

Single knob control with range-changing switch.

Some special models to meet individual specifications are in production. The basic circuit is adaptable to meet a wide variety of voltage and current requirements.

Inquiries are invited, both on these new power supplies and on our electronic consulting service.

DISTRIBUTED BY

RADIO-TELEVISION INSTITUTE, INC.

OF NEW YORK

480 LEXINGTON AVENUE PLaza 3-4585 NEW YORK 17, N.Y.

small amount of loss-producing material between electrodes. Like the vacuum unit, it has an unusually high Q, and excellent stability. Temperature, humidity, atmospheric pressure, and other external factors have little or no effect on electrical characteristics. It is mechanically secure, and not only is its gas dielectric self healing, but also the internal mechanism is protected from excessive voltages by an external adjustable spark gap. Moreover, a single capacitor will usually do the work of several conventional units in series-parallel.

Pressure capacitors are used in broadcast and similar r-f applications. They are employed in high-voltage tank circuits, and are also used for neutralizing or coupling. Pressure capacitors are suitable for use in both d-c and a-c applications. Within the past few years, considerable progress has been made in the design of these capacitors, making possible higher voltage and higher frequency applications.

References

(1) Darrow, K. K. "Electrical Phenomena in Gases" William and Wilkins Co., 1932, pp. 202–203 and Loeb, L. B. "The Kinetic Theory of Gases" McGraw-Hill Book Co., Inc., 1934, pp. 543-570.

(2) Peek, F. W., Jr. "Dielectric Phenomena in High Voltage Engineering" McGraw-Hill Book Co., Inc., 1929, pp. 43-45 and Fink, D. G. "Engineering Electronics" McGraw-Hill Book Co., Inc., 1938, pp. 184-189.

(3) Maxfield, F. A. and Benedict, R. R. "Theory of Gaseous Conduction and Electronics" McGraw-Hill Book Co., Inc., 1941, p. 298.

(4) Pender, H. and McIlwain, K. "Electrical Engineer's Handbook" John Wiley and Sons, Inc., 1936, p. 2-23, p. 2-31.

(5) Peek, F. W., Jr. "Effect of Altitude on Spark-Over Voltages" American Institute of Electrical Engineers, 1914, pp. 1721-1730.

(6) Sarbacher and Edson "Hyper and Ultra-High Frequency Engineering" John Wiley and Sons, Inc., 1943, p. 3.

(7) Hartshorn, L. "Radio Frequency Measurements" John Wiley and Sons, Inc., 1940, pp. 120-122.

A RAZOR BLADE and cat whisker act as a detector for picking up broadcasts from Rome and Naples for Pvt. Eldon Phelps, with the Fifth Army on the Anzio beachhead.

LETTERS FROM former Sylvania workers, now in the armed forces, often mention seeing and using products they formerly made. To one letter from a Seabee in the South Pacific, the censor added a postscript: "This letter was censored under one of your fluorescent lamps."

Shielding the ELECTRON MICROSCOPE From Vibration

/ith the Electron Microscope, scientists are ıabled to peer into new worlds, at magni-cations up to 100,000 times. *Vibration, how-er, magnifies at the same rate.* Even though infinitesimal it can't be felt, it must be iminated if a perfect image is to be secured.

This baffling difficulty was overcome by .S. Rubber technicians. They developed a et of rubber mountings engineered to a re-ıarkable point of precision and efficiency. bservations revealed that these mountings ompletely eliminated all traces of vibration.

Makers of delicate instruments, electronic pparatus, light and heavy machinery, even ailway and street cars draw upon the ex-erience of the "U.S." staff for new and im-ortant applications of U.S. Rubber Mount-ıgs. In "U. S." laboratories, each such problem treated individually, each mounting com-ounded and tooled to precise specifications.

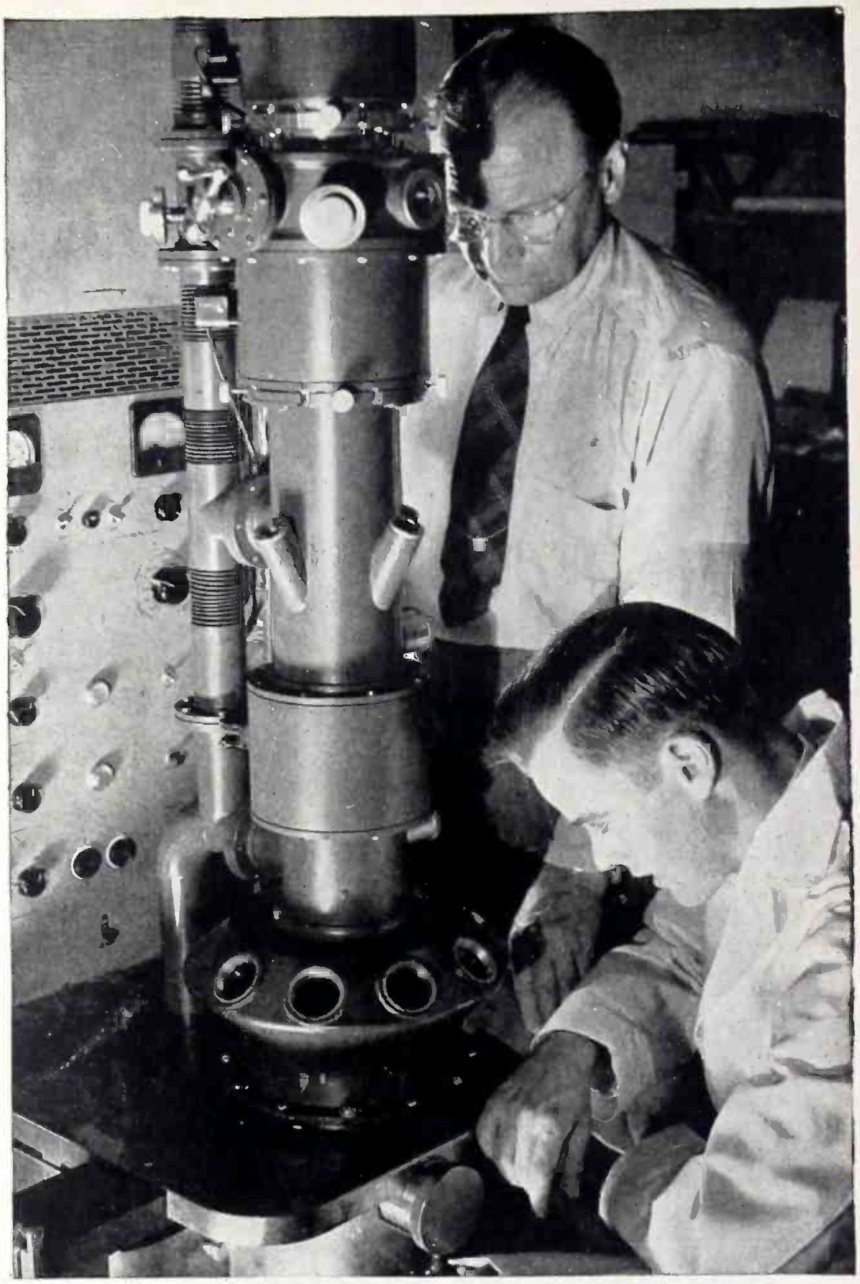
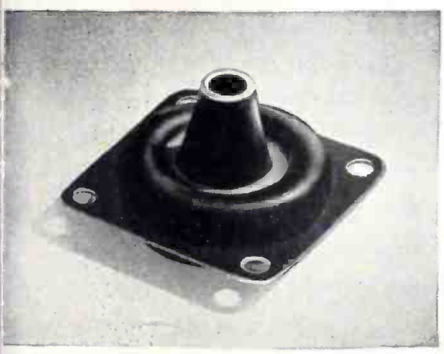
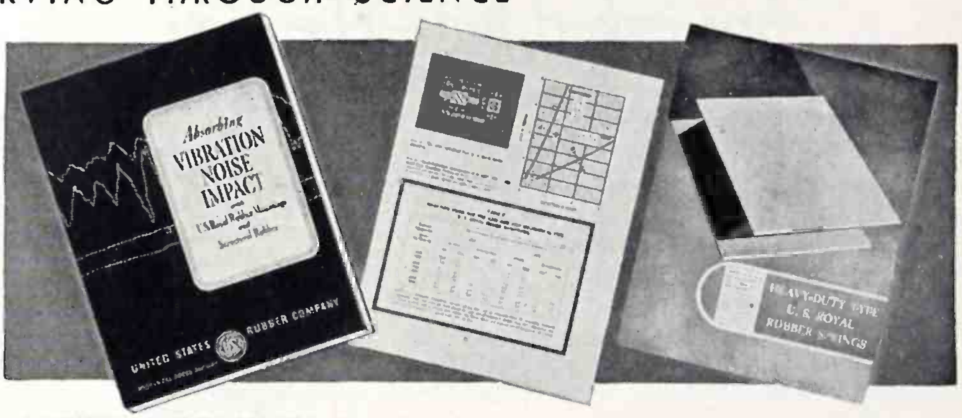


Photo Courtesy RCA

SERVING THROUGH SCIENCE





CIENCE OF SMOOTHNESS—U.S. Rub-er technology is removing guesswork rom the elimination of noise, vibration nd shock. Results are pre-determined nd qualities of performance known in dvance of installation.

AN INVALUABLE BOOK FOR ENGINEERS—an exhaustive book, "Absorbing Vibration, Noise, Impact", replete with blueprints, charts, photographs and explanatory text, contains much new and important information especially pertinent to postwar conversion and expansion. A limited number is now available. Engineers and architects can obtain copies by writing on company stationery to "Mechanical Goods Division," Room 1406. There is no obligation.

Listen to the Philharmonic-Symphony program over the CBS network Sunday afternoon, 3:00 to 4:30 E.W.T. Carl Van Doren and a guest star present an interlude of historical significance.

UNITED STATES RUBBER COMPANY

1230 SIXTH AVENUE • ROCKEFELLER CENTER • NEW YORK 20, N. Y.

Impedance Measurements

(Continued from page 140)

transformer can be placed ahead of the oscilloscope, presenting to the test circuit merely the grid loading of a vacuum tube (Fig. 1).

With the input and output impedance effects minimized, the only remaining limitation on the range of utility of this method is that of frequency. The percent deviation of the wave produced by the generator from an ideal square wave is the minimum percent error to which impedance measurements can be made. The amplitude and phase shift response of the oscilloscope must be linear from at least ten times the highest square-wave frequency at which tests are to be made, to one-tenth the lowest.

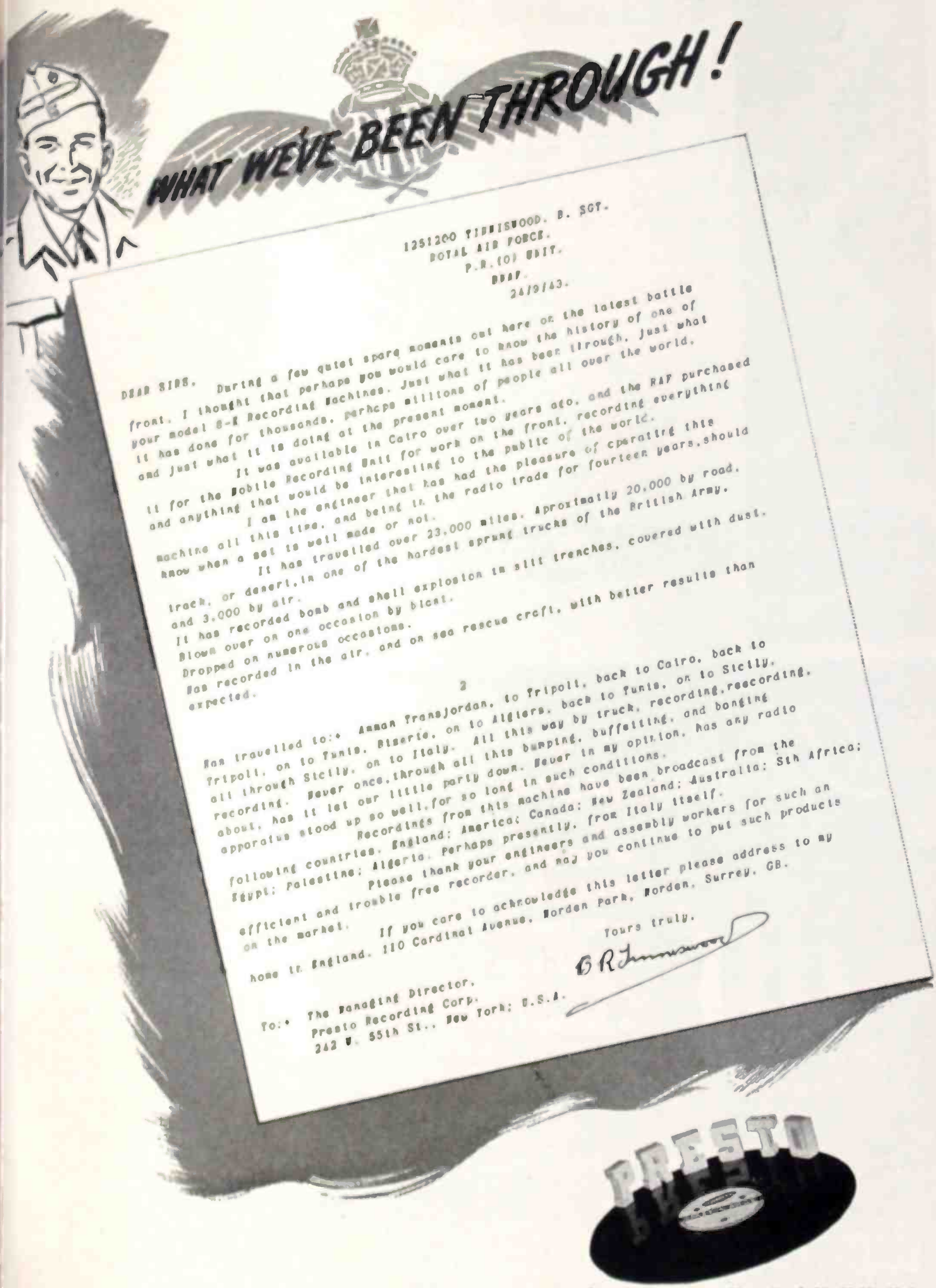
To determine the frequency range within which the equipment is reliable, the generator output should be observed on the oscilloscope to be used. This procedure does not indicate which of the instruments is at fault but, because distortion in either one is equally detrimental to accuracy, it does indicate the usable range for the combined equipment.

Stray shunt capacitances to ground must be kept small. Such strays are most likely to appear from the unknown impedance to surrounding metal such as the cases of the generator and oscilloscope. Even at moderately high frequencies, lead inductance distorts square waves and therefore it is necessary to hold all lead lengths to a minimum. Because of the wide

---

A PASHA in North Africa has an intercommunicator system that permits him to contact each room in his harem when necessary. Interested in improvement, he asked Maj. Andre Baruch, former announcer now in Africa, "How is television progressing in your country, Major?"

MORE THAN 150 new electronic tubes and 300 types of apparatus not made by anyone before the war have been developed by RCA for the armed forces.



