

FEBRUARY · 1947

electronics

A MCGRAW-HILL PUBLICATION

Heubner



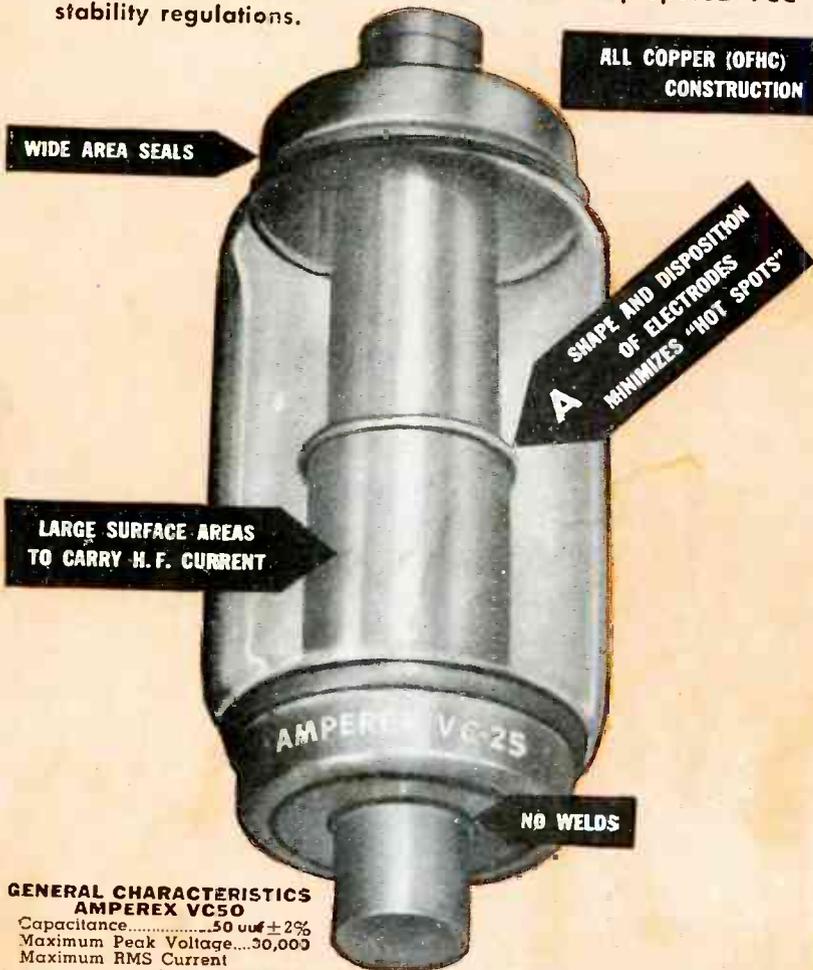
ONE-CENTIMETER TUBE

A LONG AND

STABLE LIFE...

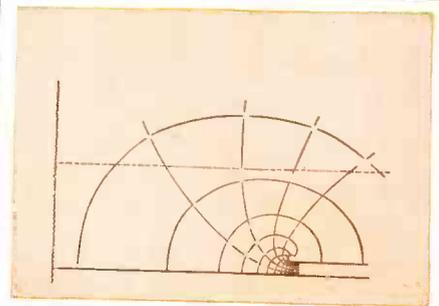
Design and Production Developments Exclusive with Amperex Set New Stability and Performance Standards for Vacuum Condensers

Released six months ago, the new Amperex VC50 and VC25 vacuum condensers have proved themselves a real contribution in communication, dielectric heating and electro-medical apparatus. Their higher current handling ability and lower I²R losses in reduced space suggest important simplifications in equipment design. Oscillators using Amperex-developed circuits and Amperex VC capacitors meet proposed FCC stability regulations.



**GENERAL CHARACTERISTICS
AMPEREX VC50**
Capacitance.....50 uuf ± 2%
Maximum Peak Voltage...30,000
Maximum RMS Current
65 Amps at 10 Mc.
40 Amps at 50 Mc.
Dimensions:
6½" ± 3/32" x 2½" Max.

**WRITE FOR
COMPLETE TECHNICAL RATING
AND DATA SHEETS**



Type of equipotential and electrostatic flux lines established by probing electrolytic bath to determine shapes and disposition of electrodes. (POINT "A" IN PHOTOGRAPH)

NEW TECHNIQUES: Design and manufacturing techniques evolved for high power copper anode tubes were successfully brought to bear in developing the unusual qualities of Amperex VC50 and VC25 vacuum condensers. Unique all-copper OFHC construction, large area seals, unusual mechanical ruggedness and elimination of welds insure more efficient and economical operation.

PRIOR ART: When the vacuum condenser project was initiated in the Amperex laboratory, one of the first steps was the prolonged testing of all available types under field conditions. Concentrated high frequency fields and bottlenecks to current passage were common to all. These "hot spots" inevitably resulted in overheating, creating the risks of puncturing and distortion of the delicate balance of elements.

THE SHAPE OF THINGS: More than 200 theoretical shapes for the VC50 electrodes were tested in the electrolytic bath. Resulting lines-of-force curves dictated the shapes finally adopted. These spread the fields of force, eliminating destructive concentrations. It was discovered, also, that elements carrying high frequency current had to offer surface areas much larger than those which had contented older practice. Wires even of comparatively large diameter were found electrically insufficient and in addition, presented mechanical hazards. Elimination of current-carrying welds was indicated. Basic developments and numerous manufacturing refinements growing out of these tests were built into the Amperex VC series. They are responsible for outstanding performance records.

AMPEREX ELECTRONIC CORPORATION

25 WASHINGTON STREET, BROOKLYN 1, NEW YORK

IN CANADA AND NEWFOUNDLAND: ROGERS MAJESTIC LIMITED
11-19 BRENTCLIFFE RD., LEASIDE TORONTO 12, ONTARIO, CANADA

electronics

A McGRAW-HILL
PUBLICATION



FEBRUARY • 1947

ONE-CENTIMETER TUBE	Cover
Internal details of a 1.25-centimeter reflex oscillator tube developed by Dr. J. M. Lafferty at General Electric Research Laboratory. The tube was cast in Lucite, cut open, and polished	
INTERNATIONAL PLAN FOR AIR NAVIGATION, by D. H. Pain	80
PICAO chooses standard ILS, vhf omnidirectional radio range, radar DME beacons, and l-f loran	
MIDGET ELECTRONIC EQUIPMENT	84
Characteristics of subminiature tubes and parts indicates feasibility of wearable units	
SLOTTED-CYLINDER ANTENNA, by E. C. Jordan and W. E. Miller	90
Design characteristics show antenna's suitability for f-m and television	
ELECTRONIC TOY-TRAIN CONTROLS, by Joseph L. Bonanno	94
Cars are uncoupled, the locomotive whistles and reverses, freight trains unload	
PULSE-TYPE TESTER FOR HIGH-POWER TUBES, by E. C. Easton and E. L. Chaffee	97
Trigger circuit fires ignitron, applying high-voltage pulse to grid of tube being tested.	
WIDE-ANGLE PHASE MODULATOR, by H. K. Bradford	100
Analysis of a phase modulator that permits crystal control of carrier frequency	
ELECTRONICS IN THE CATERPILLAR TRACTOR PLANT	104
Production line and research activity are both aided by intelligent use of vacuum-tube devices	
POWER SUPPLY FOR MICROWAVE EQUIPMENT, by Oliver Hoag	110
Servo motor adjusts an autotransformer to provide automatic voltage regulation up to 5,000 volts	
ELECTRONIC COMMUTATION FOR TELEMETERING, by Lawrence Lee Rauch	114
Pulse-controlled trigger stages feed readings of 18 aircraft instruments into f-m radio link	
TACHOMETRIC AUDIO-FREQUENCY METER, by Edward Kasner	121
Frequencies from 30 to 450 cycles are indicated directly by tachometer-motor unit	
ACOUSTIC LOCATING SYSTEM, by Eric A. Walker and Paul M. Kendig	124
Supersonic waves from a spent torpedo are received by a directional listening hydrophone	
MEASURING COMPLEX COMPONENTS OF VOLTAGE, by George Pihl	128
Direct reading a-f vtvm indicates real and imaginary components of voltage	
AIRBORNE RADAR SPECIFICATIONS	132
Details of nine recently declassified Air Forces and Signal Corps sets	
DB GAIN-LOSS CALCULATOR, by Lloyd A. Lohr	134
Gives db value directly in one setting of straightedge for individual voltage or power values or for ratios	
BUSINESS BRIEFS	74
CROSSTALK	79
TUBES AT WORK	136
INDUSTRIAL CONTROL	140
ELECTRON ART	142
NEW PRODUCTS	144
NEWS OF THE INDUSTRY	150
NEW BOOKS	268
BACKTALK	274
INDEX TO ADVERTISERS	283

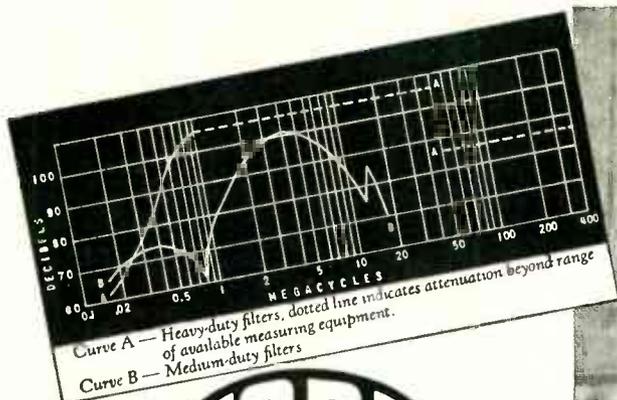
DONALD G. FINK, Editor; **KEITH HENNEY**, Consulting Editor; **W. W. MacDonald**, Managing Editor; **John Markus**, **Vin Zeluff**, Associate Editors; **Frank Rockett**, **A. A. McKenzie**, Assistant Editors; **Gladys T. Montgomery**, Washington Editor; **William P. O'Brien**, Make-up Editor; **Jeanne E. Grolmund**, Editorial Assistant; **Harry Phillips**, Art Director; **Eleanore Luke**, Art Assistant

H. W. MATEER, Publisher; **WALLACE B. BLOOD**, Manager; **J. E. Blackburn, Jr.**, Director of Circulation; **Dexter Keezer**, Director, Economics Department; **John Chapman**, World News Director; **D. H. Miller**, **H. R. Denmead, Jr.**, New York; **Ralph H. Flynn**, New England; **F. P. Coyle**, **R. E. Miller**, Philadelphia; **C. D. Wardner**, Chicago; **E. J. Smith**, Cleveland; **J. W. Otterson**, San Francisco; **Roy N. Phelan**, Los Angeles; **Ralph C. Maultsby**, Atlanta; **Paul West**, London, England

Contents Copyright, 1947, by McGraw-Hill Publishing Company, Inc. All Rights Reserved. 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.—Member A. B. P. Member A. B. C.