1251200 TINNISWOOD. B. SGT.
ROYAL AIR FORCE.
P.R.(O) UNIT.
RRAF.
24/9/43.

DEAR SIRS. During a few quiet spare moments out here on the latest battle front, I thought that perhaps you would care to know the history of one of your model 8-N Recording Machines. Just what it has been through. Just what it has done for thousands, perhaps millions of people all over the world, and just what it is doing at the present moment.

It was available in Cairo over two years ago, and the RAF purchased it for the Mobile Recording Unit for work on the front, recording everything and anything that would be interesting to the public of the world.

I am the engineer that has had the pleasure of operating this machine all this time, and being in the radio trade for fourteen years, should know when a set is well made or not.

It has travelled over 23,000 miles. Aproximatly 20,000 by road, track, or desert, in one of the hardest sprung trucks of the British Army, and 3,000 by air.

It has recorded bomb and shell explosion in slit trenches, covered with dust.
Blown over on one occasion by blast.
Dropped on numerous occasions.
Has recorded in the air, and on sea rescue craft, with better results than expected.

2

Has travelled to:- Amman Transjordan, to Tripoli, back to Cairo, back to Tripoli, on to Tunis, Bizerte, on to Algiers, back to Tunis, on to Sicily, all through Sicily, on to Italy. All this way by truck, recording, reecording, recording. Never once, through all this bumping, buffeting, and banging about, has it let our little party down. Never in my opinion, has any radio apparatus stood up so well, for so long in such conditions.

Recordings from this machine have been broadcast from the following countries. England; America; Canada; New Zealand; Australia; Sth Africa; Egypt; Palestine; Algeria. Perhaps presently, from Italy itself.

Please thank your engineers and assembly workers for such an efficient and trouble free recorder, and may you continue to put such products on the market. If you care to acknowledge this letter please address to my home in England. 110 Cardinal Avenue, Morden Park, Morden, Surrey, GB.

Yours truly,

To:- The Managing Director,
Presto Recording Corp.
242 W. 55th St., New York; U.S.A.

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

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

Walter P. Downs, Ltd. in Canada

frequency response of the osci scope, the circuit must be shield from stray fields.

Typical measurements are ill trated in the following table wh gives an indication of the accura to be expected from square-wa impedance measurements of tl type.

ACCURACY OF CAPACITANCE MEASUREMENTS

Actual μfd	Measured μfd	Percent Error	Freque cps
0.1000–	0.088	12	60
0.0100–	0.0092	8	580
0.001(4)	0.0010(2)	(2)	5200

Calibrated resistor used in this measurement 30,000 ohms.

*Generator output noticeably not a square w at this frequency.

EFFECT OF IMPEDANCE ON INDUC ANCE MEASUREMENTS

Resistance Ohms	Frequency cps	Inductar mh
314	740	0.068
3140	3300	0.152
3140	3800	0.132
31400	27000	0.185

*Internal impedance of the generator was 10 ohms for this one measurement.

Test equipment used in thes measurements was connected d rectly to the impedances under te (not as shown in Fig. 1) to illu trate the accuracies which can b expected if commercial equipmen is used directly, and to show the d sirability of using impedance changing networks where highe accuracies are required. The in ternal impedance of the squar wave generator was 500 ohms; th input impedance of the oscilloscop was 2 meg.

The value of R used in measur ing capacitance was chosen as th mean between the generator an oscilloscope impedances $(500 \times 2 \times 10^6)^{\frac{1}{2}} = 33{,}000$ ohms. The constants of the inductor for which the measured values are given are: L, 0.189 mh; f_o, 48,000; Q, 11.8 at 1000 cps.

Measurements of this inductor could not be carried out using larger resistances because of the free oscillations appearing on the trace; the low resistances used damped these oscillations. The particular values of R used in measuring inductance were chosen to cancel the π term. Data is only reliable to three places in the above measurements.

REFERENCES

(1) Brailsford, H. D., Measuring Coil Characteristics Without an Impedance Bridge, ELECTRONICS, May 1943.

(2) Richter, Walther, Cathode Follower Circuits, ELECTRONICS, November 1943.


KEN-RAD
"little Giant"
9001
KEN-RAD
Designed originally for space saving and fine reception in portable radio sets Ken-Rad miniature tubes easily adapted themselves to walkie-talkie and other military uses Expansion and future progress with this rugged Little Giant is limitless
• Write for your copy of "Essential Characteristics" the most complete digest of tube information available
TRANSMITTING TUBES
CATHODE RAY TUBES
SPECIAL PURPOSE TUBES
RECEIVING TUBES
INCANDESCENT LAMPS
FLUORESCENT LAMPS
KEN-RAD
EXECUTIVE OFFICES
OWENSBORO · KENTUCKY
EXPORTS 15 MOORE STREET NEW YORK

NEW PRODUCTS

Month after month, manufacturers develop new materials, new components, new assemblies, new measuring equipment; issue new technical bulletins, and new catalogs

UHF Calibrator

THIS MANUFACTURER specializes in the development of uhf equipment and has available a new secondary-standard calibrator, designated as Model No. C-200, which is designed to establish frequencies at uhf with quartz-crystal accuracy. The in-

strument provides fast, easy calibration up to 2000 Mc. It may be used for calibrating wavemeters, signal generators, oscillators and receivers. The unit is equipped with transmission line output and a built-in detector unit.

Lavoie Laboratories, Morganville, N. J.

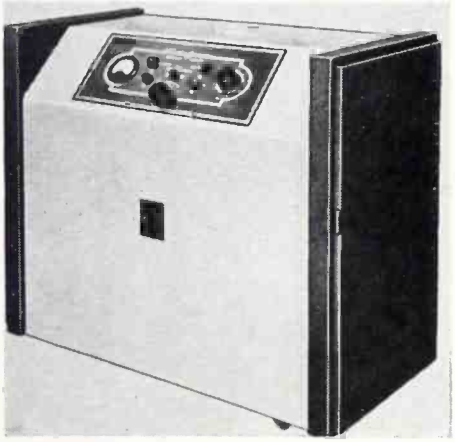
Time-Delay Relay

MODEL TD6 time-delay relay is intended for use in protecting industrial and transmitter tubes. It has a cam-operated switch mechanism and is mounted in a dust and moistureproof Bakelite case for panel mounting. A visible index shows the open and closed position by means of a graduated indicating-dial. Four screw-type terminals are included for motor and switch circuits. A totally enclosed switch unit is used in the relay. This switch has definite snap action and positive lock in both operating positions.

The R. W. Cramer Co., Inc., Centerbrook, Conn.

Electronic Heating Generators

A COMPLETE LINE OF electronic heating generators with ratings of 1, 2, 5, 10 and 20 kw, in line with NEMA standards, are available for both induction and dielectric heating loads. These units are completely self-contained and have no external cooling or other auxiliary units. They operate on 60 cps lines. Units of 50 to 200 kw capacity can be supplied in addition to the standard 1 to 20 kw ratings. The primary voltage is 220 or 440, single phase for ratings of 5 kw or lower, and 3 phase for 10 kw and higher. The oscillator, power sup-

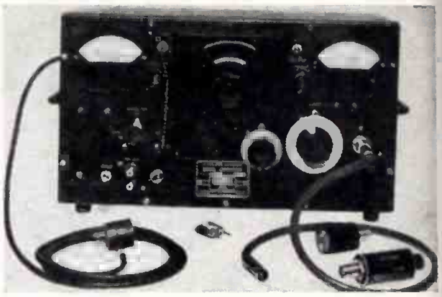


ply, blower, and other switchgear are housed in one unit. The high-frequency section is shielded to minimize the possibility of interference with nearby communications circuits. An automatic timing-control permits load cycle adjustment to a predetermined time, which can be automatically repeated. Terminals are provided for remote control. Air-cooled tubes are used in these generators.

Westinghouse Electric & Mfg Co., East Pittsburgh, Pa.

UHF Signal-Generators

THESE UHF SIGNAL generators (Type 804-CS1 and Type 804-CS2) are laboratory-type units which operate from 7.6 to 330 Mc and their frequency calibration is accurate to ±2 percent. Voltage output is controlled by an accurately calibrated attenuator network which allows control from 1 μv to 20,000 μv. The output of the instruments is arranged so that an internal source of modulation at a frequency of 1,000 cycles may be used, or, by use of an incorporated switching arrangement, external sources of modulation between 30 cycles and



20,000 cycles may be used, adjustable from zero to 60 percent, indicated by a direct-reading modulation meter.

A special input circuit is used to pulse-modulate the generators from an external source, having very steep wave-fronts and extending in rapidity to pulses of approximately 20 microseconds. Shielding and r-f filters hold stray field leakage to a minimum. Frequency changes due to power-line fluctuations, are held to a minimum by the use of a stabilized power-supply, which is incorporated in the unit for operation on either 115 v or 230 v a.c., 40 to 60 cycles, single phase.

Each generator weighs less than 35 lb and comes supplied with a 3-ft coaxial output-cable of 75 ohms impedance, a fixed 10:1 attenuation reduction unit, a special terminal unit, an adapter plug, line cord, extra blank plug-in coil form, spare pilot lamps, fuses, and one set of 4 tubes.

Federal Mfg. & Engineering Corp., 211 Steuben St., Brooklyn 6, N. Y.

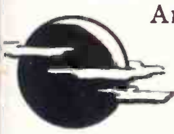
... as in the laboratory

PLANNING

IS FOREMOST IN THE NATION

America today is analogous to the laboratory where work is scientifically planned on foundations of the past, present, and future. The mistakes that the world made after 1918, the current conflict, and our hopes for the years ahead serve as the foundation components for a postwar program of peace and security and abundance. Like the laboratory technician, our country's thinkers should plan our participation on a scientific basis.

The objective of the nation is already established. You know that technical advancements, especially those in communications and transportation, have made isolationism and nationalism impossible. America, therefore, *must* participate in world affairs. Friendly relations in the international community mean not only an interchange of ideas, but an interchange of goods. Out of the former comes a better understanding of each nation's problems . . . out of the latter will come wider markets for our greatly expanded production. In gaining such markets, we can still maintain our industrial set-up as it stands today, yet avoid any of the ills that might arise from overproduction.



The effects of such a policy are closely allied to the welfare of the American people. An economy of abundance can be translated into an abundance of jobs . . . for present workers as well as men and women returning from the battlefields. Equally important, it gives our country the the opportunity to make even greater strides in securing the well-being of the individuals . . . be they capital or labor. Through such an economy of abundance, the businessman can protect his production peaks without fear of drastic reductions in sales, and resulting tragedies—and the worker can be assured of a steady job, and all that it implies.

We have the qualities for winning the war . . . that is certain. Whether or not we have the qualities for winning the peace remains to be determined. Should we recognize our nation as a huge laboratory, and ourselves as scientists, engineers and technicians working in the simplest, most direct method, we can achieve our goal of a just and lasting peace with opportunity and security for all.

READY SOON! *A sound, workable and realistic plan for a postwar world of abundance and lasting peace, prepared by the Electronic Corporation of America. Write for your copy today.*

ELECTRONIC CORP. OF AMERICA

45 WEST 18th STREET • NEW YORK 11, N. Y. WATKINS 9-1870

The Electronic Corporation of America is "on the air," eight times a week, featuring two nationally-known commentators: Johannes Steel, over Station WMCA, New York, and William S. Gailmor, over Station WHN, New York.

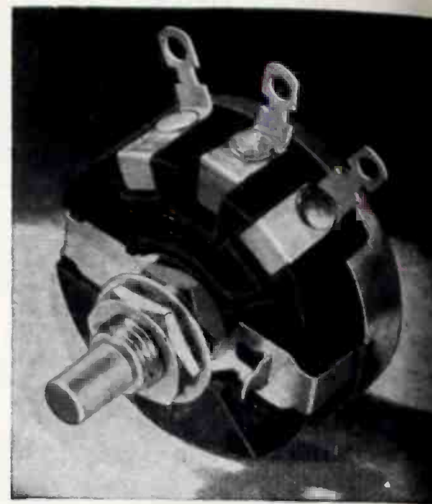
Fungus-Resistant Coating

FOR OVER-ALL TREATMENT of assembled ground equipment such as the walkie-talkie, handy-talkie, radar, power plants, etc., there is available a No. 25A moisture and fungus-resistant coating, Signal Corps approved. It is fast drying and non-toxic to humans.

Insl-x Co., Inc., 857 Meeker Ave., Brooklyn, N. Y.

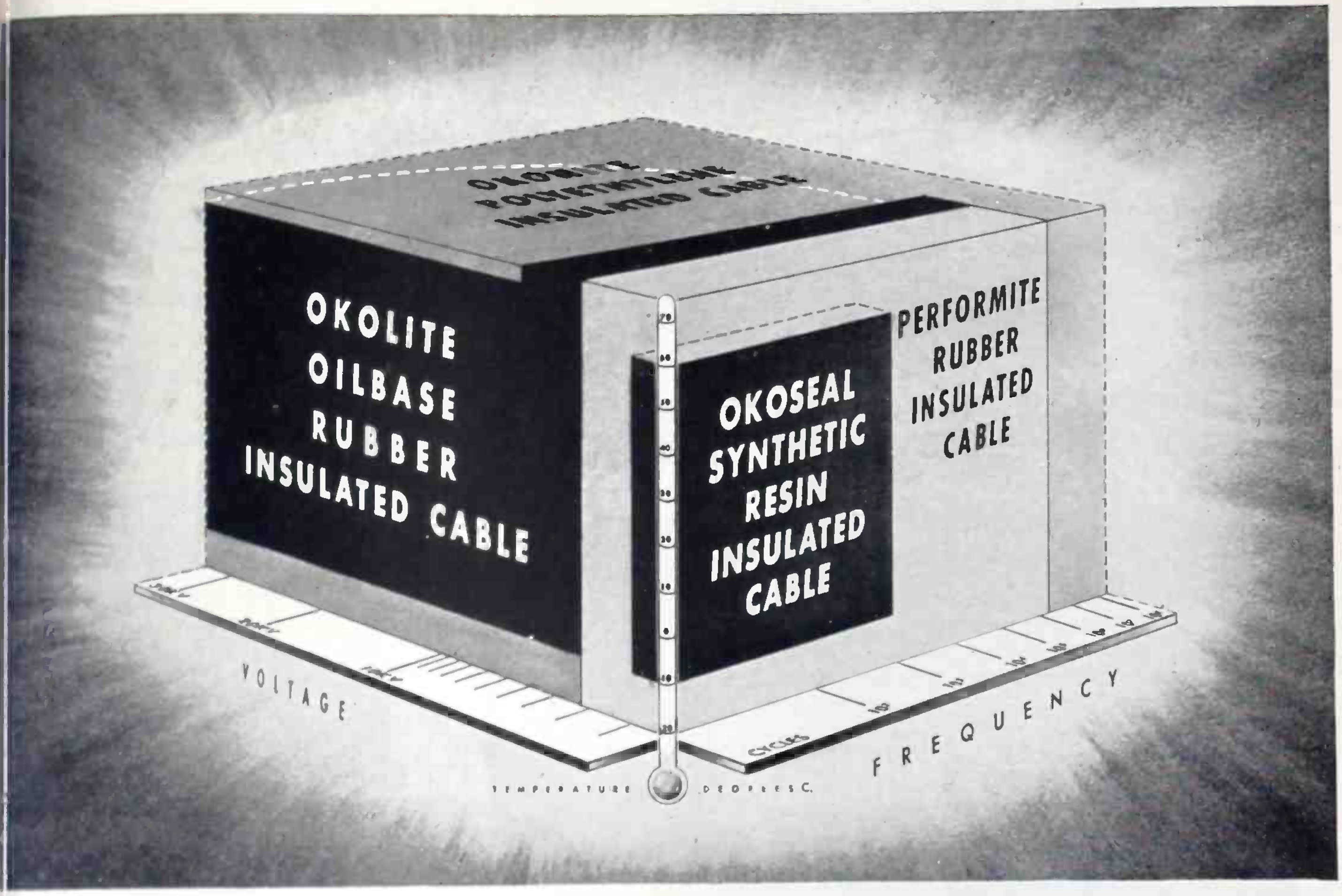
Improved Potentiometer-Rheostats

IMPROVED TYPE 58 wire-wound potentiometer-rheostats include a metal strap on the shaft face to provide for a two-position locating pin which cannot break or tear off. The metal strap grounds the metal cover which is clinched to it. The cover will not loosen or turn because it is keyed in place on the casing. The bushing is also prevented from slipping or turning, when the locking nut is drawn tightly, because it is keyed into the Bakelite case. The case is dustproof. The can is made of molded Bakelite and tends to eliminate cor-



rosion and electrolytic actions, especially when the control is used on d.c. The center rail and terminal of these units comprise one piece. There is also a direct connection between the winding and the "L" and "R" terminal lugs, which are constructed so that melted solder cannot get inside the case. There is a zero hopoff at the terminal and 1500 v insulation between the winding and the shaft. A switch can be added. Tandem units with two or more controls on a common shaft are available.