James H. McGraw, Jr., President; Curtis W. McGraw, Senior Vice-President and Treasurer; Nelson Bond, Director of Advertising; Eugene Duffield, Editorial Assistant to the President; Joseph A. Gerardi, Secretary; and J. E. Blackburn, Jr., Vice-President for circulation operations.
ELECTRONICS, February, 1947, Vol. 20, No. 2. Published monthly, with an additional issue in June, price 75c a copy. Directory issue \$1.00. Allow at least ten days for change of address. All communications about subscriptions should be addressed to the Director of Circulation.
Subscription rates—United States and possessions, \$6.00 a year, \$9.00 for two years, \$12.00 for three years. Canada (Canadian funds accepted) \$7.00 a year, \$11.00 for two years, \$14.00 for three years. Pan American countries \$10.00 for one year, \$16.00 for two years, \$20.00 for three years. All other countries \$12.00 for one year, \$30.00 for three years. Please indicate position and company connection on all subscription orders. Entered a Second Class matter August 29, 1935, at Post Office, Albany, New York, under the Act of March 3, 1879. BRANCH OFFICES: 520 North Dearborn St., Chicago 11, Ill.; 63 Post Street, San Francisco 4; Aldwych House, Aldwych, London, W.C. 2; Washington, D. C. 4; Philadelphia, 15; Decatur, Ala. 15; St. Paul, Minn. 8; Ft. Worth, Tex. 16; Atlanta, Ga.; 611 So. Hope St., Los Angeles 14; 738-9 Oliver Building, Pittsburgh 22.

For RADIO-SILENT Test Rooms

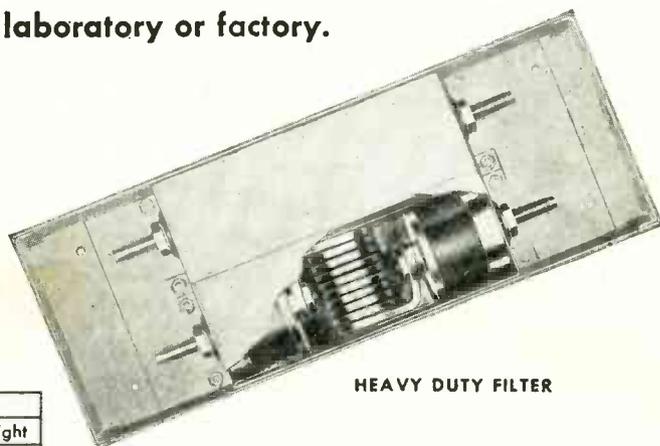


TOBE

Screen Booth Filters

isolate test rooms in laboratory or factory.

Installed where the electric power service passes through the screen, these Filterettes provide high attenuation from 150 kc to 400 mc, thus permitting operation of sensitive high-frequency test apparatus in close proximity to electric production equipment, welding generators, repulsion motors, and high-frequency induction heating equipment.



HEAVY DUTY FILTER

SPECIFICATIONS

HEAVY DUTY FILTERS					
Type	Amperes	Volts	Volt. Drop	Freq. Range	Weight
Two Wire	100	500 a-c/d-c	.2 volts per circuit	0.15 to 400 megacycles	40 lbs.
Three Wire	100	500 a-c/d-c	.2 volts per circuit	0.15 to 400 megacycles	65 lbs.
MEDIUM DUTY FILTERS (Two Wire)					
No. 1137	20	110/220 a-c 500 d-c	.5 volts per circuit	0.15 to 20 megacycles	17 lbs.
No. 1116	50	110/220 a-c 500 d-c	.5 volts per circuit	0.15 to 20 megacycles	17 lbs.

Mechanical design and assembly conform to practical electrical installation requirements. Outer housings are of welded steel; knockouts at each end accommodate electrical conduits; heavy, threaded studs facilitate attachment of cable lugs.

Widely used by government, college, and industrial laboratories, Tobe Screen Booth Filters will meet your need; Bulletin 472 E, free on request, gives additional data. For information about the complete line of Tobe Filterettes and Capacitors, ask for our general catalog.

These units employ non-inductive, mineral-oil impregnated capacitors; the inductors, of large cross section, have low series resistance, hence voltage drop is negligible. Overload ratings are: 150% of ampere rating for one hour; 200% of voltage rating for one minute.

TOBE

TOBE DEUTSCHMANN Corporation CANTON, MASSACHUSETTS

● "The impossible takes a little longer"...this is one way of saying that the draftsman lets no out-worn conceptions restrict his creative ideas. Yet without his specialized technique for expressing ideas on paper, the designs he creates could scarcely be turned into substance. As the draftsman relies on his own hands and eyes, he calls likewise on his drafting instruments to serve him functionally. So integral a part of his technique do they become, they are virtually his partners in creating.

For 78 years Keuffel & Esser drafting equipment and materials have been partners, in this sense, in creating the greatness of America, in making possible our fleets of ships, our skyscrapers, our overwhelming weight of armor on the battlefield... So universally is K & E equipment used, it is self-evident that every engineering project of any magnitude has been completed with the help of K & E. Could you wish any surer guidance than this in the selection of your own "drafting partners"?

Because of their balance, smooth action and responsiveness to your hand, you will find that using MINUSA* Drawing Instruments is almost as natural as breathing. Their legs are round and tapered, without the harsh feel of sharp corners. Joints are firm, snugly fitted, and satin-smooth in operation. Yet these instruments are strong and durable, for their precision will outlast years of continuous use. For complete data on MINUSA* Drawing Instruments, write on your letterhead to Keuffel & Esser Co., Hoboken, N. J.

partners in creating

*REG. U. S. PAT. OFF.

K + E
 Drafting, Reproduction,
 Surveying Equipment
 and Materials.
 Slide Rules,
 Measuring Tapes.


 ... the world's
 mightiest fleet


 ... speediest
 tanks


 ... tallest
 skyscrapers

KEUFFEL & ESSER CO.
 EST. 1867
 NEW YORK • HOBOKEN, N. J.
 CHICAGO • ST. LOUIS • DETROIT • SAN FRANCISCO
 LOS ANGELES • MONTREAL

Why this team is *Tops*



1915

The ocean, long a barrier to spoken communications, was conquered when Bell System engineers designed, built, and operated the transmitter which first sent the human voice across the Atlantic and Pacific.



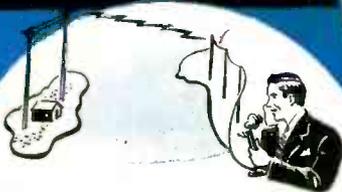
1916

A Western Electric transmitter was used in one of the pioneer ship-to-shore radiotelephone experiments. Thirteen years later the first regular commercial service was established with Western Electric equipment.



1917

With the first airborne transmitter, Western Electric demonstrated two-way radiotelephone between a plane in flight and the ground. From this earliest experiment came commercial airline equipment in 1930.



1920

Western Electric radio became a part of the nation's telephone system when it was used to connect Catalina Island to the mainland. Seven years later, the Bell System offered commercial radiotelephone service to Europe.



1922

Western Electric manufactured and installed the first "high power" (500 Watt) commercial broadcast transmitter — for the Detroit News Station WWJ.



1930

Transmitter designed by Bell Laboratories first used for one-way contact with police cars. Police used Western Electric fixed station transmitters as early as 1922, and two-way mobile equipment from 1935.

From the basic developments pictured at the left, the team of Bell Laboratories and Western Electric continued to set the pace with the best in transmitting equipment. Among the later advances pioneered by this team were:

1928. The first 50 kw commercial broadcast transmitter, built by Western Electric, installed at WLW, Cincinnati, Ohio.

1935. A 50 kw Western Electric AM transmitter installed at WOR was the first to incorporate the Bell Laboratories-designed stabilized feedback circuit, since accepted as a broadcasting standard.

1937. The first single sideband transmitter was introduced for long distance, point-to-point communications. The world-wide military communications network used in the war came directly from this development.

1938. Flying tests of the first VHF aircraft transmitter showed relatively static-free communication at all times. Modifications of the original Bell Laboratories design were used for basic Army-Navy aircraft radiotelephony in World War II.

1940. The first Synchronized FM transmitter installed at WOR enabled broadcasters to put top-quality FM programs on the air and keep them on their assigned frequency.

1941. First FM transmitter to use grounded plate amplifier circuit was Western Electric 10 kw installed at WOR.

1941. Twelve talking channels adjacent to each other, available for the first time on a single radio frequency band, used to connect telephone lines on either side of Chesapeake Bay. Envelope feedback developed by Bell Telephone Laboratories and applied to the carrier technique in radio telephony made this possible.

—QUALITY COUNTS—

for Radio Transmitters!

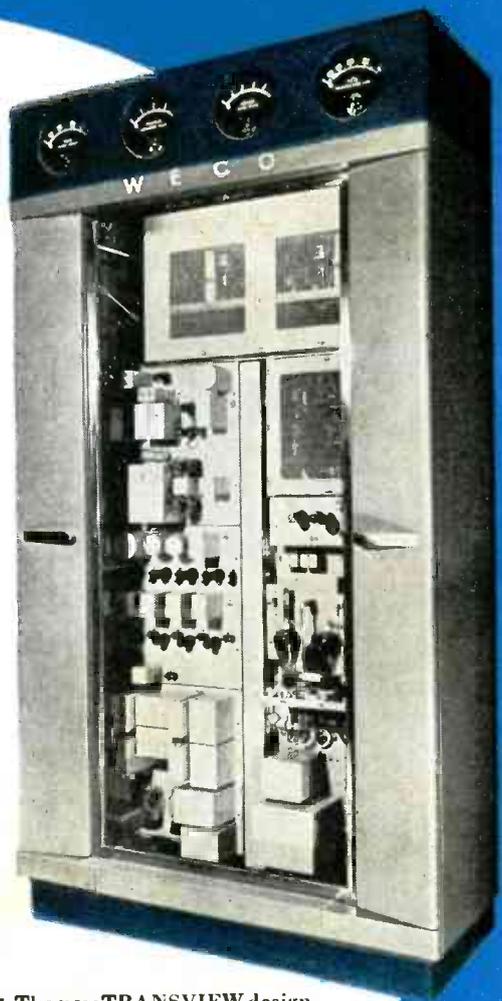
The experience gained during the war, when the Bell Laboratories-Western Electric team was the largest supplier of communications equipment, added greatly to the skill and knowledge acquired through 30 years of transmitter development.

This background, plus unequalled research and manufacturing facilities, provides assurance that there are no finer transmitters than those designed by Bell Telephone Laboratories and built by Western Electric—whether for AM or FM broadcasting, point-to-point radiotelephony, or any type of communication or mobile service.

1943. The ARC-1, a crystal controlled ten frequency transceiver, used by the Navy's fighter planes during the war, has been accepted as standard VHF equipment by U.S. airlines. Provides nine plane-to-ground frequencies and one plane-to-plane frequency.



1947. The Western Electric 238-type mobile radiotelephone system is providing dependable Bell System service between vehicles and any wire telephone in a growing number of cities and along trunk highways.



1947. The new TRANSVIEW design FM transmitter, being produced in 1, 3 and 10 kw units, for the first time provides the operator with an unobstructed view of all tubes while in operation. Incorporates Bell Laboratories-developed synchronized frequency control.