These potentiometer - rheostats



PERSPECTIVE: Selecting Insulated Cable Requires a Multi-Dimensional Approach

This 3-dimensional graph illustrates practical fields of usefulness of 4 widely-used types of cable insulation. Each type has particular characteristics that make it suitable for definite applications — but at the same time each possesses certain limitations.

The pictured values show the present maximum voltage, frequency and temperature limits for which these four insulations are commonly used. The insulations with the higher values can, in many cases, be used as alternatives for those having lower values.

Design engineers may find this rather unusual graph helpful in selecting a cable for some specific application. The problem, however, is not always as simple as indicated because it is often necessary to obtain cables having additional characteristics not covered by this graph — such as resistance to moisture, oil, chemicals, flame, etc.

Actually there are available many other insulations developed through Okonite Research — such as glass, paper, cambric, rubber and many synthetics — that cover the full range of electrical applications. Through intensive laboratory and long field experience, our engineers have acquired the over-all perspective that can help you select the *one* cable best suited for your purposes from *every* angle. Just outline your problem and let us make recommendations. The Okonite Company, Passaic, New Jersey.

ARMY E NAVY

OKONITE OKONITE SINCE 1878

INSULATED WIRES AND CABLES

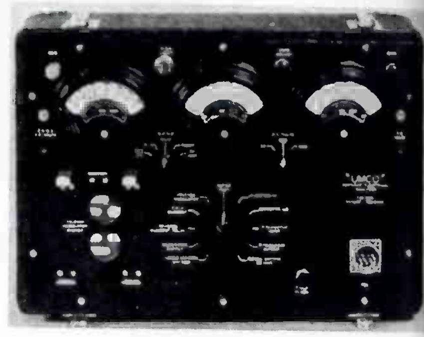
3760

have a linear rating of 3 w, V and W tapers are rated at 2; L, N, and U tapers, 1.5 w. Linear resistance values are from 1 to 75,000 ohms and tapered resistance values range from 10 to 50,000 ohms.

Clarostat Mfg. Co., Inc., 285 North 6th St., Brooklyn, N. Y.

Aircraft Electrical Analyzer

PRACTICALLY ALL wiring and electrical troubles of aircraft can be analyzed and located by a compact,



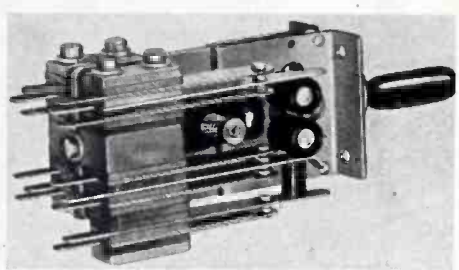
lightweight, portable testing unit which can be used for checking open circuits and shorts, for measuring resistances of any circuit element, and for testing and adjust-

ing voltage regulators and reverse-current relays. The unit, complete with all accessories weighs approximately 25 lb.

United Hydraulic Mfg. Co., Los Angeles, Cal.

Master-Cam Lever-Switch

A NEW MASTER-CAM lever-switch (Model MCL-CS) is designed for use in electronic and communications equipment, and wherever multiple circuits must be controlled. The switch is static-shielded and



non-corrosive. The positive positioning-cam has roller detents which eliminates friction and contact bounce. Coil springs are used on both sides of the cam, so that equalized pressure is assured regardless of the number or arrange-

ment of contact assemblies. All contacts can be removed from the frame by removing a single bolt. The control knob can be supplied with light or stiff action. Contact rating is 10 amps, 125 volts a.c., and 2 amps, 125 volts d.c.

General Control Co., 1200 Soldiers Field Rd., Boston 34, Mass.

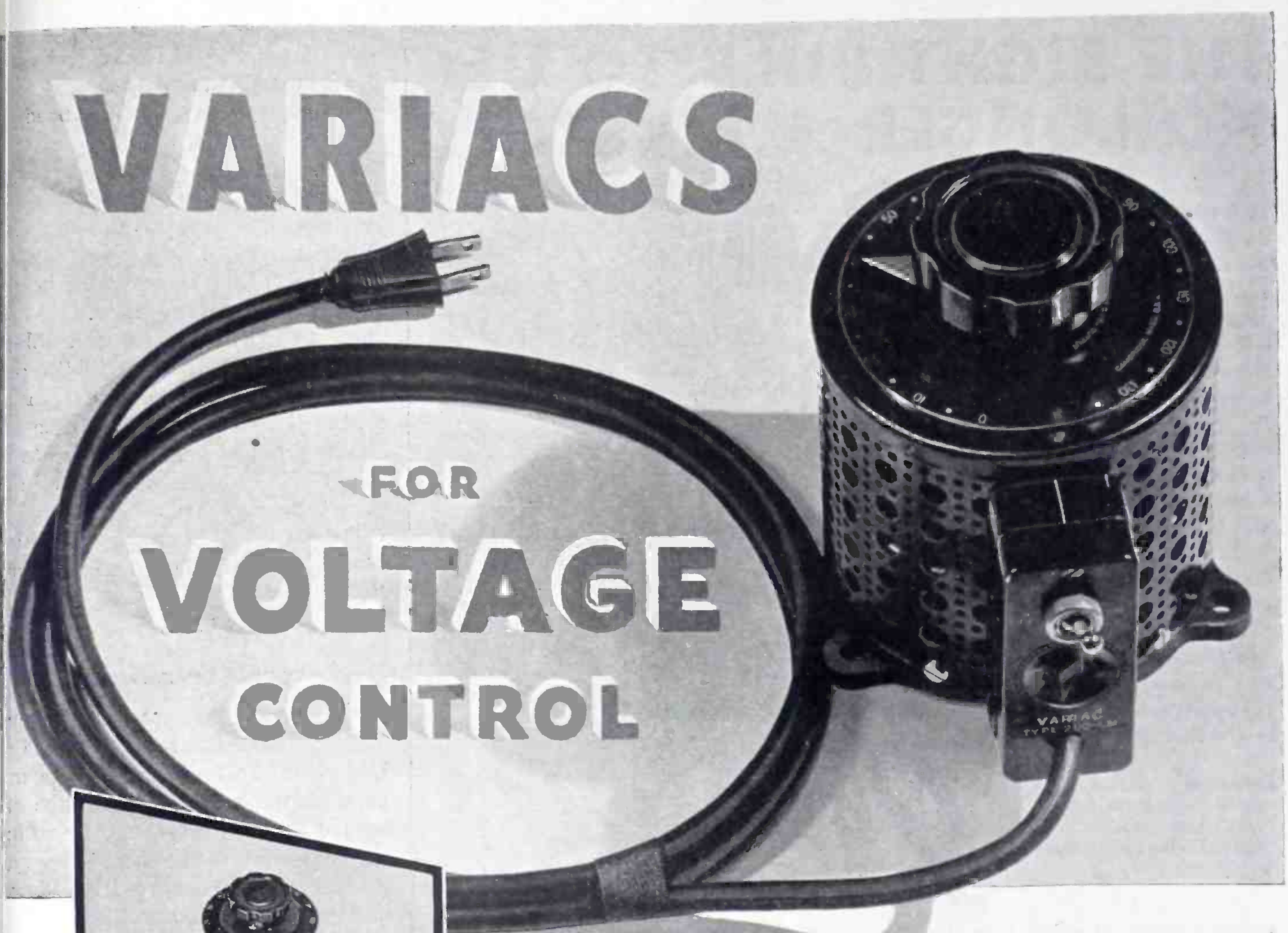
Mandrels

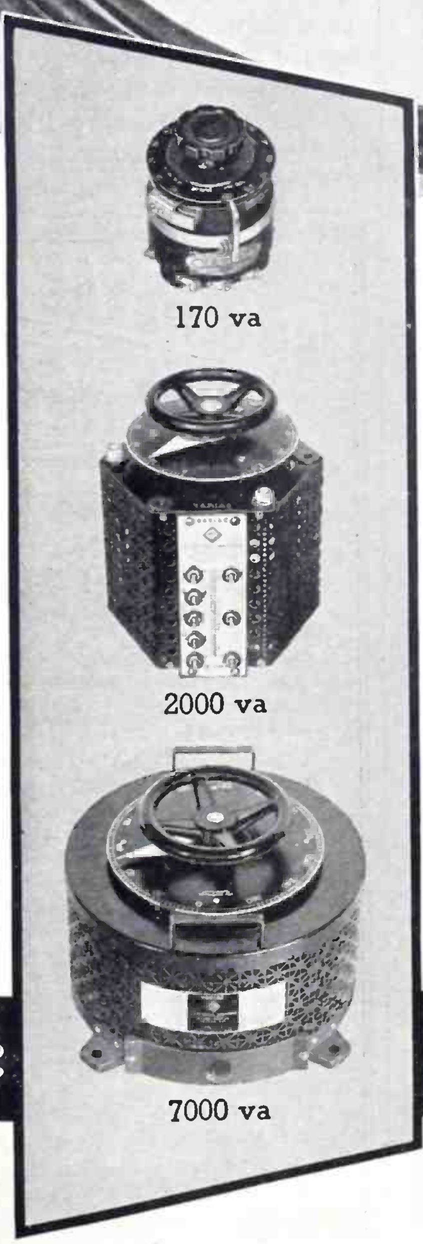
THIS MANUFACTURER has extended his line of mandrels so that approximately 750 different types are available for the forming of round, square, and rectangular paper tubes, used as coil bases. These mandrels are available for immediate use in many sizes, shapes and lengths, and any ID or OD, and handle kraft, fish paper, cellulose acetate, or combinations of these materials.

Precision Paper Tube Co., 2023 W. Charleston St., Chicago 47, Ill.

Dummy Tubes and Tube-Pin Straighteners

TO AID RADIO manufacturers in obtaining accurate alignment of panel openings and contact points, minia-





170 va

2000 va

7000 va

THE VARIAC . . . the *original* continuously adjustable, manually operated a-c voltage control . . . has these features:

- **SMOOTH CONTROL** — The VARIAC may be set to supply any predetermined output voltage with absolutely stepless variation.
- **HIGH EFFICIENCY** — Exceptionally low losses both at no load and at full load.
- **HIGH OUTPUT VOLTAGES** — VARIACS supply output voltages 17% higher than line voltage.
- **LINEAR OUTPUT VOLTAGE** — Output voltages are continuously adjustable from ZERO by means of a 320 degree rotation of the knob.
- **SMALL SIZE** — VARIACS are smaller than any other voltage control of equal power rating.
- **CALIBRATED DIALS** — VARIACS are supplied with reversible dials which read directly in output voltage both from zero to line voltage and from zero to 17% above line voltage.
- **ADVANCED MECHANICAL DESIGN** — Rugged construction; no delicate parts or wires; two or more units may be ganged on the same shaft for multi-phase operation.

VARIACS are stocked in nine models with power ratings from 170 va to 7000 va; prices range between $10.00 and $100.00.

Because all of our facilities are devoted to war projects, VARIACS are available at present only for War work; all orders must have a priority rating.

VARIACS are made *only* by General Radio

GENERAL RADIO CO. Cambridge 39, Mass.
NEW YORK CHICAGO
LOS ANGELES

- WRITE FOR BULLETIN 883

ture dummy tubes and tube-pin straighteners are available.