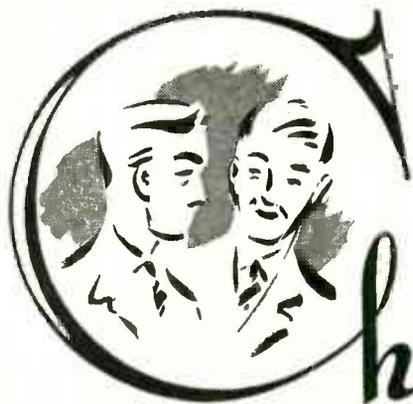
Distributed by
Graybar
OFFICES IN 95 PRINCIPAL CITIES



BELL TELEPHONE LABORATORIES
World's largest organization devoted exclusively to research and development in all phases of electrical communications.

Western Electric

Manufacturing unit of the Bell System and the nation's largest producer of communications equipment.



HQ-129-X

choice of THOUSANDS



Hams are pretty shrewd individuals when it comes to selecting the gear they use. Many thousands knew what they wanted — they're using HQ-129-X receivers on the air every day. That, we believe, is one of the finest endorsements any product can achieve. Materials are still hard to get but hundreds of HQ-129-X's are being shipped every month.

36
BACKED BY

YEARS OF KNOW HOW

SEE THE HQ-129-X AT YOUR DEALER'S

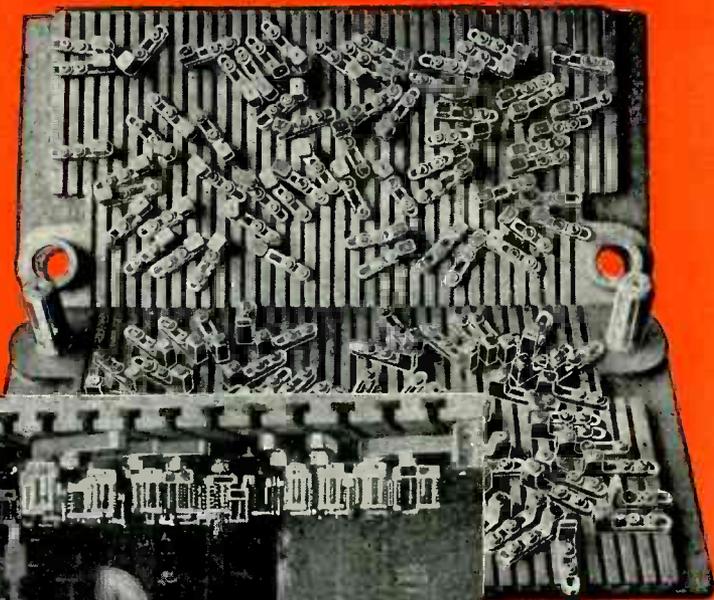
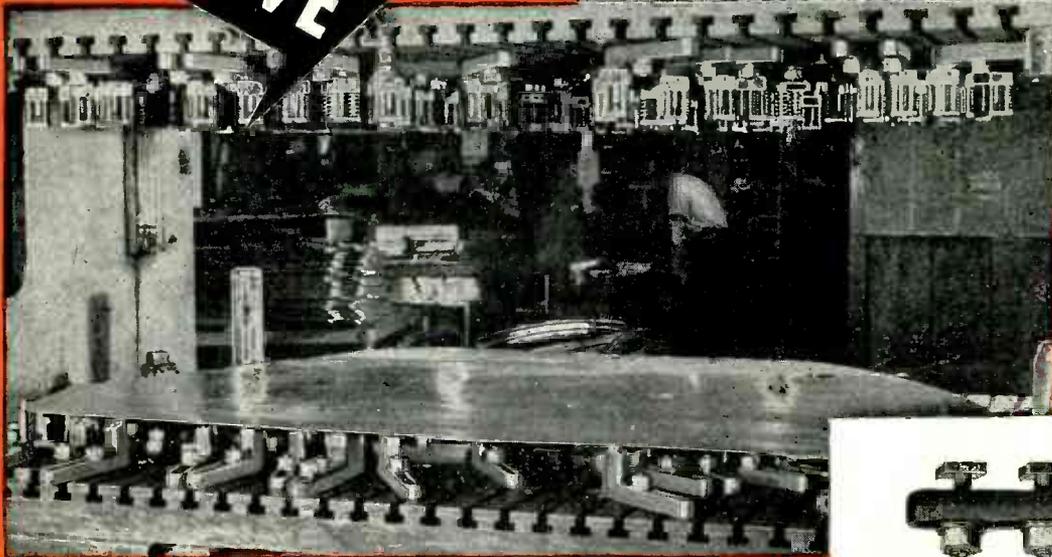


HAMMARLUND

THE HAMMARLUND MFG. CO., INC., 460 W. 34TH ST., NEW YORK 1, N. Y.
MANUFACTURERS OF PRECISION COMMUNICATIONS EQUIPMENT

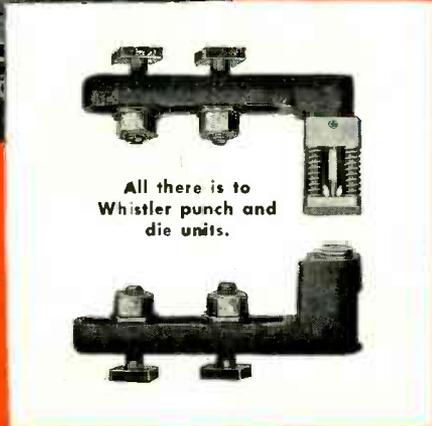
February, 1947 — ELECTRONICS

**DIE COSTS
TAKE A
NOSE DIVE**



Typical examples of set-ups made from stock units. No delay in starting production.

WHISTLER Adjustable Perforating Dies Offer Added Production Economy



WRITE FOR YOUR WHISTLER CATALOGS. Know the production advantages of Whistler Adjustable Dies.

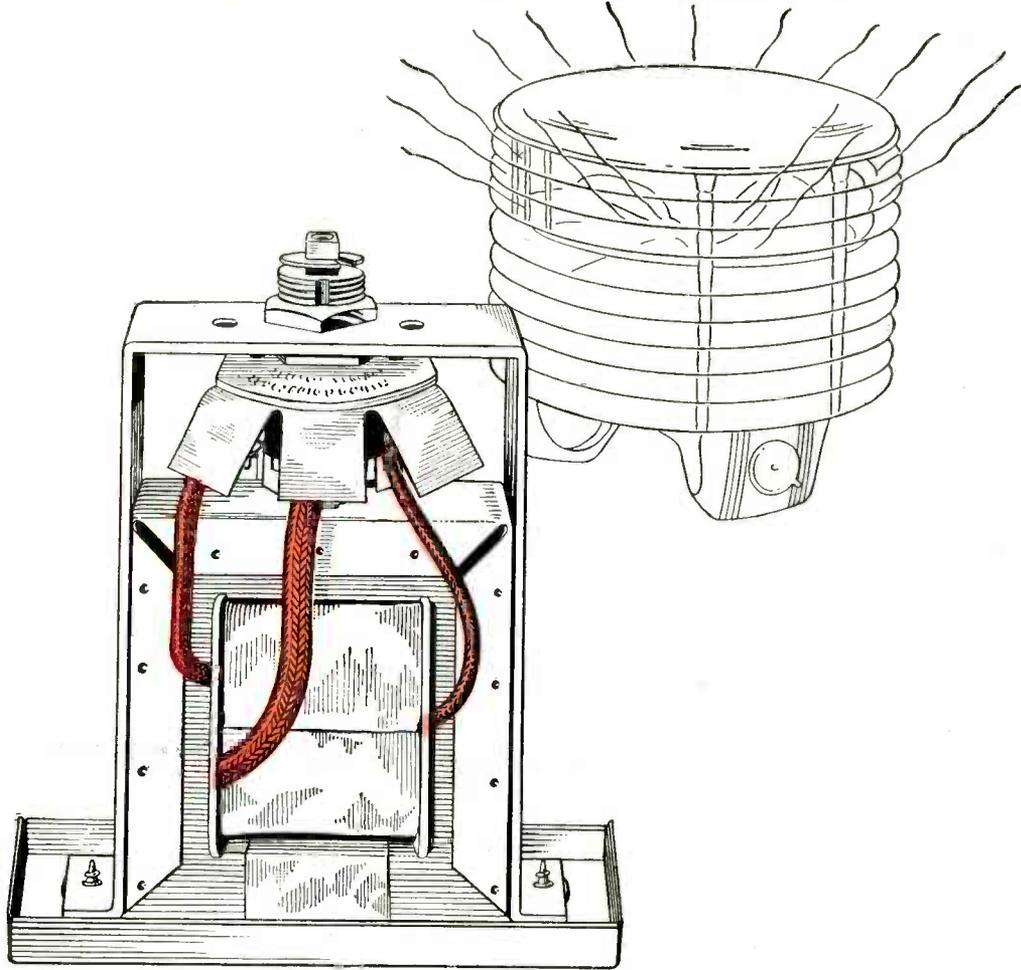
5-10-50 and even more different set-ups with the same dies? Impossible? Not when you use Whistler Multi-Use Adjustable Dies. For it's simple to rearrange these units...add or delete...get back into production within a few hours. Even so-called complicated arrangements are easy to set up. And, with first cost invariably less than for single purpose dies, this continued re-use of the same dies effects added economy in quickly writing off initial die invest-

ment. Over 750 prominent manufacturers have proven in their own plants that Whistler Adjustable Dies have sent costs into a nose dive.

No special tools are needed. Work in practically any size and type of press. Ordering now is particularly advantageous. Large stocks of standard diameter units from 1/32" up are available for overnight shipments. Notching, group dies and special shapes and sizes can be quickly made to order. Write today to:

S. B. WHISTLER & SONS, Inc.
752-756 MILITARY ROAD BUFFALO 17, NEW YORK

LET BENTLEY, HARRIS WAR-TIME RESEARCH PAY DIVIDENDS FOR YOU TODAY.



Designing a 3-way speed control for an air circulating unit, a transformer manufacturer needed an insulation that would not split or crack under constant vibration. Recalling his war-time use of Bentley, Harris Fibreglass Sleeving in hermetically sealed transformers, he tried it in his new product. Here is his report:

"BH Fibreglass Sleeving has the unusual flexibility, strength, durability, and non-fraying qual-

ities we need. Even after aging, it does not split or crack under mechanical vibration."

Test BH Fibreglass Sleeving in your own plant, in your own product—under actual service conditions. Compare it to ordinary saturated sleeving. Learn why America's leading manufacturers of home appliances and industrial equipment have standardized on Bentley, Harris Fibreglass Sleeving in their plans for post-war production.

BENTLEY, HARRIS MFG. CO., CONSHOHOCKEN, PA.

BH *Fibreglass** SLEEVINGS

*BH Non-Fraying Fibreglass Sleevings are made by an exclusive Bentley, Harris process (U. S. Pat. No. 2393530). "Fibreglass" is Reg. TM of Owens-Corning Fibreglass Corp

USE COUPON NOW

Bentley, Harris Mfg. Co., Dept. E-7, Conshohocken, Pa.

I am interested in BH Non-Fraying Fibreglass Sleeving _____ for _____
 (size) (product)
 operating at temperatures of _____°F. at _____ volts. Send samples so I can see for myself how
 BH Non-Fraying Fibreglass Sleeving stays flexible as string, will not crack or split when bent.

NAME _____ COMPANY _____

ADDRESS _____

Send samples and prices on other BH Products as follows:

- Magneto Varnished Tubing Grade "A"
- Flexible Varnished Tubing Grade "B"
- Saturated Sleeving Grade C-1
- Saturated Sleeving Grade C-2
- Saturated Sleeving Grade C-3

IT'S THE

"INSIDES" THAT COUNT!

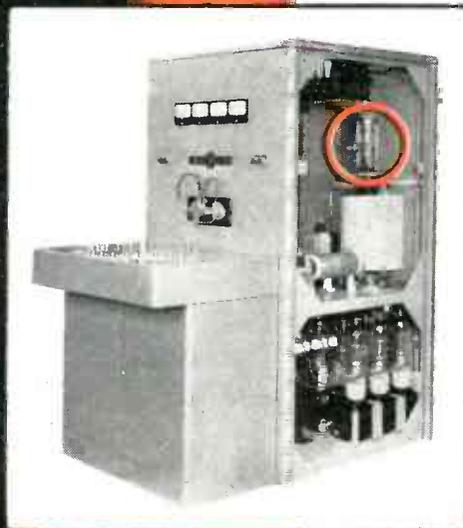
That's Why Every FEDERAL
Industrial Power Tube is

X-RAY TESTED

to Last Longer in Heavy-Duty
Electronic Equipment

IT'S THE ORDINARILY unseen details, deep in the heart of a tube, that can spell long success or early failure in heavy-duty industrial service. But in Federal tubes, the "insides" are seen—and carefully checked for perfection of every detail! For every tube gets not one, but *three* X-ray tests before being OK'd for shipment. This, plus other exacting requirements, is your positive assurance that every Federal tube will have the stamina—the "*guts*"—to take the terrific strains of sudden load changes, mechanical shock and vibration.

The 9C23, like all Federal industrial tubes, is built to take a beating. As shown in this actual X-ray photo, all internal elements are widely spaced and well braced. Flexible leads reduce strains and simplify installation. For complete information, write to Dept. L413.



One 9C23 tube gives ample power for this 20-KW Electronic Heater, made by REEVE ELECTRONICS, INC., CHICAGO, ILL.

DATA FOR 9C23 TUBE

Filament Voltage 22 volts
Filament Current 82 amp.

Maximum Ratings for Maximum Frequency of 20 MC

DC Plate Voltage 15000 volts
DC Plate Current 4.0 amp.
Plate Dissipation 25 Kw.

Type of Cooling
Water (Minimum Flow, 10 G.P.M.)

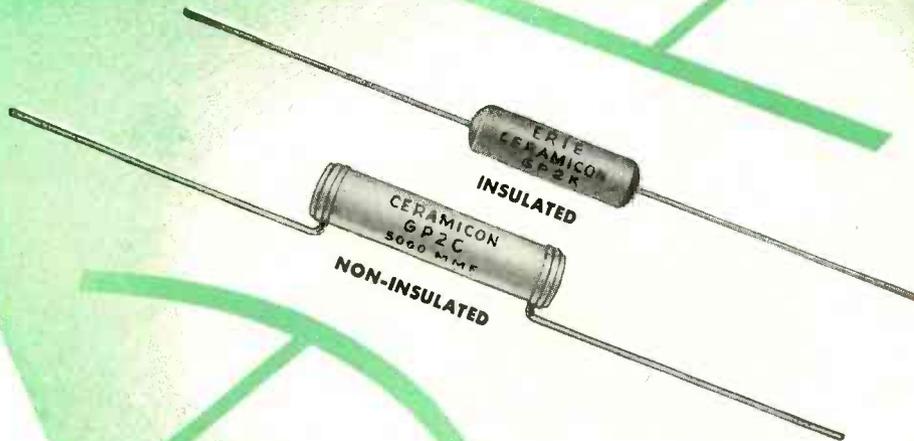
Federal Telephone and Radio Corporation

In Canada:—Federal Electric Manufacturing Company, Ltd., Montreal.
Export Distributors:—International Standard Electric Corp. 67 Broad St., N.Y.C.



Newark 1,
New Jersey

The Trend is Toward Ceramic Condensers
For By-Pass Applications



specify *Erie* "GP" *Ceramicons**
for best performance

The Erie line of General Purpose Ceramic Condensers has been set up to provide ceramic dielectric condensers quickly and economically for by-passing and coupling applications.

By "General Purpose" is meant those condensers which are not directly frequency determining, such as those used for AVC Filtering, Resistance-Capacitance Audio Coupling, Tone Compensation, Volume Control R.F. By-Passing, Audio Plate R.F. By-Passing, Oscillator Grid Coupling, R.F. Coupling, Antenna Coupling. In these applications, power factor is not critical and moderate capacity changes caused by temperature variations do not affect the proper functioning of the circuits.

The GP (General Purpose) line of Erie Ceramicons does not sacrifice quality in any way

whatsoever. Since the line of Erie GP Ceramicons is limited to definite capacity values, it is practical to manufacture large quantities of any given value at one time, with consequent saving in production costs.

Condensers classified as GP1 have a temperature coefficient between $+130$ and -1600 P/M/ $^{\circ}$ C and are available up to 510 MMF. Condensers classified as GP2, manufactured in capacities of 150 MMF and higher, may include all of the above dielectrics and, in addition, the Erie Hi-K type.

Erie GP Ceramicons are made in insulated styles in popular capacity values up to 5,000 MMF and in non-insulated styles up to 10,000 MMF. Write for full details.

*Ceramicon is the registered trade name of silvered ceramic condensers made by Erie Resistor Corporation.

Electronics Division

ERIE RESISTOR CORP., ERIE, PA.

LONDON, ENGLAND • • TORONTO, CANADA





GET SET

FOR COMPETITION

USE **alliance** MOTORS

THE NEW MODEL A shaded pole, induction-type Alliance Fan Motor for speeds from 500 to 1050 R.P.M. operates on 50 or 60 cycles at voltages up to 220, 1/30th horse power, size $4\frac{5}{8} \times 2\frac{3}{4}$ inches. Porous bronze, oilless-type sleeve bearings. Open or fully enclosed construction. Approx. 8 to 40 oz. in. full load running torque, depending on stack length. Exceptionally quiet. For continuous or intermittent duty. Runs clockwise or counter clockwise—not reversible.

ALLIANCE PHONOMOTORS — POWR-PAKT MOTORS in shaded pole induction and split-phase reversible resistor types rated from less than 1/400th h.p. on up to 1/20th h.p. for powering valves, switches, controls, driving turntables, fans, record changers and automatic devices.

Drive your products to market—use Alliance Motors to drive vital component parts. Big advantages for the Alliance Powr-Pakt line are compactness, light weight, versatile performance characteristics, and mass production at low cost.

Alliance Powr-Pakt Motors are rated from less than 1/400th h.p. on up to 1/20th h.p. They'll supply just the *right amount of power at strategic points* to impart automatic action, instant control and greater usefulness for your products and processes.

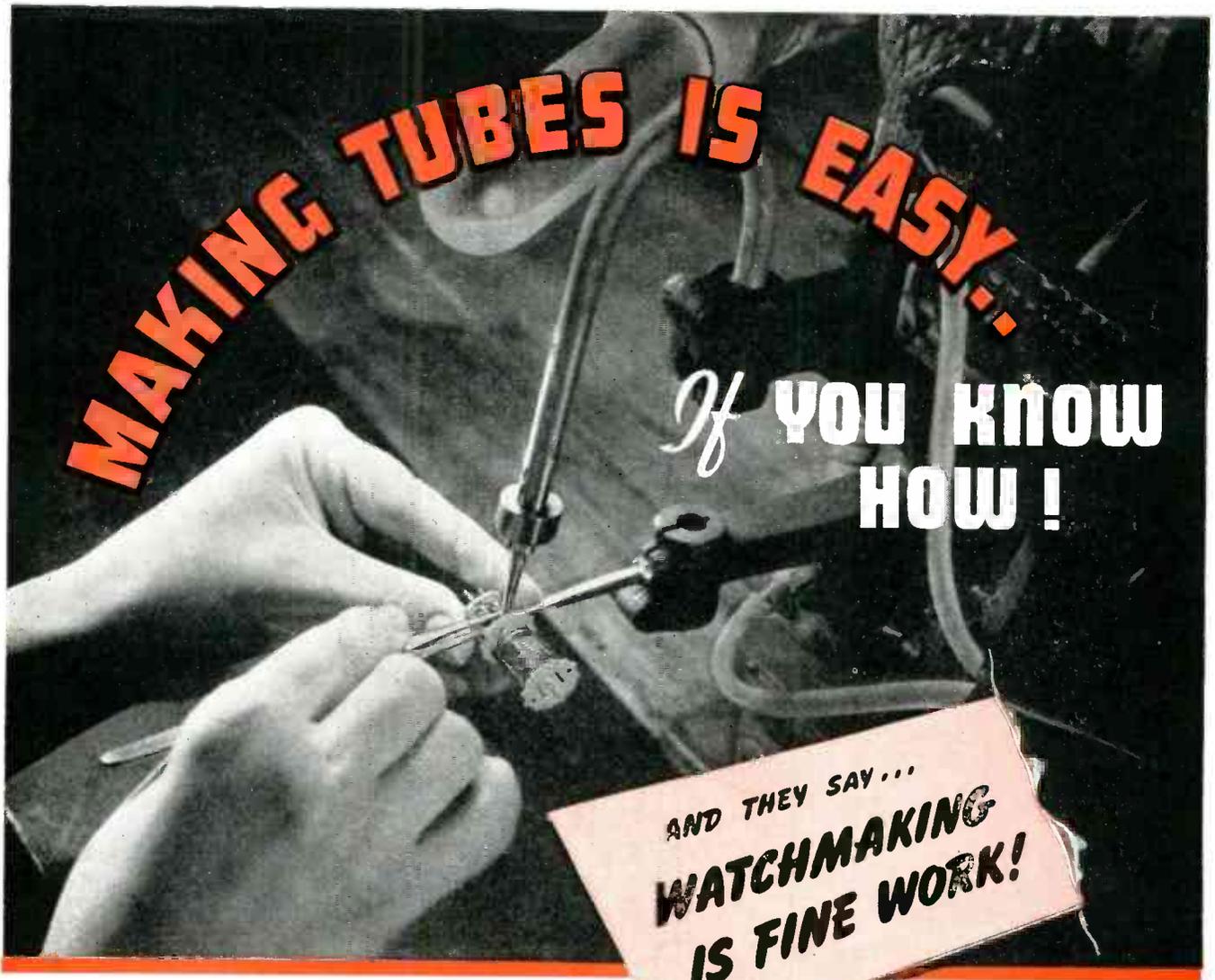


WHEN YOU DESIGN—KEEP

alliance

MOTORS IN MIND

ALLIANCE MANUFACTURING COMPANY • ALLIANCE, OHIO



MAKING TUBES IS EASY!

If **YOU KNOW HOW!**

AND THEY SAY...
WATCHMAKING IS FINE WORK!