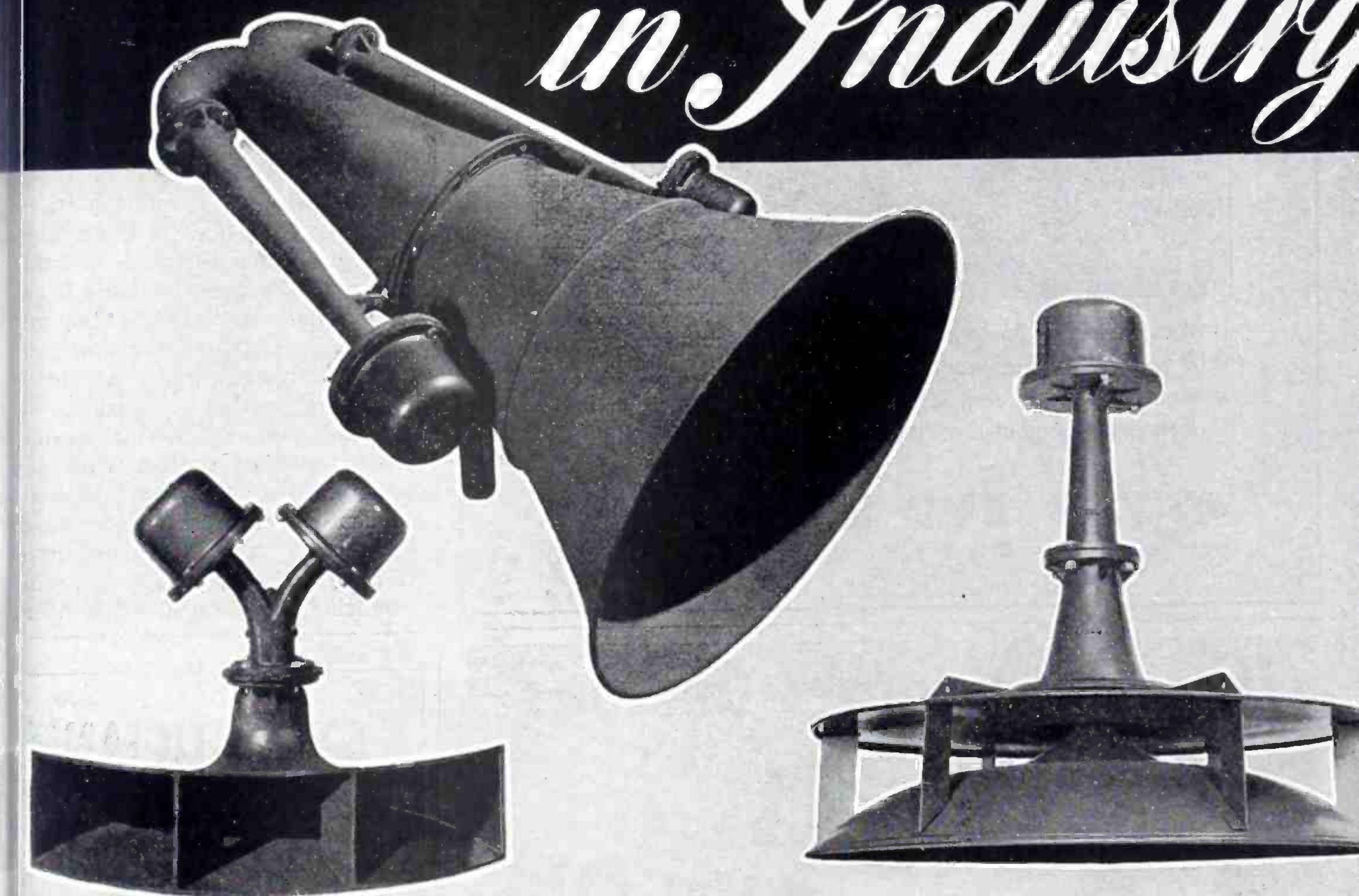
Stainless steel pins are used in the dummy tubes, which are used to hold socket clips in correct alignment during wiring. The tube-pin straighteners are available with either hardened tool steel inserts (for factory use) or with stainless-steel inserts (where greater resistance to corrosion is desirable). Body and posts are plated with cadmium. Inserts are replaceable. Both the tubes and tube-pin straighteners meet requirements of the WPB Sub-Committee on miniature tube standards.

Robert L. Stedman Machine Works, Oyster Bay, Long Island, N. Y.

Disconnect Terminals

QUICK ACCESS to contacts of small switches is facilitated by the use of solderless knife-disconnect terminals. Switches which have tabs extended from the contact, to which the external connections are soldered, may be converted readily to quick-disconnection switches without affecting the housing or any

VOICE* *in Industry*



*** Units illustrated are designed for maximum intelligibility through high noise levels plus economy of installation. Recommended for areas where wide angle distribution of high frequencies are necessary. Complete technical bulletins describing the above upon request.**

Type 26-B is designed for voice reproduction when used by itself. Also an excellent high frequency component to a wide range system. Provides uniform distribution over horizontal angle of 120° and vertical of 40°. Handles power input of 40 watts when equipped with two Jensen U-20 drive units. 22" wide, 14½" deep, 20" high.

Type 24-A is primarily an outdoor speaker. At 50 watts input produces a sound level of + 94 db. (Zero reference level 10^{-16} watts per cm^2) at 100 ft. distance on the axis of horn. Two or four Jensen U-20 drive units allow a maximum of 50/100 watts input. 38" long, 26" wide, bell diameter 25".

Type L-360 is designed for 360° horizontal coverage and 40° vertical with uniform frequency and power distribution. Handles power input of 20 watts when equiped with a single Jensen U-20 drive unit. 23" in diameter overall; weight 25 lbs.

The Langevin Company

INCORPORATED

SOUND REINFORCEMENT AND REPRODUCTION ENGINEERING

NEW YORK
37 W. 65 St., 23

SAN FRANCISCO
1050 Howard St., 3

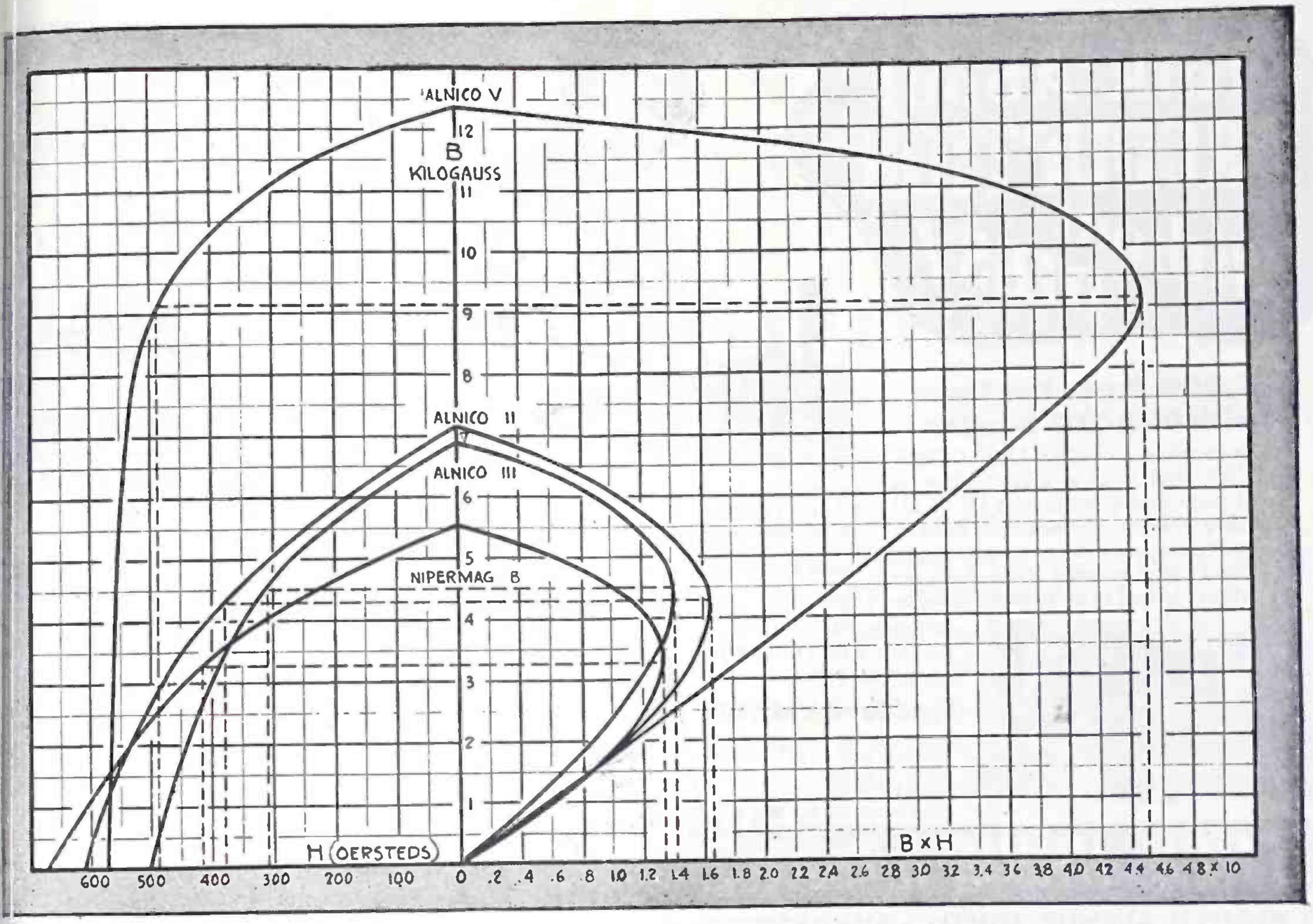
LOS ANGELES
1000 N. Seward St., 38

switch parts other than the contact members. Switches which have screws or binding posts for external connection may also be converted. These terminals may also be used as a soldering tab for emergency repair or replacement, where splicing terminals are not available on the external leads, or a solderless connection may be made, if desirable.

Aircraft-Marine Products, Inc., 1591-B North 4th St., Harrisburg, Pa.

Voltage Regulator

THIS A-C VOLTAGE regulator (Type TH Transtat) is a rotating transformer-type device. It is designed for use by manufacturers of small apparatus. Features include a brush arm which is an accurately-machined die-casting permitting good heat dissipation, and a simple means of changing brushes. It protects the commutator against short-circuiting contact with the brush holder. The shaft is independent of the brush-arm assembly and the unit can be quickly changed from panel mounting to table mounting, or ganged with other



IMPORTANT CURVES

uring our many years of service to industry in esigning and manufacturing permanent magnets, e have conducted hundreds of tests. From the esult of these tests we have been able to plot charts nd nomographs for taking much of the guess out f magnet design.

he one shown above—"Typical Demagnetization nd Energy Product Curves"—is used constantly by ur own engineers in designing magnets from the arious proved alloys. If you are designing your wn magnets, these curves should be useful, particularly as they are accompanied by an instructive amphlet—"Permanent Magnet Design".

end for the chart and pamphlet. Try designing our magnets. We'll be glad to check your results.

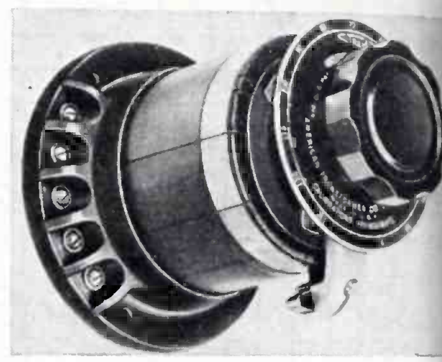
CINAUDAGRAPH CORPORATION
2 Selleck St. Stamford, Conn.

Send for the chart shown above; also for a copy of "Permanent Magnet Design"

CINAUDAGRAPH CORPORATION

9-CC-2

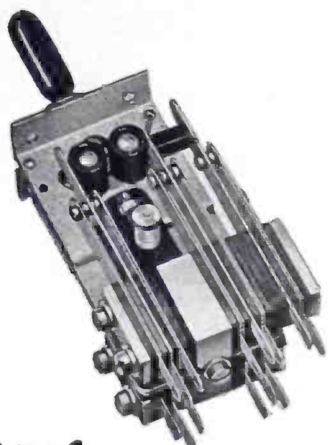
units for polyphase or simultaneous single-phase control. Accidental lead-shorting is prevented, and high dimensional conformance is assured by the use of phenolic thermosetting plastic parts. Other features include vinylacetal insulated-wire, impregnation of core



and coil with a synthetic-phenolic resin varnish of the polymerizing type, corrosion-resistant fittings, and a new dual mounting arrangement for open delta, three-phase control that reduces space requirements.

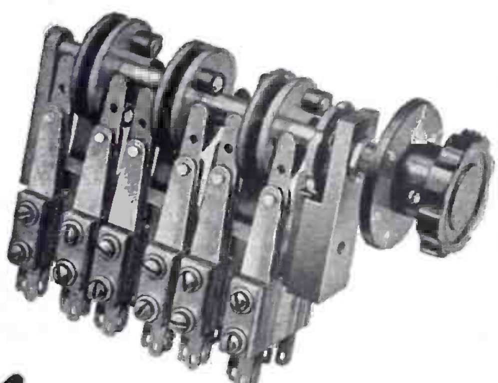
American Transformer Co., 178 Emmett St., Newark, N. J.

Two new Master GENERAL CONTROL COMPANY CAM LEVER SWITCHES



General Control Company, the original cam lever switch specialists, are pleased to announce two new cam lever switches. The new Model MCL-CS is similar in design to the well-known Model MCL-FS, except that coil springs are used instead of flat springs to assure longer life and equalized pressure on both sides of the cam, regardless of the number or arrangement of contacts on each side of the switch. Also it can be supplied with either light or stiff action on the control knob to suit your requirements. This model is rated at 10 amperes, 125 volts A.C. and is outstanding for long life and dependability.

New MODEL MCL-CS



The new Model MR Rotary Cam Lever Switch is designed for one to six index positions. It fills a definite gap, and a definite need, in the multiple contact switch field. With the new Rotary, any combination of contact arrangements can be used in each of the six positions. It is adaptable to actuate practically any number of circuits in sequence (or repeat) with the convenience of a single control knob. Its unique construction provides such features as circular cams for locating from one to five low-friction, roller spring actuators on each cam. A single hole only is required for mounting, and contacts in any section can be removed from frame by removing a single bolt. This switch can be easily rearranged. The Rotary is rated at 10 amperes, 125 volts A.C.

New MODEL MR ROTARY

OTHER GENERAL CONTROL COMPANY PRODUCTS

MODEL MCL-FS

Same construction as MCL-CS except with flat springs for pressure on cams. Contact possibilities are unlimited.

MODEL MCL-MT

Now under development for aircraft and other light duty applications. The lightest switch of its type in the field.

MC MI MH MF

MANUALLY OPERATED (FOOT) SWITCHES

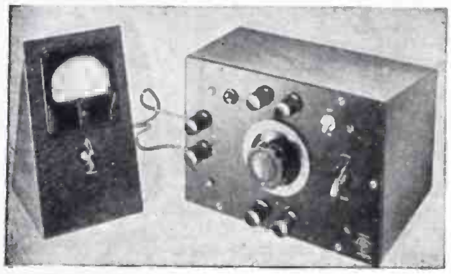
These switches relieve the machine operator, prevent fatigue, increase production and safety. The 35 types cover every application. Send for catalog No. 441.

GENERAL CONTROL COMPANY

1202 SOLDIERS FIELD ROAD, BOSTON 34, MASS.

Comparison Bridge

FOR SPEEDY TESTING of resistors, capacitors or inductors in terms of ohms, microfarads or henries, respectively, the Type LB direct-indicating comparison bridge may be used. Components under test are connected one by one to terminals and are then rejected or passed. Components outside the limits set up (limits may be set with any combination of high or low value, such as −6, +14 percent) will result in a meter deflection.



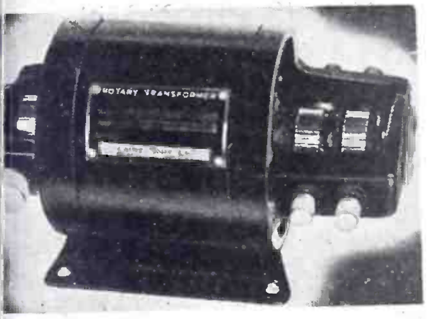
This production-test instrument is an a-c slidewire bridge with a vacuum tube null-indicator arranged so that resistors, capacitors or inductors can be compared with a similar standard. Ranges are:

acitance, between 0.0001 to 1.0 d; resistance, between 2000 ohms l 20 megohms; inductance, be-en 5 and 50,000 henries. The lewire is uncalibrated. External ndards are used. The instrument nprises a main unit which meas-us 7 x 8 x 5½ in., and a separate nter.