A fine watch—delicate Italian lace—these are synonymous with superb craftsmanship. But imagine such hand-to-eye co-ordination at mass production speeds. The mount operator who assembles with a small spot welder the tiny internal parts of your Hytron tubes displays just such craftsmanship. Despite painstaking engineering and intricate machinery, it is finally her accuracy, speed, perseverance, and appreciation of fine tolerances which build Hytron quality. Assembly mistakes once sealed within a tube cannot be corrected.

That is why Hytron is so fussy about selecting and training its mount operators. Each applicant must pass exacting tests for eyesight and for finger and tweezer dexterity. Then begins a long training cycle: two months to master a single constructional step; up to two years to

develop the versatility of the expert moulder.

Every possible aid is given to the Hytron mount operator. Work simplification helps her co-ordinate smoothly and efficiently motions of eyes, hands, and feet. Parts design is simplified; supporting micras serve as templates. Welding is automatically timed. Tight spacing tolerances (.003") and frequent engineering changes prohibit widespread use of jigs and fixtures. Magnification is impracticable, because of width and depth of field. Major effort must always be to train the moulder's keen eyes and nimble fingers to assemble delicate parts to fine tolerances, despite varying materials and machine set-ups.

Yet the Hytron moulder works so effortlessly that it all looks easy. It is easy only because she has the know-how. Next time you pick up a Hytron tube, examine her handiwork.

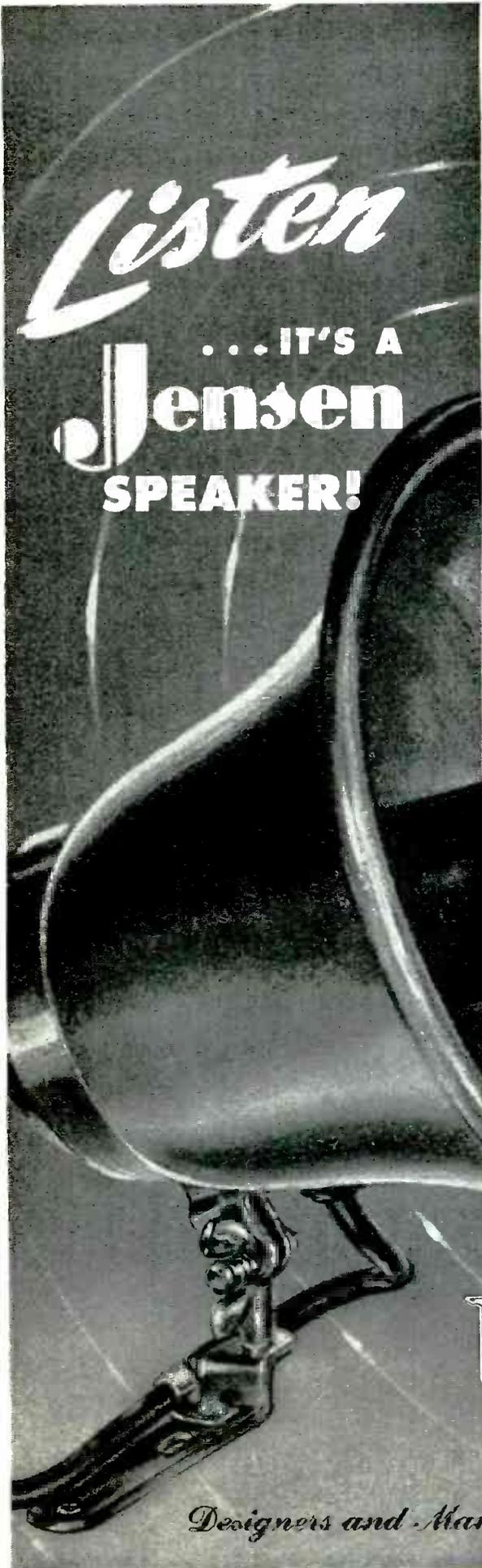


SPECIALISTS IN RADIO RECEIVING TUBES SINCE 1921

HYTRON
RADIO AND ELECTRONICS CORP.

MAIN OFFICE: SALEM, MASSACHUSETTS





Listen
... IT'S A
Jensen
SPEAKER!

MODEL VH-91 *Hypex** PROJECTOR

This latest addition to the famous JENSEN Hypex line meets a real need for paging and intercommunication applications. Particularly efficient in the voice frequency range, it delivers clear, intelligible speech with maximum "punch" to override high noise levels.

By reason of an extremely clever mounting bracket, this projector can be pointed in any direction and securely locked into position with a single wing nut. Two holes in the bracket are provided for mounting on table, wall, ceiling or a post.

The diaphragm is cloth base, phenolic impregnated. Nominal voice coil impedance, 8 ohms; power handling capacity, 15 watts maximum speech signal input. Two-wire RC cable is provided for connections. Mounting facilities are also provided on the bracket for a $\frac{5}{8}$ " x $\frac{3}{4}$ " core or smaller transformer. Because of the Hypex flare formula, useful output is attained for a 100° total angle.

This new Hypex projector is now in production; deliveries are expected early in 1947 and literature will be available shortly.

JENSEN MANUFACTURING COMPANY

6607 S. LARAMIE AVE., CHICAGO 38, U.S.A.

In Canada: Copper Wire Products Ltd., 11 King St. W., Toronto, Ont.

*Trade Mark Registered



Jensen
SPEAKERS WITH *ALNICO 5*

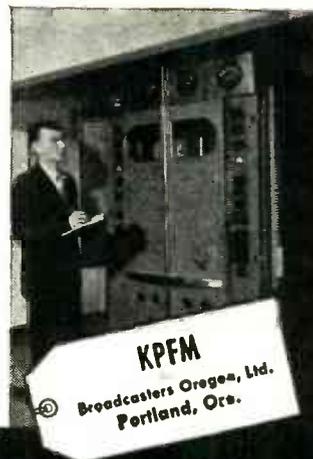
Designers and Manufacturers of Fine Acoustic Equipment



KHJ-FM
Don Lee B'casting System
Hollywood, Calif.



KJBS-FM
KJBS Broadcasters
San Francisco, Calif.

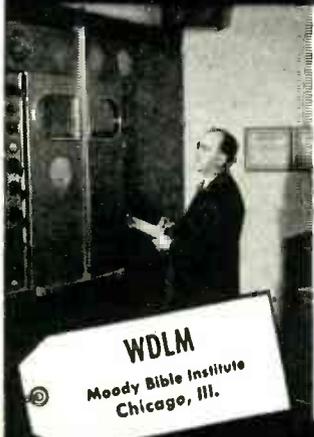


KPFM
Broadcasters Oregon, Ltd.
Portland, Ore.

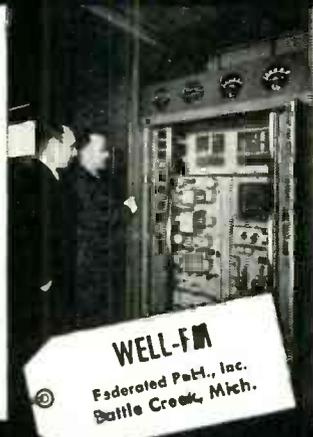


KUSC
Univ. of So. California
Los Angeles, Calif.

Western Electric



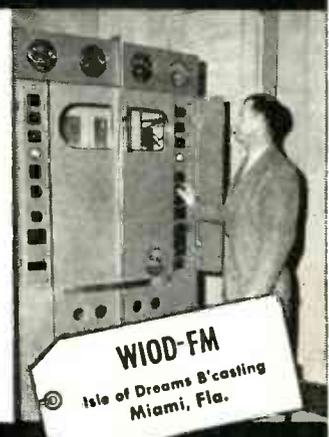
WDLN
Moody Bible Institute
Chicago, Ill.



WELL-FM
Federated P.H., Inc.
Battle Creek, Mich.



WGHF
W. G. H. Finch
New York, N. Y.



WIOD-FM
Isle of Dreams B'casting
Miami, Fla.

NOW ON THE AIR...



WTSP
Times-Picayune Publ. Co.
New Orleans, La.



WAXAG
Georgia School of Tech.,
Atlanta, Ga.



W8XMY
Miami Valley B'casting Co.
Dayton, Ohio

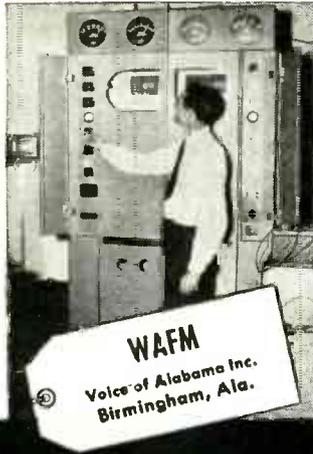


W8XUB
United Broadcasting Co.
Cleveland, Ohio

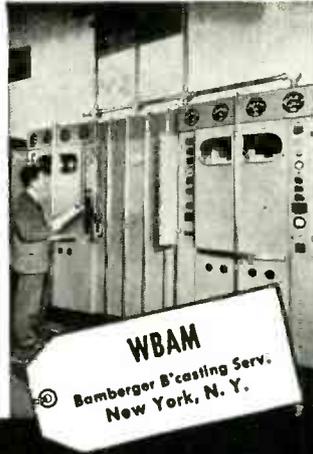
These Western Electric FM broadcast transmitters—22 in all—are now on the air in the 88-108 mc band...and others (not shown) are in operation for experimental purposes, or are in process of installation. • In FM—as in AM—transmitters of Bell Telephone Laboratories design and Western Electric manufacture have acquired a reputation for quality,



WABF
Metrc. Television Inc.
New York, N. Y.



WAFM
Voice of Alabama Inc.
Birmingham, Ala.



WBAM
Bamberger B'casting Serv.
New York, N. Y.



WBCM-FM
Bay Broadcasting Co. Inc.
Bay City, Mich.

F M TRANSMITTERS



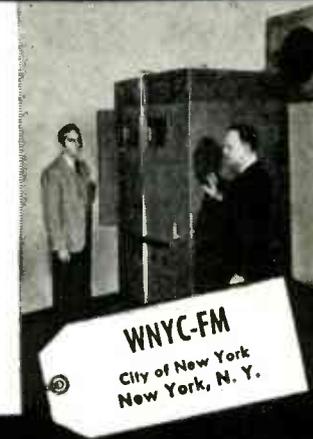
WIP-FM
Pennsylvania B'casting Co.
Philadelphia, Pa.



WITH-FM
Maryland B'casting Co.
Baltimore, Md.



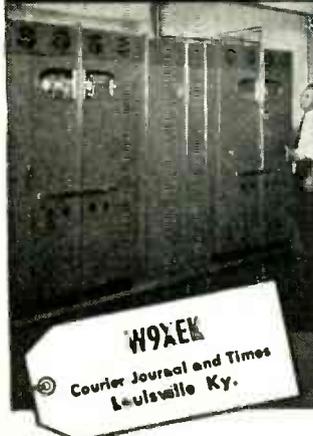
WMGM
Marcus Loew Booking Agcy.
New York, N. Y.



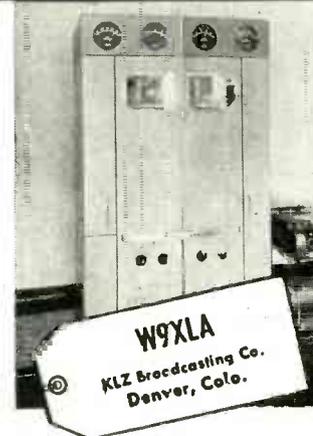
WNYC-FM
City of New York
New York, N. Y.



IN THE NEW BAND



WQXK
Courier Journal and Times
Louisville Ky.



WQXLA
KLZ Broadcasting Co.
Denver, Colo.

NEW LINE OF FM TRANSMITTERS

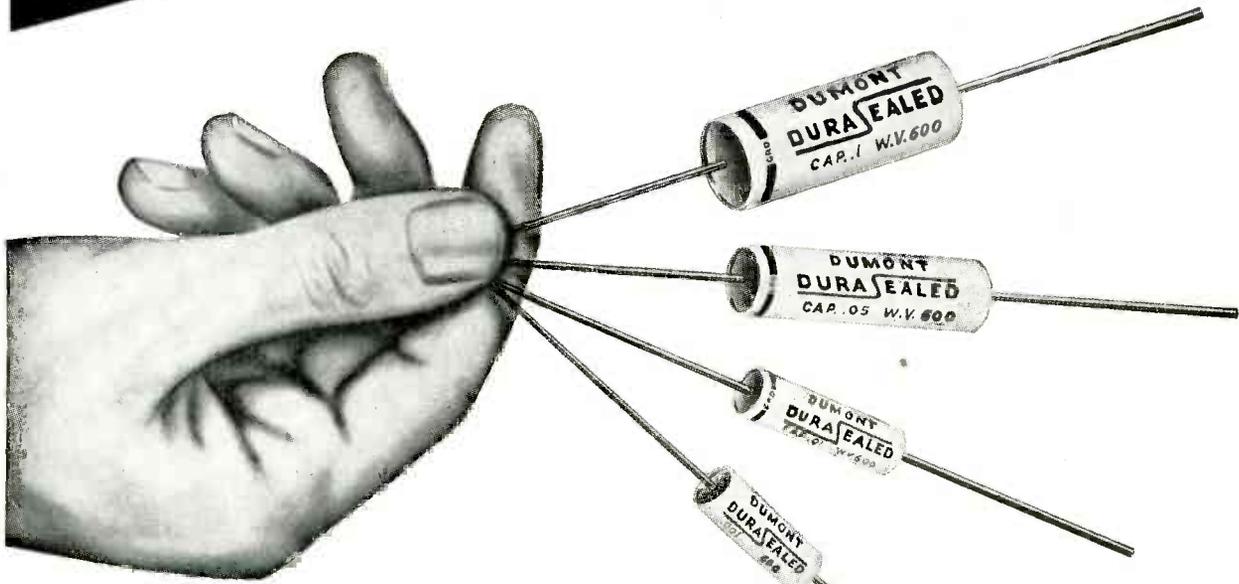
Outstanding in styling and performance! 250 watt, 1, 3, 10, 25 and 50 kw.

Distributed by
Graybar
OFFICES IN 95 PRINCIPAL CITIES

dependability and low operating cost. • For FM equipment from 250 watts to 50 kw, contact your local Graybar Broadcast Equipment Representative. He will be glad to tell you all the technical features and advantages which make them outstanding, or—write to Graybar Electric Co., 420 Lexington Ave., New York 17, N. Y. **QUALITY COUNTS**

AT LAST!

SPECIAL WARTIME DEVELOPMENT NOW
AVAILABLE FOR PUBLIC USE . . .
TYPE P6 DUMONT PAPER CAPACITORS



BAKELITE
RESINOID
SEALED
CANNOT MELT

AC-DC CONTINUOUS
AT HIGH TEMPERATURES



PAT. PEND.

BAKELIZED
TUBES

★ Dumont engineers scored in the greatest single achievement in paper tubular capacitors . . . meeting the most exacting requirements. This type P6 has the ends sealed in BAKELITE RESINOID. Leads cannot PULL OUT or MELT OUT. Bakelite treated tubes sealed in vacuum.

- ★ HEAT PROOF
- ★ MOISTURE PROOF
- ★ LONGER LIFE
- ★ VACUUM SEALED
- ★ SOLVES SPACE PROBLEMS

DUMONT ELECTRIC CORP.
MFR'S OF CAPACITORS FOR EVERY REQUIREMENT

34 HUBERT STREET
NEW YORK, N. Y.

Plastics where plastics belong

The tip insulators on this welding electrode holder are excellent examples of the use of technical plastics where plastics belong... using resistance to heat and impact and electrical insulating properties.

Synthane (our type of plastics) qualifies well for this job. Glass base laminated resists heat and impact fatigue, insulates and wears well.

For these reasons and others, Synthane finds its way into an army of applications requiring electrical, chemical, mechanical or combined specifications.



If you have a use for Synthane, let us help you before you design. Perhaps we can save you time and trouble with design, materials or completely fabricated parts. Write for the complete catalog of Synthane Plastics and their applications today. Synthane Corporation, 6 River Road, Oaks, Penna.

SYNTHANE
S

where Synthane belongs

DESIGN · MATERIALS · FABRICATION · SHEETS · RODS · TUBES
FABRICATED PARTS · MOLDED · MACERATED · MOLDED-LAMINATED

SYNTHANE TUBING FOR GENERAL AND

SYNTHANE SHEETS... Grades, finishes, sizes, colors.

... OF QUALITY

... tolerances, special

FOR SYNTHANE SHEETS

Get your copy before you plan with plastics

general properties and uses
 THESE PROPERTIES ARE IN GENERAL
 FOR WHICH SYNTHANE IS VALUED:

THIS IS SYNTHANE... WHY

SYNTHANE
 It is produced by the application of pressure of tubic...
 layers of paper or fabric...
 Manufactured in the form of...
 and grades, colors, finishes...
 and machined from these primary...
 Certain parts, depending on...
 also be produced by mold...
 processes into finished...
 or no machining.

Many Properties
 Synthane is... of quality



technical plastics



INDEX	Page	Quality, Standards of...	Page
Cam Blanks	13	Representatives	4-5
Combination Materials	12	Rods	16
Corrosion-Resisting Synthane	14	Sheets	9
Design Suggestions	13	Special Materials	6-7
Gear Material	10-11	Synthane vs. Metals	11
Molded-Laminated Synthane	10-11	Tubing	8-9
Molded-Macerated Synthane	2	Uses of Synthane	3
Properties of Synthane	2	Weights, Sheet, Rod and Tube	15



SYNTHANE CORPORATION
 OAKS, PENNSYLVANIA

SYNTHANE CORPORATION, 6 RIVER ROAD, OAKS, PA.
 Gentlemen:
 Please send me without obligation the complete catalog of Synthane technical plastics.

Name _____
 Company _____
 Address _____
 City _____ Zone _____ State _____

SYNTHANE

PLAN YOUR PRESENT AND FUTURE WITH SYNTHANE TECHNICAL PLASTICS • SHEETS • RODS • TUBES • FABRICATED PARTS • MOLDED-LAMINATED • MOLDED-MACERATED

THIS COUPON BRINGS IT



50

YEARS OF PROGRESS

This new year of 1947 marks the completion of a half-century of devotion to the design, production, improvement and application of X-ray and other electron tubes. Pioneers fifty years ago, we are still pioneering, and in that earnest spirit pledge for the years to come still greater achievements in the electron art, increasing and broadening its service to the Public Health, to Industry, and to Communications.

MACHLETT LABORATORIES, INC., SPRINGDALE, CONNECTICUT

Phillips Screws

**GIVE POSITIVE "FIX"
ON CRITICAL ASSEMBLY FOR**

FOXBORO

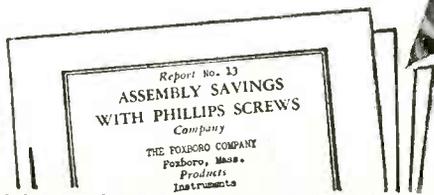
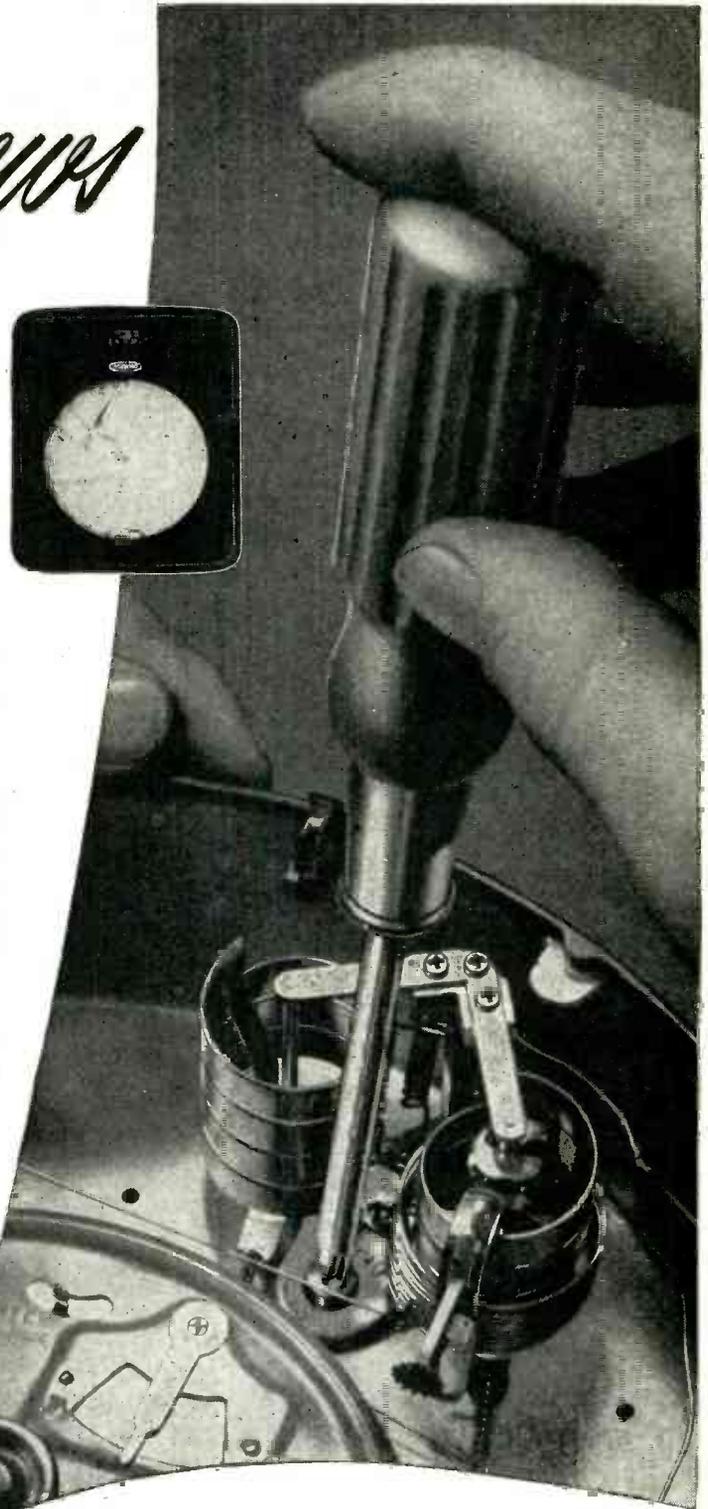
High spots from independent investigator's on-the-scene report . . . another study of assembly methods in key industrial plants by James O. Peck Company.