Industrial Instrument, Inc., 17 llock Ave., Jersey City, N. J.

ulti-Output Dynamotor

IIS PIECE OF equipment is de-ned to save space and battery crent in mobile applications, par-ularly where a transmitter and receiver are used. The dynamotor capable of delivering simultan-



usly as many as three separate itputs. For instance, it is possible obtain 6.3 volts a.c., "B" power r the receiver, and also high volt-ge for the transmitter.

Carter Motor Co., 1608 Milwau-ee Ave., Chicago, Ill.

onstant-Voltage ransformer

LLUSTRATED BELOW is a small, com-act unit in a hermetically sealed ase, designed for chassis mount-ng. Rated at 6.3 v, 17 va output, his constant-voltage transformer vill maintain that value within ± 1 ercent regardless of line-voltage ariations as great as ± 12 to 15 ercent. This unit is especially

ɪitable for use in stabilizing elec-
ɒn-coupled oscillator circuits.
ectronic equipment in which this
ansformer is included does not
quire filament voltmeters or
ıanual filament-voltage controls.
Bulletin DCV-102 describes this
ıd other new designs of trans-
rmers available from the manu-
cturer, Sola Electric Co., 2525
ybourn Ave., Chicago 14, Ill.

npluse-Initiated Timer

YPE PSEH-1 TIMERS can be sup-
ied for a-c operation on 110 or
20 v, 60 cycles or 25 cycles; or for
c operation at any specified volt-
ge from 6 to 120 v. Typical units
easure $3\frac{1}{2} \times 3\frac{3}{8} \times 3\frac{3}{4}$ in. Contact op-
ation occurs at the end of a delay
terval after power has been ap-
lied, or after receipt of a momen-
ry impulse from a pushbutton,
mit switch, or other source. The
djustable timing range is 20-to-1,
ıd the mechanism is immediately
ecycling. A built-in DP, DT auxil-
ry relay provides a variety of cir-
ıit arrangements common to, or
olated from, the control circuit.
Struthers-Dunn, Inc., 1321 Arch
t., Philadelphia 7, Pa.

ivot Type Ball-Bearings

IVOT TYPE BALL-BEARINGS are avail-
ble in sizes ranging from 2 to 10
ım O.D. They are made of beryl-
um, stainless or chrome steel.
ach bearing is equipped with four
alls of the same material as the
up, and fitted with a retaining cup.
Miniature Precision Bearings,
eene, N. H.

riple-Action Locknuts nd Fasteners

HE MAIN FEATURE claimed for
ype 6NAC Palnut locknuts and
asteners is a triple locking action.
he sides have been extended and
he ends of the petals are turned
n, leaving a hole in the top slightly
maller in diameter than the out-
ide diameter of the bolt. When the
olt extends through the top, it
orces the top open so that a strong
pring pressure is exerted on the
olt, resulting in a triple grip. Be-
ause this spring tension is con-
tant and will hold the nuts in any
esired position on the bolt regard-
ess of vibration, this type of nut
may be used as an adjustment nut

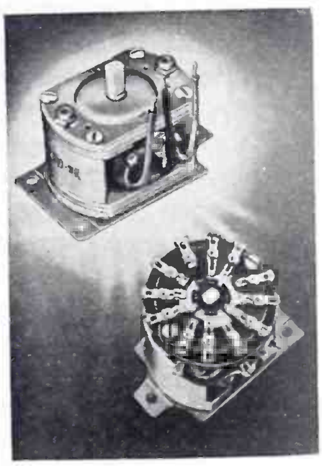
f electrical contacts, and mechan-
il travel-limits.

Type 6NAO nuts may also be u d, because of their light weight, o bolts holding together parts nde of glass, plastic and other sh materials, where a resilient ftening is required that can be thtened without danger of fractring relatively brittle materials. Aother feature of these Palnuts is tat they are all-metal and will terefore withstand high temperaures.

The Palnut Co., 77 Cordier St., Irington, N. J.

otary Relay

D-TROL is a new type of relay hich operates on a rotating balce principle. It is designed espeally for applications involving vere vibration, temperature and hmidity specifications. The basic nit is a compact driving-mechanm providing up to 30 deg of ockwise or counter clockwise rotion. When used to operate switch

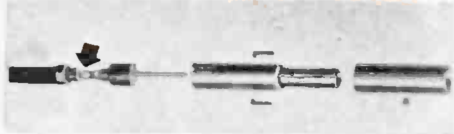


vafers, the basic unit makes a reay providing a great variety of ontact arrangements adaptable for paced wafer switches, or switches n separate compartments. Where witch wafers are not used, a special self-contained coil breakswitch is provided. The unit measres 2½ x 1½ x ¾ in.

Price Brothers Company, Frederick, Md.

Coaxial Plugs and Jacks

TO MAKE SOLDERING of coaxial plugs and jacks an easy and out-in-the-open job, these plugs and jacks are built with sliding sections so that they can be quickly disassembled. The conductors to be soldered are



easily exposed by removing one screw and sliding the sections apart with the fingers. It is not necessary to solder through a window. These plugs and jacks are machined from bar brass and have positive connection between outer conductor and inner conductor. The inner-conductor contacts are silver plated for maximum conductivity. Mycalex is used as insulation.

Andrew Co., 363 East 75th St., Chicago 19, Ill.

Fungus-Proof Resistors and Switches

FIXED WIRE-WOUND resistors (Akra-Ohm), and switches which have been treated with anti-fungus materials and which meet Signal Corps Specification No. 71-2202A are available without any manufacturing delay occasioned by this special treatment.

Shallcross Mfg. Co., Collingdale, Pa.

Aircraft Push-Pull Circuit Breaker

KLIXON D-6751 designates a new aircraft circuit-breaker which makes use of a push-pull feature to permit the opening of the circuit breaker manually. Thus maintenance and repairs to a circuit can be accomplished without de-energizing the entire power system. A deliberate pull is required, and the off position is retained safely against accidental tripping when operating adjacent switches. The push-pull button travels outwardly approximately ¼ in. upon tripping and ex-

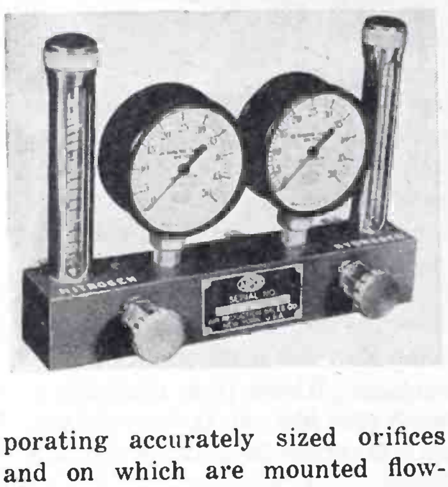
poses a three-colored band which is partly luminous so that indication is given under all conditions. A specially designed shunting-switch is used to provide "non-trip-free" action.

These breakers are lightweight and will carry approximately 120 percent of rated current continuously, and trip ultimately at 138 percent of rated current in an ambient temperature of 25 deg C. Regardless of the mounting position, the units meet shock, vibration and motion requirements, and conform to Navy specifications M-538 and NAF-1213. They are available in ratings from 5 through 50 amps with standard AN mounting dimensions. They are suitable for 30 v, d-c systems.

Spencer Thermostat Co., Attleboro, Mass.

Gas Proportioner

THIS NEW PIECE of apparatus was developed as an aid for electronic tube manufacturers, heat treaters and others who use mixtures of gases for protective atmospheres. It is designed to produce an accurately proportioned mixture of such gases at a pressure not in excess of 5 lb per sq in. The device consists of a mixing block incor-



porating accurately sized orifices and on which are mounted flowmeters, pressure gauges and needle valves as well as inlet and outlet nipples. It can be furnished with any two of six available flowmeters. Flowmeters for hydrogen service cover a range of from approximately 2 to 200 cu ft per hour. For nitrogen, the range is from approximately 6 to 140 cu ft per hour.

Air Reduction Sales Co., 60 East 42nd St., New York 17, N. Y.

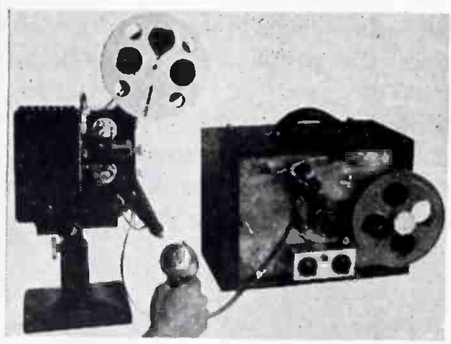
Marking Unit

DELICATE AND precision parts having a ground or mirror surface may be marked without marring by means of a marking unit (Airgrit) which is operated by air pressure and employs a principle similar to sand-blasting except for the fact that it is especially designed for delicate materials. A timing unit aids in making uniform markings.

James H. Matthews & Co., 3942 Forbes St., Pittsburgh, Pa.

Film Recorder

FILMGRAPH IS a new device for permanently recording and reproducing sound on film instantaneously and without processing. The instrument consists of an electromagnetic dual-purpose head (recording and playback), sapphire stylus, motor, and necessary controls and connections. It is available in a cabinet complete with an amplifier, speaker and microphone, (weight is 16 lb), or without these



accessories. Recordings can be made on Filmgraph M-5 special film, on which a number of sound tracks (up to 40) may be recorded, or a recording may be made directly on 16 mm film. Recordings cannot be made directly on 8 mm film because the speed of 8-mm projectors is too slow for good results on this recorder. Where it is desirable to use 8-mm film, it is necessary to use Filmgraph M-5 film as an auxiliary.

Miles Reproducer Co., Inc., 812 Broadway, New York 3, N. Y.

Electronic Weld Controls

TWO TYPES OF welding controls are available. The first of these is Model 40, which is a general-purpose control for seam, spot, or pulsation-welding machines. It is designed for the control of welders

here more than one kind of operaon is to be controlled by a single eneral-purpose control, and parcularly where more than one type f operation is to be performed inrchangeably on the same machine.

Model 41 is specifically designed ɔr production seam-welding conɔl. Heat and cool times repeat utomatically for continuous seamelding until interrupted by the perator. This unit is simple to adıst and is easy to maintain.

Bulletin No. WT-40-41 illustrates nd describes these units in greater etail. It is available from the ıanufacturer, Weltronic Co., 19500 7. Eight Mile Road, Detroit 19, lich.

Literature

'elevision Pamphlets. Two comanies have issued brochures on elevision:

The first of these is entitled 'Television" and the purpose of his 24-page book is to tell the adances of television; its progress ınd promise. A map is included vhich tends to show how east ınd west may be linked in a teleision network. Department of nformation, Radio Corporation of America, 30 Rockefeller Plaza, New York, N. Y.

The second booklet is entitled "The Story of Electronic Teleision" and it attempts to tell the ayman in simple language, and with illustrations, how television s accomplished. Two pages in the back of this 28-page book are devoted to television equipment available from the manufacturer, Farnsworth Television & Radio Corp., Fort Wayne 1, Ind.

Transformer Buletin. A complete range of transformers for small and large electric power requirements are illustrated and described in a bulletin entitled "Standard Transformers For Every Need" available from Standard Transformer Co., Warren, Ohio.

High Frequency Electrical Insulation. The manufacture, surface treatment and precision grinding of ceramics is discussed, and a

table of mechanical and electrical properties is included in Bulletin No. 143. The bulletin also describes and illustrates insulators made of this ceramic material (which is designated AlSiMac No. A196). American Lava Corp., Chattanooga, Tenn.

Thermoswitches. The purpose of this catalog is to introduce the complete line of standard temperature and pressure control apparatus made by this manufacturer. It contains 44-pages of descriptive material, including installation drawings and photographs, plus a brief history of the company. Fenwal Inc., 200 Pleasant St., Ashland, Mass.

Flexible Shaft Machines. Catalog No. 130 illustrates and describes machines for light production work and for maintenance needs on small irregularly-shaped parts which cannot be handled by conventional machine set-ups. Available accessories are also described. Foredom Electric Co., 27 Park Place, New York 7, N. Y.

D-C Motor Control. "Electronic Control of D-C Motors" is a reprint, with changes, of a series of articles on this subject by E. E. Moyer, which appeared in 1943 **Electronics**. This reprint is designated as Filing No. 8930 and the articles in it are "Outline of General Principles", "Reference Voltage and Speed - Control Methods", Extending Speed Range by Electronic Means of Field Weakening", "Starting, Stabilizing, and Reversing", and "Regeneration by Inverter Action, and Stopping." Electronics Section, Industrial Control Engineering Div., General Electric Co., Schenectady, N. Y.

Springs. Catalog No. 44, entitled "Springs for All Purposes", contains a spring design chart. When he dimensions, load and travel distance is known, this chart may be used to find the number of coils and the proper wire size which one should use. Round or square wire 0.006 to 0.375 in. diameter, and strips of 0.003 to 0.187 in. thickness, and of any desired material are available. Types of springs illustrated in the catalog include compression, extension, torsion, clock type, slips and stampings. The Reliable Spring & Wire Forms Co., 3167 Fulton Road, Cleveland 9, Ohio.

Dry Electrolytic Condensers. The many types of dry electrolytic condensers available from this manfacturer are described in Catalog No. 10 which also contains application notes, characteristic charts and size factor tables. Sprague Electric Co. (formerly Sprague Specialties Co.), North Adams, Mass.

Handy Folder. A handy folder, Form C-112-5-4-44, labeled "Federal Telephone and Radio Equipment" is available. It contains literature put out by this manufacturer on Intelin coaxial u-h-f cables; booklet No. C-101-3-2-4 which describes type No. FTR-3 transmitter; booklet No. C-103-3-3-44 on type FTR-5 transmitter. Both of these transmitters are multi-unit types. Also included in the folder are two pieces of literature describing the Megatherm electronic heating unit. One booklet is devoted to the plastics industry, while the other booklet describes sterilization of packaged foods. Federal Telephone & Radio Corp., Newark, N. J.

Questions and Answers on RCA. This 48-page catalog entitled "RCA, What It Is, What It Does—Questions and Answers" is exactly what the title implies. The catalog is carefully indexed according to subject matter. Subjects include research and engineering, pioneering, broadcasting, television, manufacturing, communications, marine radio and technical training. Radio Corp. of America, 30 Rockefeller Plaza, New York 20, N. Y.

Smoke and Combustion Control. Indicators, controllers and recorders for smoke and combustion controls are illustrated and described in an 8-page folder form (Bulletin No. 431). Ess Instrument Co., Fort Lee, N. J.

Resistors. A new 28-page catalog (No. 10E) includes specifications and engineering data on the complete line of Koolohm wire-wound resistors. Resistor Div., Sprague Electric Co., North Adams, Mass.

Temperature extremes from 295°F. o minus 80°F. are just one sample of he varied conditions which "Surco-American" flexible plastic tubing is ible to meet. Over twenty-six different ormulations provide positive and tested qualities such as ageless durability, ion-inflammability, tremendous flexibility, and proof against moisture, all kinds of weather, dilute acids, oils and nost solvents.

Dielectic strength averages 1500 volts per mil. thickness. "Surco-American" is available in any color and in continuous lengths with inside diameters from .005" to 2". Exclusive packaging methods maintain this tubing in its original round form.

Flexible plastic insulated wire is another "Surco-American" pre-tested product—available in all lengths and colors and in wire sizes #12 to #48 A.W.C., solid or stranded, shielded, tinned or silver plated copper wire and cable.

Ask for Bulletins with complete technical data. Address Department C.

Special tubing, tape and wire, extended and molded plastic parts made to specifications.

SURCO PRODUCTS

Surprenant

ELECTRICAL INSULATION CO.

84 Purchase Street, Boston, Mass.

REGULATED POWER SUPPLY

PROVIDES electronically regulated power supply for general laboratory and production testing. Especially useful to supply moderate amounts of d-c power at 180-300 volts.

This instrument is widely used in equipment such as amplifiers, television pulse generators, constant-frequency oscillators.

Other units in the new General Electric line of laboratory measuring instruments include: Visual alignment signal generator, wave meters, wide band oscillosopes, square wave generators. *Electronics Dept., General Electric, Schenectady, N. Y.*

GENERAL ELECTRIC

164-C9

ELECTRONIC MEASURING INSTRUMENTS

TYPE AR 300A

(Manufactured to Army - Navy Specification JAN-212E).

Medium power triode for use as audio-frequency amplifier or modulator and radio-frequency oscillator or amplifier at medium frequencies.

A-F Power Amplifier and Modulator—Class B

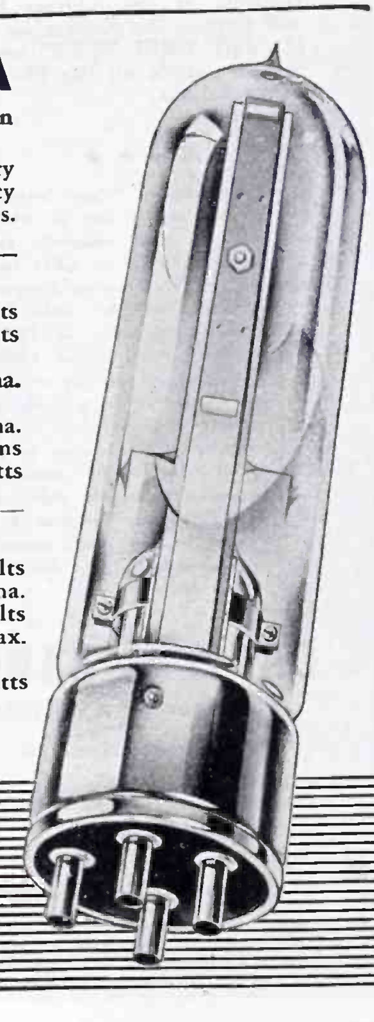
D-C Plate Voltage	2000 volts
D-C Grid Voltage	-105 volts
Zero-signal D-C Plate Current per tube	40 ma.
Max.-signal D-C Plate Current per tube	300 ma.
Load resistance plate-to-plate	8000 ohms
Power Output (2 tubes)	650 watts

Plate-Modulated R-F Power Amplifier—Class C Telephony

D-C Plate Voltage	1500 volts
D-C Plate Current	300 ma.
D-C Grid Voltage	-200 volts
D-C Grid Current	75 ma. max.
Carrier output for mod. factor of 1.0	300 watts

Makers of high-quality Transmitting and Receiving Tubes since 1926.

IN-2-44



ROGERS

ROGERS ELECTRONIC TUBES, LIMITED

TORONTO CANADA

Industrial X-Ray Unit. "Searchray", Model 150, is a self-contained industrial x-ray unit manufactured by North American Philips Co., Inc., for the internal inspection of castings, parts, assemblies, etc., and for locating flaws and defects. This unit is described in folder No. S150 distributed by Walker-Jimieson, Inc., 311 South Western Ave., Chicago 12, Ill.

Adhesive Data. Viscosity, bonding range, and method of application are all contained in a booklet entitled "3-M Adhesive Data" which is designed to serve as a reference book to anyone using adhesives or coating materials, impregnators, spray-on insulators and sound-deadening compounds. Minnesota Mining & Mfg. Co., 411 Piquette Ave., Detroit 2, Mich.

Frequency Meters. Type 21-FX miniature frequency meter, which supersedes Model 21-F, is described in Bulletin VF-43-lb. Meters which operate on 60, 120, and 400 cps are available. These meters are designed to match other $2\frac{1}{2}$ in. panel instruments. J-B-T-Instruments, Inc., 441 Chapel St., New Haven 8, Conn.

Introductory Booklet. "Let Lewyt Do It" is the name of a brochure which illustrates and describes the facilities this company has to offer other manufacturers in the production of mechanical and electrical products. Some of the jobs they do include tool and die, machine work, sheet metal, welding techniques, mechanical and electrical assembly, product finishing, inspection and production engineering. Lewyt Corp., 60 Broadway, Brooklyn 11, N. Y.

Coaxial Transmission Line. Type 83 ($\frac{7}{8}$ in. diameter), a low loss coaxial transmission line for high or uhf radio frequencies is illustrated and described in Bulletin No. 29, which also contains descriptions of accessories for this line. Andrew Co. 363 East 75th St., Chicago 19, Ill.

Spot Welders. This is the name of a 58-page catalog, No. CE-44W, which shows all types of standard and many special resistance welding machines manufactured in ca-

pacity ranges from 3 kva to heavy duty models up to 500 kva. Another booklet available is called "Light Type Bench Spot Welders" and this booklet features small spot welding machines from ¼ to 3 kva. Eisler Engineering Co., 740 S. 13th St., Newark 3, N. J.

Connector Chart. Type K and RK wall chart, No. 3, contains, in condensed form, material on K connectors. It is for use in schools and factories for the instruction, identification, assembly, ordering, servicing or repair of these connectors and accessories. It is free of charge and is available from Cannon Electrical Development Co., 3209 Humboldt St., Los Angeles, Cal.

Story of Tubes. "It Was a Tube They Wanted" is the name of brochure which briefly tells of the part tubes played in the summer of 1940. It contains illustrations and descriptions of the part this laboratory played in producing tubes. Amperex Electronic Products, 79 Washington St., Brooklyn, N. Y.

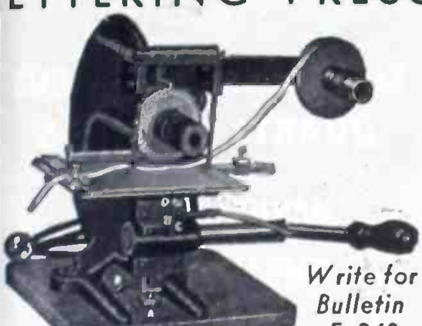
Pilot Light Assemblies. "Pilot Light Assemblies for Panel Board and Instrument Signaling" is a 24-page catalog and data book which illustrates and describes pilot light models for a wide range of applications and voltages, including variable intensity and fixed types. Lamps, brackets and accessories are also listed. Gothard Mfg. Co., 1300 N. Ninth St., Springfield, Ill.

Resistance Material. A brief description of this manufacturer's resistance material having negative temperature coefficient is presented in a folder which also contains a graph of typical characteristics of resistance units. Keystone Carbon Co., Inc., St. Marys, Pa.

Colored Brochure. This beautifully colored brochure contains reproductions of various advertisements of this manufacturer's war effort. A very brief description is included of Model SCR-299 mobile radio station. The Hallicrafters Co., Chicago 16, Ill.

NUMBERALL

NUMBERING and LETTERING PRESS



Write for Bulletin E 240

An ideal machine for hot stamping letters and figures on plastic name-plates, and other small parts, with the use of colored roll leaf. Furnished with an electric heating element, and rheostat for regulating heat. All figures and entire alphabet are on one dial.

•

We also make numbering machines . . . automatic and non-automatic . . . for stamping, either hot or cold, numbers and letters into various materials.

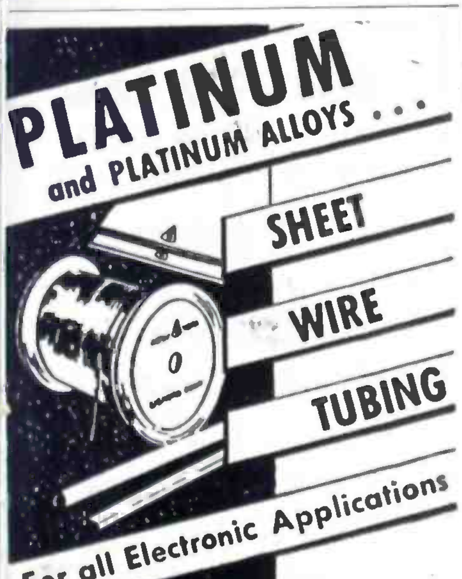
NUMBERALL STAMP & TOOL CO.
HUGUENOT PARK STATEN ISLAND 12, N. Y.

Air and moisture cannot penetrate this transformer case. That's why climatic extremes do not affect the unfailing performance of Peerless hermetically-sealed transformers.

PEERLESS

ELECTRICAL PRODUCTS CO.

6920 McKINLEY AVENUE, LOS ANGELES 1, CALIFORNIA



Platinum metals scrap and residues refined and reworked on toll charges; or purchased outright by us . . .

Write for list of Products. Discussion of technical problems invited . . . .

SIGMUND COHN & CO.
44 GOLD ST. NEW YORK
SINCE 1901

ENGINEERS . . . .

Are You Concerned With YOUR POST WAR FUTURE ?

The Federal Telephone & Radio Corporation, the manufacturing unit of the International Telephone & Telegraph Corporation with its multiple business activities extending to all parts of the civilized world, will accept applications from experienced men for immediate employment with almost limitless post war possibilities. These positions should interest those with an eye to the future and whose interest lies in forging ahead with this internationally known organization whose expansion plans for post war are of great magnitude covering all types of radio & telephone communications. Advancement as rapid as ability warrants. Majority of positions are located in the New York area!

We need the following personnel! Men with long experience or recent graduates considered.

- *ENGINEERS*
  - ELECTRONICS
  - ELECTRICAL
  - RADIO
  - MECHANICAL
  - CHEMICAL
  - TRANSFORMER DESIGN
- SALES AND APPLICATION ENGINEERS
  - PHYSICISTS
  - DESIGNERS
  - DRAFTSMEN
  - TOOL DESIGNERS
  - TECHNICAL WRITERS

Look Ahead With Federal!

If inconvenient to apply in person, write letter in full, detailing about yourself, education, experience, age, etc., to Personnel Manager

FEDERAL TELEPHONE & RADIO CORP.
39 Central Avenue
EAST NEWARK NEW JERSEY

NEW BOOKS

Plastics in the Radio Industry

By E. G. Couzens and W. G. Wearmouth, *Hulton Press, Ltd., 43 Shoe Lane, London, E. C. 4, 60 pages, price /8.*

Publishers of *Electronic Engineering* are issuing a series of technical monographs to give radio engineers and students at low cost information that could only be obtained otherwise from a number of books and periodicals. The title is justified largely by the fact that the last of six chapters gives special attention to electrical and dielectric properties of plastics. Tables of comparative properties and graphic charts showing variation of power factor and dielectric constant with temperature are included in this chapter.

The first three chapters give a brief chemical picture of the different types of plastic materials and their manufacture, with the aid of numerous reproduced photographs. These are followed by a chapter devoted to physical properties of plastic products made of different materials and another describing the different methods of fabrication.

Appendices give miscellaneous information such as analyses or names of cements and solvents, how to identify the raw materials by heating tests, and a bibliography of books and articles on plastics.—M.G.V.

• • •

Calculus Refresher for Technical Men

By A. Albert Klaf, *Civil Engineer, Board of Water Supply, City of New York. Whittlesey House, McGraw-Hill Book Co., New York, 1944, 431 pages. Price $3.00.*

Designed for the engineer who has allowed his calculus to get a little rusty, this work serves the purposes of review most effectively by its unusual arrangement as a series of questions with related and full answers. This format likewise helps in reference because each question is set forth in boldface type so a particular point is easy to find.

Subject matter is divided into three sections, one each for differential and integral calculus, and a third presenting applications of calculus to various fields of technology. The integral calculus section includes an introduction to differential equations. All through, the text is illuminated with illustrative examples and problems. Answers are provided in an appendix.

While the volume is primarily set up for use by a technical person with previous training in calculus, the sequence, scope, and depth of the presentation make it equally suitable for use by the student getting his first introduction to the subject.—F.H.

• • •

Radio Waves and the Ionosphere

By T. W. BENNINGTON, *British Broadcasting Corp. Iliffe & Sons Ltd., Dorset House, Stamford St., London, S. E. 1. 85 pages, price 6/-net, 1944.*

MANY WHO WORK with radio or make a hobby of short-wave broadcasting and receiving, but who do not have use for mathematical conceptions of short-wave propagation as the subject is usually presented, will be interested in this little book. Its aim is to explain short-wave communication, and in particular the part that the ionosphere plays in bending radio waves around the earth, in as simple language as possible without any mathematics.

Although the book is not a textbook, it can be recommended as preliminary reading for anyone who is planning to delve deeper and master the mathematics involved.

The six chapters of the book deal with ground waves vs. sky waves, the ionosphere and its characteristics, how the ionosphere is sounded, its variations, long-distance transmission, and disturbances and other abnormalities of the ionosphere.—M.G.V.

• • •

Electronics Today and Tomorrow

By JOHN MILLS, *published by D. Van Nostrand Co., 250 Fourth Ave., New York, N. Y., 1944, 178 pages, price $2.25.*

THE AUTHOR GIVES THE READER the benefit of his more than 30 years of teaching, writing, study and working in the field of electronics. Starting with electrons, he discusses the history of their discovery and in-

CONTACTS

FOR THE FIELD OF ELECTRONICS

Continuously Since 1930

PRECISION GROUND *Crystals* BY HIPOWER

AIRCRAFT · MARINE · BROADCAST · POLICE · COMMERCIAL · AMATEUR

HIPOWER CRYSTAL COMPANY
Sales Division — 205 W. Wacker Drive, Chicago 6
Factory — 2033 Charleston St., Chicago 47, Ill.

MORE RF KILOWATT HOURS PER DOLLAR WITH

F & O
TRANSMITTING TUBES

Inquiries Invited—Let us explain how Savings are effected and the F & O greater guarantee.

FREELAND & OLSCHNER PRODUCTS, Inc.
611 Baronne St., New Orleans 13, La.
Raymond 4756

High Power Tube Specialists Exclusively (¼ To 100 KW)

Electron Tube Machinery

of every type,—standard, and special design

Specialists in Equipment for the manufacture of Radio Tubes, Cathode Ray Tubes, Fluorescent Lamps, Incandescent Lamps, Neon Tubes, Photo Cells, X-ray Tubes and other glass or electronic products, on production or laboratory basis.

Kahle
ENGINEERING COMPANY
1307-1309 Seventh St., North Bergen, N. J.

MICROMETER FREQUENCY METER
for checking transmitters from 1.5 to 56 mc., within 0.01 per cent

LAMPKIN LABORATORIES
Bradenton, Fla., U. S. A.