• "We gave Phillips Screws a big responsibility," Foxboro's chief engineer explained, "to maintain an accurate alignment of the helical coils in our temperature recording and control instruments.

"PHILLIPS' POSITIVE DRIVE makes positive fastening easier, more certain. Five Phillips Head Screws hold in accurate position the helical coils which are the heart of these instruments. The four-point contact of the driver in the Phillips recess makes it easy for the assembler to start the screws and drive them home. And we can depend on them to hold securely despite vibration or shock.

"WE SAVE DRIVER SLIPS that would cost us up to \$50 apiece. This is a tight-spot assembly where the slip of a driver - a constant hazard when driving slotted head screws - would irreparably damage the delicate capillary tubes, less than a half-inch away. The cost of such a slip - disassembly, replacing the damaged element, and reassembly - runs up to fifty dollars."

GET THE WHOLE INSIDE STORY of this critical assembly and other equally interesting studies . . . of metal, wood and plastic products. Plenty of tips to help you improve your own assemblies. FREE-use the coupon.



PHILLIPS *Recessed Head* SCREWS

Wood Screws • Machine Screws • Self-tapping Screws • Stove Bolts

24 SOURCES

Phillips Screw Mfrs., c/o Horton-Noyes

2300 Industrial Trust Bldg., Providence, R. I.

Send me reports on Assembly Savings with Phillips Screws.

Name

Company

Address

E-14

American Screw Co.
Central Screw Co.
Chandler Products Corp.
Continental Screw Co.
Corbin Screw Div. of
American Hdwe. Corp.
The H. M. Harper Co.
International Screw Co.
Lamson & Sessions Co.
Milford Rivet and
Machine Co.

National Lock Co.
National Screw & Mfg. Co.
New England Screw Co.
Parker-Kalon Corporation
Pawtucket Screw Co.

Pheoil Manufacturing Co.
Reading Screw Co.
Russell Burdall & Ward
Bolt & Nut Co.
Scovill Manufacturing Co.
Shakeproof Inc.
The Southington Hardware Mfg. Co.
The Steel Company of Canada, Ltd.
Sterling Bolt Co.
Stronghold Screw Products, Inc.
Wolverine Bolt Company

A NEW

Twist

to a BEDTIME STORY



A section of the heating element used in Simmons Electronic Blanket, showing waterproof insulation and rayon core. Light wire is D-H 99 Alloy, dark wire copper.

Controlled Sleeping Comfort Made Possible by a New Driver-Harris Alloy

SLIP beneath a new Simmons Electronic blanket, turn the control to the temperature desired and relax for a night of comfort.

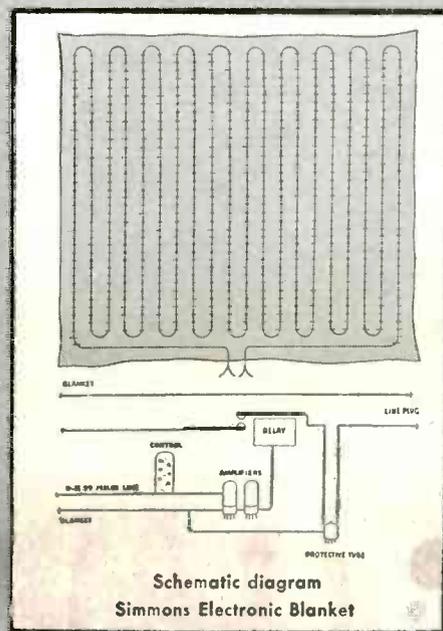
Separately insulated, but wound together on a rayon core and waterproofed, fine copper wire and even finer D-H 99 Alloy Wire form a network throughout the blanket. The copper wire supplies the heat — the D-H 99 Alloy wire controls it by flashing faint signals to an electronic control box whenever blanket temperature varies as little as 1° C.

Simmons selected D-H 99 Alloy for

this highly demanding application because it, alone, met or exceeded every specified requirement. D-H 99 Alloy had the corrosion resistance to withstand washing or cleaning, the fatigue resistance to withstand repeated folding and the constant sensitivity so vital to operating safety and comfort. Only .0039" in diameter, D-H 99 Alloy has a stable temperature coefficient of .00636 per degree C and is dependably uniform from spool to spool.

If your products or processes involve electrical circuits that require a high

T. C. of resistance, you'll find D-H 99 Alloy unequalled for these applications.



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

Driver-Harris
COMPANY
HARRISON, NEW JERSEY

BRANCHES: Chicago • Detroit • Cleveland
Los Angeles • San Francisco • Seattle

TYPE 10CP4

METALLIZED TELETRON

For Brighter Television
- without **ION-TRAP** -

CHARACTERISTICS:

Length: $16\frac{5}{8}$ "
Max. diameter: $10\frac{1}{2}$ "
Duo-Decal 7 pin base
Heater voltage = 6.3v.
Anode voltage = 10,000 v.
Second grid voltage = 250 v.
Neg. grid voltage = 45 v. \pm 40%

↓
**Further
details on
request**

▶ The Du Mont Type 10CP4 metallized teletron is designed for greater efficiency in utilizing the available light output of a television picture tube and for greater economy in receiver manufacturing. By eliminating the ion-trap a troublesome circuit adjustment is done away with, for it is unnecessary to provide an ion-deflection field in the neck of the tube. In addition to protecting the screen, the metallization acts as a mirror. The major portion of the available light is reflected through the viewing screen with a striking increase in light output and contrast. The Du Mont Type 10CP4 metallized teletron is interchangeable with older types with only slight modifications.

© ALLEN B. DU MONT LABORATORIES, INC.

DU MONT

Precision Electronics & Television

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

Impervious TO ATMOSPHERIC MOISTURE

Proof AGAINST INDUSTRIAL FUMES . . .

Unaffected BY EXTREME HEAT OR COLD

Withstand SEVERE MECHANICAL SHOCKS

. . . in short, constructed to last under the worst of operating conditions.

★ Although essentially fitted for the "tough" applications, Chicago Transformer's *Sealed in Steel* construction is being specified with increasing frequency by engineers who design electronic equipment for only average, or normal, conditions, but who, because of the vital services performed by their products, require an extra margin of dependability.

Their reasoning —

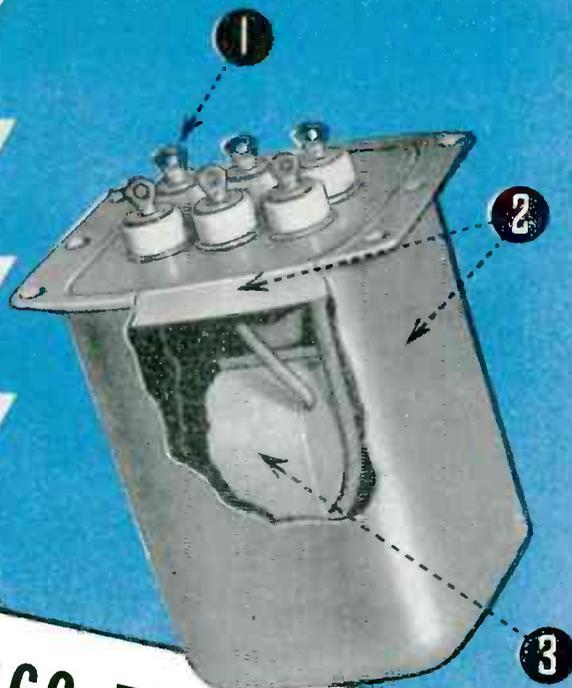
(a) Water vapor, oxygen, and carbon dioxide exist in all atmospheres; chlorine and sulphur compounds in the air of industrial localities.

(b) The action of these agents, intensified by heat and direct current potentials, corrodes copper coil windings, shortens transformer life.

(c) Moisture, even when not excessive in the air, frequently condenses on the inside of partially sealed or unsealed cases and shields as the result of variations in temperature.

Their conclusion —

It is good engineering to specify the transformers that have met with outstanding success the most rigid military tests for sealing against corrosion, have been proven to stay sealed in extremes of heat and cold . . . Chicago Transformers, *Sealed in Steel*.



CHICAGO TRANSFORMERS
Sealed in Steel
FOR LASTING DEPENDABILITY

- 1 C.T.'s exclusive Bushing-Gasket Seal at terminals employs tough resilient gaskets to permanently seal all openings and to cushion terminals and bushings against mechanical shock or drastic changes in temperature. (No cracking because of sudden heat transfer from soldering iron to terminals during chassis assembly operation.)
- 2 Seamless, Drawn Steel Case and C.T.-innovated Deep Seal Base Cover provide a strong, impenetrable housing which, with its compact, modern, and streamlined "good looks," helps sell the equipment in which it appears.
- 3 Coil is impregnated by a process using heat and alternate cycles of vacuum and pressure. By use of vacuum, all moisture is withdrawn from the coil, while pressure and heat thoroughly impregnate it with wax or varnish. Superior to ordinary impregnation processes, this method insures that the transformer is potted without moisture trapped inside.



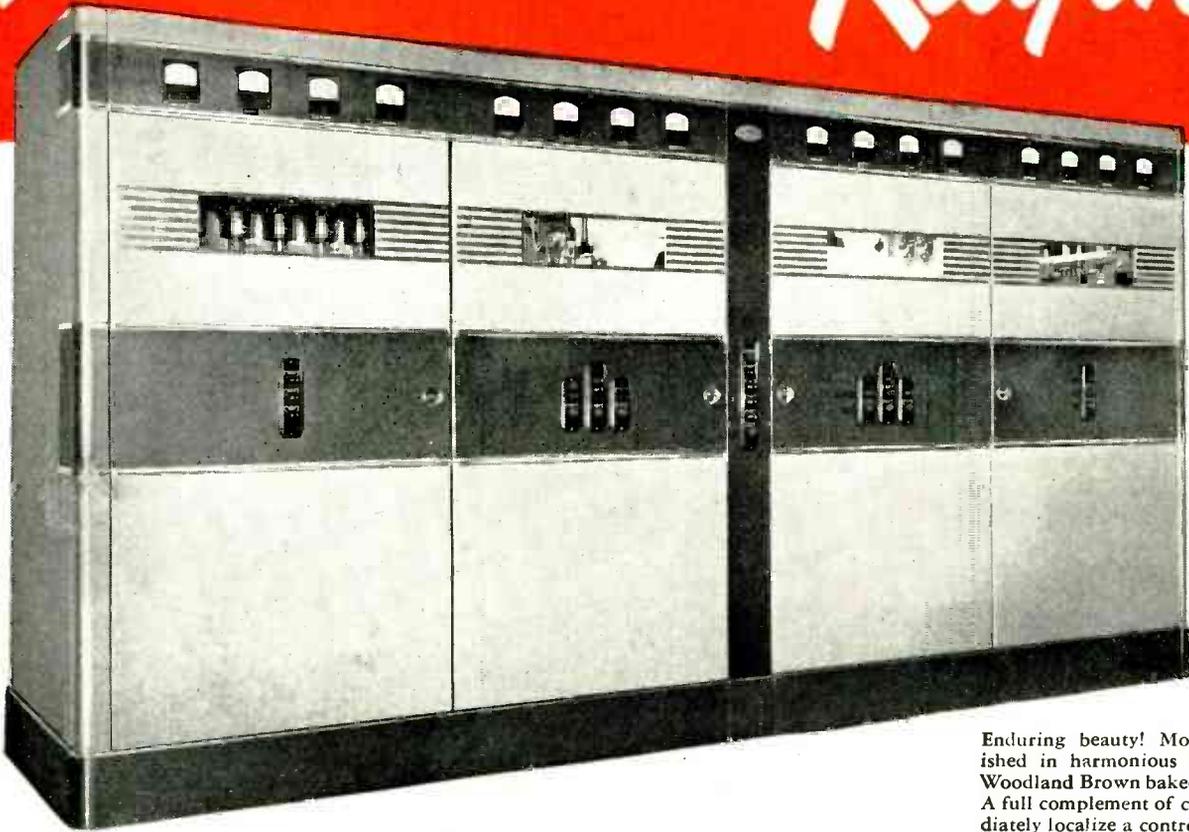
CHICAGO TRANSFORMER

DIVISION OF ESSEX WIRE CORPORATION

3501 ADDISON STREET • CHICAGO 18, ILLINOIS

NOW FOR THE LARGER STATION

Raytheon



Enduring beauty! Modern functional design, finished in harmonious contrast of Dove Grey and Woodland Brown baked enamel, trimmed in chrome. A full complement of circuit indicating lights immediately localize a control circuit failure.