We Manufacture a complete line of equipment

SPOT WELDERS, electric, from ¼ to 50 KVA
TRANSFORMERS, special and standard types
INCANDESCENT LAMP manufacturing equipment
FLUORESCENT TUBE MAKING EQUIPMENT
ELECTRONIC EQUIPMENT, vacuum pumps, etc.
WET GLASS slicing and cutting machines for laboratory use
GENERAL GLASS working machines and burners.
COLLEGE GLASS working units for students and laboratory

AC ARC WELDERS From 100 to 400 Amps.

EISLER ENGINEERING CO.
731 So. 13th St. (near Avon Ave.) Newark, New Jersey

Save Fingers with Steel-Grip Finger Guards

Hundreds of factories are saving time and injuries in war production by protecting workers with Steel-Grip Finger Guards. Used for handling rough or sharp articles, for buffing, grinding, sanding, polishing, punch press work and hundreds of other jobs. Protect fingers or thumb, front or back, from cuts, abrasions or blisters. Made of durable leather with elastic web back for snug, cool, comfortable fit. Easy on and off. One size fits all, men or women. Send 10c each for samples or trial order box of 50 at 8½c each, less 10%.

Catalog of Steel-Grip Safety Apparel free on request

OLD HICKORY STEELGRIP
Famous Industrial (Safeguards Since 1910

INDUSTRIAL GLOVES COMPANY
325 Garfield, Danville, Illinois
In Canada SafetySupplyCo., Toronto)

CUP WASHERS

for Binding Screws

WHITEHEAD
WHITEHEAD STAMPING CO.
1691 W. Lafayette St., Detroit 16, Michigan

Strip Insulated Wires QUICKER...BETTER

with *"Speedex"*
AUTOMATIC WIRE STRIPPER
... Speeds Production

Strips insulation from all types of wire — instantly, easily, perfectly. Just press the handles and the job is done. Cuts wire too. Strips 800 to 1000 wires per hour. Available for all size solid or stranded wires —No. 8 to No. 30. List Price $6.00.

Write Dept. E For Full Particulars

GENERAL CEMENT MFG. CO.
Rockford, Illinois, U.S.A.

FINE RIBBONS OF TUNGSTEN MOLYBDENUM

Making a modest but effective contribution in Electronics' War accomplishments.

H. CROSS
15 Beekman St. New York

AIRCRAFT COMMUNICATION AND CONTROL UNITS
FABRICATION OF ELECTRONIC EQUIPMENT AND SUB-ASSEMBLIES
CHASSIS WIRING
CABLE ASSEMBLIES
ANTENNA SYSTEMS
ELECTRO-MECHANICAL ASSEMBLY
SHORT PRODUCTION RUNS

Aeronics Inc.
132 NASSAU ST. NEW YORK 7, N.Y.

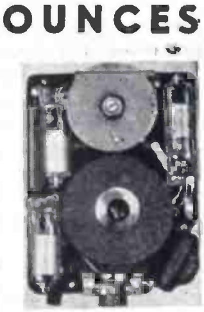
This
CONTACTS
Section

supplements other advertising in this issue with these additional announcements of products essential to efficient and economical production and maintenance. Make a habit of checking this page, each issue.

Departmental Staff
ELECTRONICS

ONLY 3 OUNCES

Small 3-Stage AMPLIFIER



Only 2⅛" by 3" by ⅝"

DOES YOUR PRODUCT REQUIRE A MORE COMPACT AMPLIFIER?

We are specialists in the art of conserving space. Your inquiries are invited.

PARAPHONE HEARING AID INC.
2056 East 4th Cleveland 15, Ohio

Radio AND ELECTRONIC DEVICES

BURSTEIN-APPLEBEE CO.
1012-1014 McGee St. • Kansas City 6, Missouri

dicates their characteristics. To illustrate the principles involved he gives a detailed explanation of lightning—both natural and man-made.

Next comes a discussion of various types of electron tubes, how they work and functions which they can perform. Each type of tube is described separately and is introduced with a brief historical sketch of its development. Following this are sections on electron microscopes, the ultra highs or microwaves, ultra-high-frequency generators and cyclotrons.

Mr. Mills' style makes easy reading. All physics and electricity not immediately needed have been ruthlessly omitted. His analogies are appropriate and help immeasurably to explain the highly technical phases of electronics and electronic equipment for the benefit of non-technical readers. However, even electronic technicians should at least enjoy reading the book, and the author's viewpoint and method of handling the material might well stimulate people in the field to greater heights of research, invention and developments.—K.S.P.

SEARCHLIGHT SECTION

POSITIONS VACANT

ELECTRICAL ENGINEER—Large progressive company located in East, now 100% on War Work, needs services of electrical engineer—experienced in transformer and motor design—able to meet and discuss technical problems with customers. Permanent job with a splendid future for the right man. Please give age and experience. P-713, Electronics, 330 W. 42nd St., New York 18, N. Y.

WANTED: Radio Engineers with experience in frequency modulation transmitting and receiving equipment. Familiarity with F.C.C. rules and field operation of equipment desirable. Please give complete experience and education in letter of application, and state salary desired. Company located in the Midwest where living conditions are good, and expenses below average. P-714, Electronics, 520 N. Michigan Ave., Chicago 11, Ill.

PRODUCT ENGINEER—Major manufacturer of electrical wiring devices has a special interest in employing a designer-engineer with a proved record of accomplishment. Firm possesses far-sighted management, varied production facilities, and ample capital to undertake and promote new products—the scope and opportunity of the position are limited only by the skill, imagination and initiative of the man. Salary open—location, New England. All applications will be held in strict confidence. Write even though a U.S.E.S. release might not be immediately available. P-715, Electronics, 330 W. 42nd St., New York 18, N. Y.

EMPLOYMENT AGENCY

ELECTRONICS—More positions are coming in daily for well qualified men in Electronics. Our service is Nation wide and covers all branches of Engineering. More than 51 years at the same address. The Engineering Agency, Inc., 53 W. Jackson Blvd., Chicago 4, Illinois.

EMPLOYMENT SERVICE

SALARIED POSITIONS — This advertising service of 34 years' recognized standing negotiates for high salaried supervisory technical and executive positions. Procedure will be individualized to your personal requirements and will not conflict with Manpower Commission's. Retaining fee protected by refund provision. Identity covered and present position protected. Send for details. R. W. Bixby, Inc., 278 Delward Bldg., Buffalo 2, N. Y.

WANTED

SENIOR Radio Engineers

Executive type with thorough practical and educational background in radio and electronics. Must have substantial experience and demonstrated initiative in design, research, and development. Capable of supervising development and production engineers. Excellent working conditions. Permanent positions with ample opportunity for advancement. Outline complete details of qualifications, experience, and when available. Salaries open. Confidential inquiries respected. Write.

Personnel Director

AIR COMMUNICATIONS, INC.
Kansas City 10, Missouri

POSITIONS WANTED

ENGINEER for development, production, promotion of a product or group of products for now and post-war. Unusual record; electrical, chemical and mechanical. Age below 35. PW-712, Electronics, 330 W. 42nd St., New York 18, N. Y.

ENGINEER age 42, 10 years practical experience in Electronics, radio and audio-frequency amplifiers, loud speakers and microphones. Desires a position in a research and development laboratory. L. J. F. 128 Colorado Ave., Buffalo 11, N. Y.

EXPERIENCED EXPORTER desires to join progressive manufacturer of radios to organize foreign sales. PW-716, Electronics, 330 W. 42nd St., New York 18, N. Y.

REPRESENTATIVE AVAILABLE

SUCCESSFUL NEW YORK firm of electronic representatives with an established trade of twenty years continuous contact with distributors, industrials, laboratories and government agencies wishes to add additional lines such as tubes, capacitors, resistors, relays, meters or allied electronic parts. RA-691, Electronics, 330 W. 42nd St., New York 18, N. Y.

WANTED

DEVELOPMENT ENGINEERS

Mechanical and electrical. Graduate or equivalent training. Required for development work in the following branches:

1. Electro-mechanical devices, communication systems. Must be interested in development and familiar with magnetic circuits.
2. Measuring and control instruments. Background should be in electrical engineering, including electronics.

Statement of Availability Required.

P-682, Electronics
330 West 42nd St., New York 18, N. Y.

RADIO EXECUTIVE

Medium size midwest radio - electronics manufacture seeks assistant chief engineer capable of wider responsibilities. Salary open. All queries confidential. Write

P-711, Electronics
520 N. Michigan Ave., Chicago 11, Ill.

WANTED

SALES MANAGER

Long established mid-western manufacturer of electrical equipment—electro-magnetic relays — solenoids—switches—selling principally to manufacturers in the following industries:

Automotive
Farm Equipment
Radio
Aircraft
Industrial Controls

Man selected for this position must have sufficient engineering knowledge of our products and their uses to be able to discuss them intelligently with engineers; to visualize potential markets, to suggest new products, and developments.

Write, giving complete resumé of past experience, salary desired etc. to

SW-693, Electronics, 520 North Michigan Ave., Chicago 11, Ill.

WANTED

ELECTRONIC ENGINEER

to work 100% on the job—rather than 25% actual work and 75% "holding the job."

The Engineer we need must have substantial experience and demonstrated initiative in design, research and development.

The position offers an excellent opportunity with a well-established company in western New England, employing over 100 personnel. This company's 5 years pre-war industrial background assures a continued program of post-war advancement.

P-686, Electronics
330 West 42nd St., New York 18, N. Y.

ELECTRONIC

ENGINEERS
TECHNICIANS
DESIGNERS
DRAFTSMEN
TUBE TECHNICIANS

EXCELLENT OPPORTUNITIES IN A MAJOR POST-WAR FIELD!

Openings available at our Research Laboratories and Electronics Manufacturing Unit. Leaders in the design and development of vital electronic equipment for the Armed Forces.
Essential workers need release.
Write, stating Experience, Education, Draft Status, Salary. Include snapshot if available. Or apply to

SPERRY
GYROSCOPE COMPANY, INC.
RESEARCH LABORATORIES
STEWART AVE. & CLINTON RD.
GARDEN CITY, NEW YORK

SYLVANIA ELECTRIC PRODUCTS, Inc.

has openings for

Electrical Engineers Mechanical Engineers

to work with us on the design, development and production of radio tubes, fluorescent lamps, electronic equipment and devices.

Men experienced in using their talents while working under pressure and who are looking ahead for greater development in the post-war world are invited to write to us giving age, education and experience to our

Industrial Relations Department

500 Fifth Ave., New York (18), N. Y.

IMMEDIATELY AVAILABLE

An Ohio sales organization thoroughly versed in Radio-Electronics, contacting Government Agencies, leading Industrial, wholesale and retail clientele, ready to negotiate with outstanding manufacturers for immediate and post war representation as distributor, dealer or representative.

ELECTRONIC SALES CO.
402-5 Mutual Home Bldg., Dayton 2, O.
Adams 5208

Additional Employment Ads on pages 348, 352, 354 & 379

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

PHYSICISTS and ELECTRICAL ENGINEERS

Needed in connection with the manufacture of a wide variety of new and advanced types of communications equipment and special electronic products. Openings for Electrical Engineers available in St. Paul, Minn., Eau Claire, Wisc., and Chicago. Apply or write, giving full qualifications and furnish snapshot.

D.L.R.—Employment Dept.

WESTERN ELECTRIC COMPANY
Hawthorne Station Chicago 23, Ill.

IS YOUR OPPORTUNITY HERE?

Think this over carefully. Where do you go from the spot you're in now? Are your surroundings friendly and full of promise for the future? Consider now the place you might fill in the electronic industry leadership assured to the fine staff of engineers, scientists, technicians at NATIONAL UNION RADIO CORPORATION. We're all young in years and ideas though most of us are old in electronic experience. We enjoy working together. We know we're going places! We're inviting you to join us if you have the qualifications. If you're looking for a success pattern for your future, it may be here with us at National Union. Find out! Come in and talk it over or write us!

NATIONAL UNION WANTS:

- **QUALITY CONTROL ENGINEER and SENIOR TUBE ENGINEERS** —These men MUST have executive ability and extensive experience with radio tube manufacture. The pay and opportunities are commensurate with your ability.
- **COMMERCIAL ENGINEERS** —Men with pleasing personalities, initiative and a knowledge of vacuum tube applications.
- **QUALITY CONTROL MEN**—Statistical Training is chief requirement though a knowledge of vacuum tubes will help.
- **JUNIOR ENGINEERS—MEN or WOMEN**—If you have a college degree in Physics, Electrical Engineering, Mathematics or Chemistry and are the type of young person who is able to 'go places', you'll be starting with your best foot forward if you are accepted at National Union Radio Corporation.
- **FOREMEN and ASSISTANT FOREMEN**—Men with foremanship experience in Exhaust, Steam and Grid operations in radio tube manufacture.
- **TECHNICIANS**: Maybe you've been repairing radios, maybe you've gained a knowledge of circuits by working on test equipment. It makes no difference either way if you have the 'know how' of circuits write us about the opportunities we have to offer!

WOMEN!

We have a number of fine young women engineers with us now. We need more. If you have a degree in Electrical Engineering, Physics, Chemistry or Mathematics and are seeking career opportunities, investigate.

Phone or Write

DR. L. GRANT HECTOR, Director of Engineering

NATIONAL UNION RADIO CORPORATION

RESEARCH LABORATORIES

Plane St. at Raymond Blvd. Newark, 2, New Jersey

WMC RULES OBSERVED

OPPORTUNITIES TO "*GROW*"

A leading organization in New England with extensive present and postwar development program in commercial electronics wants mechanical and electrical engineers of proved talent for engineering and development work. Company now producing mechanical, electrical and electronic instruments for war purposes. Permanent positions for right men. Reply by letter giving complete outline of education, experience, and personal statistics. Address:

P-702, Electronics
330 West 42nd St., New York 18, N. Y.

WANTED

ELECTRONIC ENGINEER

Having Experience in Industrial Applications

Consulting radio engineering firm starting Industrial Electronics Department offers permanent position to experienced man to head department, and to a number of assistants having knowledge of Industrial Applications of Electronics—controls and heating. Some engineers also required having experience in broadcasting. Immediate need is for essential war work.

P-708, Electronics
330 W. 42nd St., New York 18, N. Y.

Openings For

RADIO ENGINEERS

ELECTRICAL ENGINEERS

MECHANICAL ENGINEERS

In the development and production of all types of radio receiving and low-power transmitting tubes. Excellent post-war opportunities with an established company in a field having unlimited post-war possibilities.

Apply in person or in writing to:

Personnel Manager

RAYTHEON MANUFACTURING CO.

Radio Receiving Tube Division

55 Chapel St. Newton, Mass.

FIELD SERVICE ENGINEERS

For Domestic and Foreign Service

Must possess good knowledge of Radio

Essential workers need release

HAZELTINE ELECTRONICS CORP.

58-25 Little Neck Parkway Little Neck, L. I.

ENGINEERING OPENING

Project Supervisor

Permanent position with an established concern manufacturing communications equipment.

Prefer top-notch man with UHF experience who can take charge of development or design project.

Salary commensurate with ability. Additional compensation for assignment of patents to company.

Pleasant working conditions.

W.M.C. rules observed.

Address

DALE POLLACK
Engineering Director
TEMPLETON RADIO COMPANY
Makers of Temple Radios
MYSTIC, CONN.

A Rare Opportunity for Several Top-flight Radio and Mechanical Engineers

The Research and Development Division of this Company, which has made an enviable reputation in the design and production of radio communications equipment both before and since Pearl Harbor, can offer a worth-while future to several men of first class talent and training.

The radio engineers must have proved exceptional ability in designing radio communications, radar, air traffic control or fire control equipment, during at least three years of experience.

The mechanical engineers will be called on for outstanding skill in the design of small, intricate mechanical parts. The need is for men who are rich in ideas and mature in judgment.

If you can qualify, and are giving serious thought to future security, write us fully stating age, education, experience, draft status and compensation desired. Must comply with W.M.C. regulations. Our staff knows about this advertisement.

P-707, Electronics
520 North Michigan Ave., Chicago 11, Ill.

SENIOR RADIO ENGINEERS

Top bracket midwest radio-electronics manufacturer has present and postwar positions for three development, two research, and one specifications and standards. Salaries open. Confidential inquiries respected. Write

P-709, Electronics
520 N. Michigan Ave., Chicago 11, Ill.

Electronic Engineer or Electrical Engineer with High Frequency Experience

A desirable position is open in the Electronic Research Division of one of our clients, a stable, well established, industrial concern in the northwest part of Chicago. Man with mechanical engineering background preferred. Position has to do with the manufacturing problems of industrial electronic equipment and is permanent. Give full information as to extent and nature of education and experience, salary expected, age, draft and marital status.

Business Research Corporation
79 West Monroe St., Chicago 3, Ill.

ENGINEERS WANTED AS

APPLICATION ENGINEERS

Exceptional opportunity for several bright men; graduate engineers or equivalent, with imagination and ability to prove equipment and application. Radio, ultra high frequency or communication experience an asset. These positions provide excellent post war possibilities with one of the largest communication manufacturers in the world.

Write in full details, age, experience, education to Personnel Manager.

FEDERAL
TELEPHONE & RADIO CORP.
The Mfg. unit of the I. T. & T.
39 Central Ave., East Newark, N. J.

Electrical Engineer

Wanted as chief of research and development section of a Metropolitan N. Y. division of nationwide manufacturer. Must have a sound educational background and outstanding design experience on light equipment. Salary open. Reply in confidence giving complete personal data, experience resume, availability for release, etc. to

P710 Electronics
330 West 42nd St., New York 18, N. Y.

WANTED

Graduate Junior and Senior Mechanical and Civil Engineers

Excellent immediate and post-war opportunity for qualified engineers who have specialized on Stress Analysis.

Apply by letter only to:

LEAR AVIA, INC.
PIQUA, OHIO
R. J. Biggs, *Special Representative*

WANTED

SENIOR ENGINEER

with at least seven years industrial experience in important electronic research and development work. Capable of executing important assignments from development to finished products.

JUNIOR ENGINEERS

with sound educational background and at least one year's experience in factory or engineering departments.

RADIO TECHNICIANS

with factory or model shop experience in building test equipment on production testing electronic equipment.

MECHANICAL ENGINEER

preferably experienced in electronic field.

PRODUCTION MAN

experienced in setting up and supervising production lines.

These positions offer unusually good permanent opportunities—top compensation commensurate with qualifications—congenial, progressive organization with new and one of the best equipped laboratory and factory facilities in the industry. Interesting work on most advanced type of military communication equipment now and broad field of quality radio-phonograph and industrial electronics after V-Day. Please write detailed qualifications, including availability, if not occupied to full extent of ability in war work, to Dept. F.

THE MAGNAVOX COMPANY
Fort Wayne, Indiana

TECHNICAL MANUSCRIPT WRITER

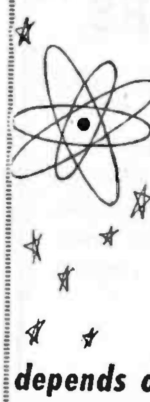
TO ASSIST ENGINEERS WITH PREPARATION OF MANUSCRIPTS FOR PUBLICATION, AND TO SUPERVISE PREPARATION OF INSTRUCTION BOOKS FOR RADIO EQUIPMENT. SALARY COMMENSURATE WITH ABILITY AND EXPERIENCE. SEND COMPLETE DETAILS OF EXPERIENCE, DRAFT STATUS, AND RECENT PHOTOGRAPH IN FIRST LETTER. STATE SALARY EXPECTED, AND IF NOW EMPLOYED IN WAR INDUSTRY, STATE CONDITION OF AVAILABILITY.

ADDRESS: DALE POLLACK,
CHIEF ENGINEER

TEMPLETONE RADIO COMPANY
MYSTIC, CONNECTICUT

Your Future

AS A
- Radio Engineer
- Assistant Engineer
- Layout Draftsman
- Laboratory Assistant
- Quality Tester
- Analyser
- Phaser



depends on what you do now!

Why not find out what Motorola offers you in future security, rapid advancement, recognition, and salary increases. The positions open are in Development, Specifications, Production, Engineering and Test Equipment. List your qualifications on one side of a sheet of paper. Name the position you want. We'll send you the details. Get your letter in the mail today.

Motorola Radio
GALVIN MFG. CORPORATION, 4545 AUGUSTA BLVD., CHICAGO 51, ILL.

WANTED

AC-DC MOTOR ENGINEER

Thoroughly experienced in development of small fractional H/P DC Aircraft motors and similar electro-mechanical devices. Good post-war opportunity. State age, education, complete experience, draft status, salary. Replies confidential.

F. A. Smith Manufacturing Co., Inc.
P. O. Box 509 Rochester 2, N. Y.

WANTED

ENGINEER

EXPERIENCED IN THE MANUFACTURING OF

TRANSFORMERS

GOOD FUTURE WITH GROWING CONCERN

Our employees have been informed of this Ad

LOCATION CHICAGO

P-703, Electronics
520 N. Michigan Ave., Chicago 11, Ill.

WANTED

PRODUCT DESIGN ENGINEERS

by a long established manufacturer of electrical equipment — electro-magnetic relays — solenoids — switches. Located in small midwestern city, convenient to Chicago.

Relays, solenoids, switches, and related items to be designed, are primarily for

Automotive
Farm
Radio
Aircraft and
Industrial Control Equipment

Write, giving complete resumé of past experience, salary desired etc. to

P-694, Electronics
520 North Michigan Ave., Chicago 11, Ill.

An Exceptional Opportunity for Research Scientists

One of America's largest organizations engaged in conducting research for industrial corporations and governmental agencies is expanding its present staff of 300 people.

Research-minded engineers and scientists, who can measure up to this organization's high standard, are invited to investigate the wartime and postwar opportunities of the Armour Research Foundation.

Important work of challenging interest is open to scientists in the following fields:

Physics	*Automotive Engineering*
Chemistry	*Chemical Engineering*
Metallurgy	*Electrical Engineering*
Ceramics	*Mechanical Engineering*
Electronics	*Civil Engineering*

Men and women who can be released from present duties and meet the above qualifications are assured salary and opportunity commensurate with ability. And, future research commitments promise postwar permanence. If you are interested, please write immediately.

[Applications are also invited from scientists who are on leave of absence from educational institutions for the duration.]

ARMOUR RESEARCH FOUNDATION
39-A West 33rd Street, Chicago 16, Illinois

Progressive Brooklyn manufacturer of automatic machinery requires services of young man with knowledge of the theory of electronics for use in development work on electronic controls. Excellent post war future.

American Machine & Foundry Co.
5502 Second Ave., Brooklyn, N. Y.

WANTED

ELECTRONIC SALES ENGINEERS

Aggressive, well-established Electronic Tube Manufacturer, located in Midwest, requires Sales-Engineers to cover Midwest, or East Coast. Applicants should have electrical engineering degree, knowledge of electronic circuits and applications, and ability to contact customers. Excellent wartime and postwar opportunity for the right men. Salary and bonus. Please give complete information in reply.

SW-704, Electronics
520 North Michigan Ave., Chicago 11, Ill.

TECHNICAL MANUSCRIPTS
INSTRUCTION MANUALS
CONSULTATION SERVICE

In All Phases of Electronics

INDUSTRIAL ELECTRONICS, INC.
21 Henry St. Detroit 1, Mich.

FOR SALE

30 Weston Type 425 Round Bakelite Case Thermogalvanometers. 0 to 115 Milliamperes. Good Condition. Price: $10.00 each.

BLILEY ELECTRIC CO.
Union Station Building ERIE, PENNA.
Telephone 26-857

FOR SALE

2 High Frequency Generators

2 k.w. output, 3 phase, up to 50 megacycles, suitable for experimental work only.

Forest Products Engineering Co.
Manhattan Building Chicago, Ill.

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.

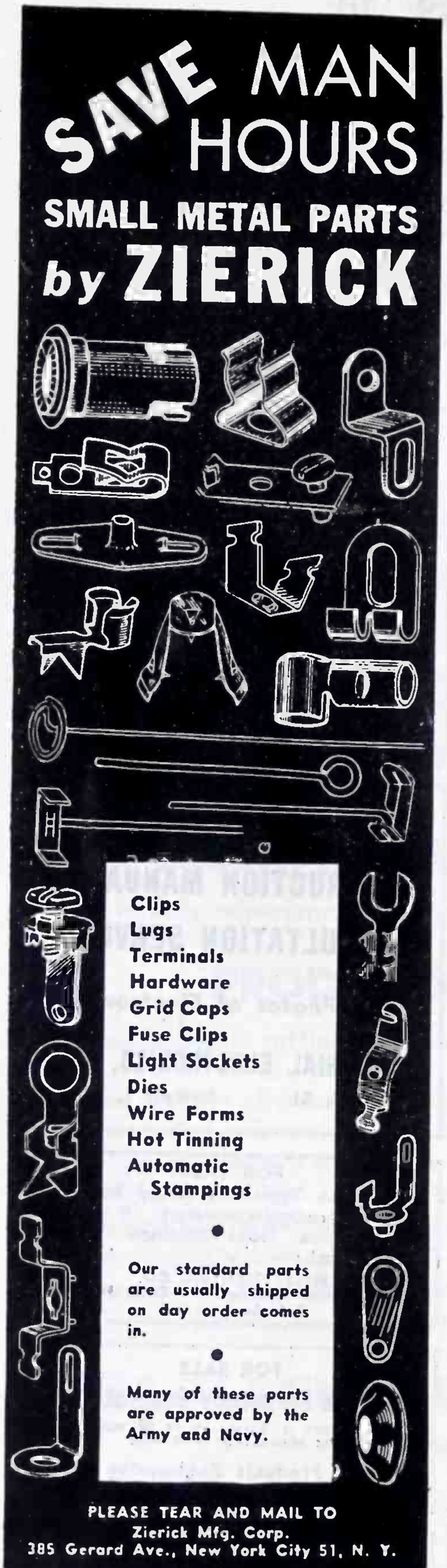
AMERICAN ELECTRICAL SALES CO., INC.
65-67 East 8th St. New York, N. Y.

MOTORS

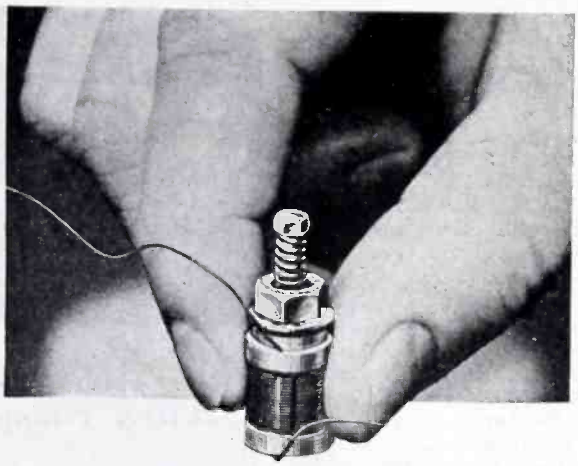
Fractional H.P. Motors/Armatures
Rewound-Rebuilt

Ship at our expense. All work guaranteed. Highest grade materials used throughout.

IMPERIAL ELECTRIC COMPANY
100 Blackstone St., Woonsocket, R. I.



INDEX TO ADVERTISERS



There's No "IF" About This I-F TRANSFORMER

It's a tested and proved product. Developed and used with excellent results in high priority radio and electronic equipment, this permeability-tuned, precision built LS-1 Transformer is now available for other applications.

Better get the complete story on the LS-1. It may come in mighty handy in connection with some of your present or projected components. Write to

CAMBRIDGE *Thermionic* CORPORATION

439 CONCORD AVENUE • CAMBRIDGE 38, MASSACHUSETTS

SEARCHLIGHT SECTION
(Classified Advertising)

Geon outlasts ordinary insulation 168 to 1!

A new type of electrical assault wire insulation was tested comparatively against ordinary insulation in Army maneuvers not along ago. Stretched across a highway—run over by tanks, trucks, jeeps, men—the old kind lasted 2 hours. *Under the same conditions GEON 6461 lasted 2 weeks.*

That's one reason why GEON insulated assault wire by the thousands of miles is being used for communications in combat service everywhere.

Here are some other reasons. No braid is needed, the smooth GEON coating makes the wire easy to handle, prevents catching on rocks, bushes, other obstructions. Its resistance to weather, aging, and abrasion means communications are surer, that messages will get through.

Right now GEON is available to industrial users subject to allocation under General Preference Order M-10. However, limited quantities can be had for experiment. And in days to come, GEON's outstanding characteristics will mean better, cheaper, safer industrial and domestic wiring.

For more complete information, or for help on specific problems, write, Department F-4, Chemical Division, The B. F. Goodrich Company, Rose Building, E. Ninth and Prospect, Cleveland 15, Ohio.

Geon
Vinyl Resins & Plastics

CHEMICAL DIVISION
THE B. F. GOODRICH COMPANY
ROSE BUILDING, E. NINTH & PROSPECT, CLEVELAND 15, OHIO

Beyond what the eye can see . . .

It's an easy matter to disassemble a DAVEN ATTENUATOR, as we have done here. And even a hasty glance is sufficient to gain a favorable impression. The resistive network*, with its demand of infinite skill and patience . . . the new, large detent gear on the stainless steel attenuator shaft . . . the detent gear roller and spring recessed within the steel attenuator cover . . . the new positive stop, eliminating stress on the rotor hub . . . the tarnish-proof silver alloy contacts . . . the unique two-piece, dust-tight steel cover —these, and other features, have won wide acceptance for DAVEN ATTENUATORS. *Because*, beyond what the eye can see is a certainty of dependability that is rooted in DAVEN'S long experience and leadership in designing and building good attenuators. Specify DAVEN ATTENUATORS.

DAVEN ATTENUATORS are made in the following circuits: Ladder, T or H, Potentiometer (Potential Dividers), L and Rheostat, balanced or unbalanced. Any desired impedance, number of steps and DB per step; with or without detent.

**Resistive network completely wire wound under exclusive DAVEN patent. New attenuator construction, patent pending.*

Buy More War Bonds and Hold on to Them Until Maturity

DAVEN COMPANY

191 CENTRAL AVENUE
NEWARK 4, NEW JERSEY