FEATURES

High Fidelity Signal—flat frequency response 30 to 10,000 c.p.s.—distortion less than 3% at 95% modulation—noise level minus 60 db below 100% modulation.

Low Operating Cost—simple circuit design plus quality components operated at well below capacity assure exceptionally long tube life and economical operation.

Fast, Easy Maintenance—full length doors, large compartments and improved mechanical design provide maximum convenience and accessibility.

Instantaneous Power Reduction for nighttime operation through a single switch, without program interruption.

High Stability Crystal Oscillator with transfer switch. Provision for second crystal.

Easy to Operate—centralized manual or automatic plus remote console control. Minimum number of tuning controls, sixteen meters instantly check all circuits, full complement of circuit-indicating lights, modern motor tuning.

Automatic Recycling minimizes lost air time.

Easily Meets All FCC Requirements and is fully approved.

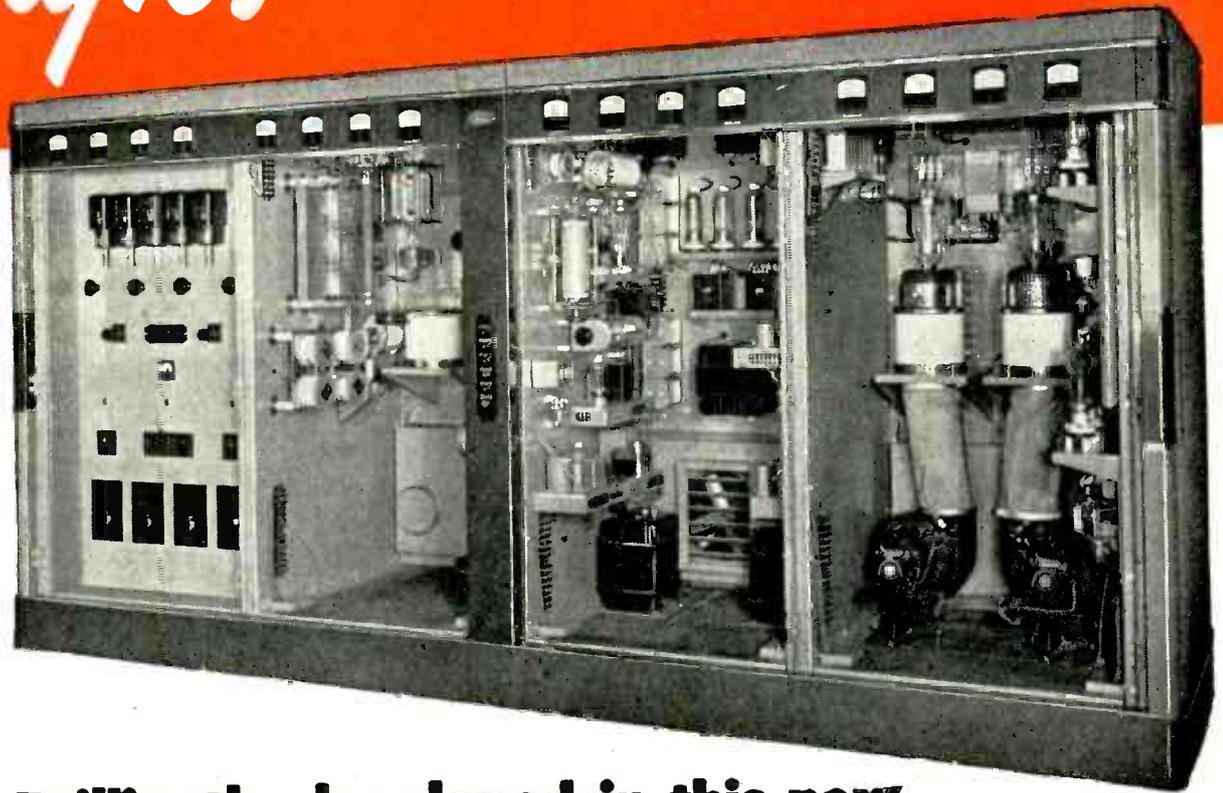


This handsome control console gives the engineer fully automatic control of all transmitter operations plus studio switching facilities for handling emergency programs originating at the transmitter. Controls audio and monitor switching; contains VU meter and remote antenna current meter. Finished in colors to match transmitter.

DEVOTED TO RESEARCH AND MANUFACTURE

... all the basic advantages of *Design!*

Rugged and completely accessible. Compartments, large enough for a man to enter, make cleaning and servicing easy.



Brilliantly developed in this new **5 or 10 KILOWATT AM TRANSMITTER**

Big station engineers all over the country designed this transmitter. It is custom engineered to their specifications—to give you *exactly* what you want and have asked for. That, is the advantage of Raytheon design.

For the first time—*complete* accessibility including convenient servicing from the inside of any one of the roomy compartments.

Reliability that is built into every circuit plus extra safeguards against program interruption. Control features that instantly locate a failure, meter every circuit, allow manual or automatic operation at the centralized control panel or at the remote console.

Positive safeguards to equipment are provided—double

RAYTHEON

Excellence in Electronics

protection to personnel—quiet high-velocity air cooling with an individual blower for each modulator and power amplifier tube.

The efficient high level system of modulation means real operating economy. The low initial

cost will also surprise you.

Before you order *your* transmitter get all the facts on the RA-5 or 10. Write today for fully illustrated booklet containing complete technical specifications, inside views and schematic diagram.

RAYTHEON MANUFACTURING COMPANY

Broadcast Equipment Division

7475 North Rogers Avenue

Chicago 26, Illinois

FOR THE BROADCASTING INDUSTRY

STACKPOLE

MOLDED IRON CORES

STANDARD AND HIGH-FREQUENCY TYPES

A pioneer in Iron Core production, Stackpole can supply practically any desired type from 100 cycles to upward of 175 megacycles and in an infinite variety of shapes, sizes and characteristics. Also available are High-Resistivity Cores showing a resistance of practical infinity; Insulated Cores wherein the screws are kept out of the coil field and "Q" consequently increased; Iron Cores for choke coils; and Side-Molded Iron Cores featuring uniform permeability with respect to linearity. Write for details and samples of any type.

for higher "Q" STACKPOLE SCREW-TYPE MOLDED CORES

These Stackpole developments are proving highly popular for circuits where small assemblies are the order of the day, and where "Q" must be kept at an absolute maximum. The cores themselves are threaded, thus eliminating the conventional brass core screw. Tubes can be threaded to fit cores if desired. More economical, however, is the use of a wire C-spring clip placed (obtainable from usual sources of supply) in a slot in an unthreaded tube. Stackpole Screw-Type Cores are ideal for the design of I-F and dual I-F Transformers for AM and FM.

IRON SLEEVE TYPES

... for better coils in less space

By use of Stackpole Sleeve Cores, much smaller cans of any material may be used to provide "Q" that is equal to, or better than, that of conventional cores and cans. Thus they facilitate an exceptionally high order of tuning unit efficiency in greatly reduced size. Cans are not always necessary — and, where they are, inexpensive aluminum containers may often be used.

LOOK FOR THE
STACKPOLE MINUTE MAN . . .
your assurance of
the highest in
molded materials
quality.

STACKPOLE CARBON CO., *Electronic Components Division*, ST. MARYS, PA.

MEISSNER

Coils

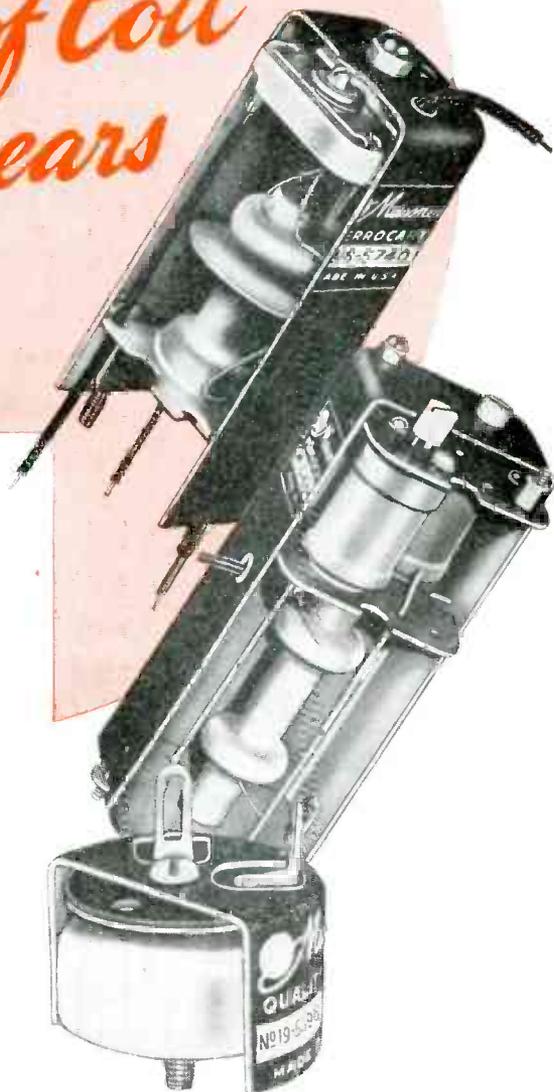
*The Standard of Coil
Quality for 24 years*

Meissner Coils, long the accepted standard for engineers who insist on high quality performance, are designed to meet your most exacting requirements. Precision-made, these superior components are backed by a 24 year reputation for quality and uniformity in manufacture.

A complete line, including Air Core Plastic I. Fs, Iron Core Plastic I. Fs and standard I. Fs. Send for free catalog.

Available Soon!

The new Hazeltine Combination AM-IF and FM-IF Single Unit Coils. The answer to space and production problems in the design of AM-FM receivers.



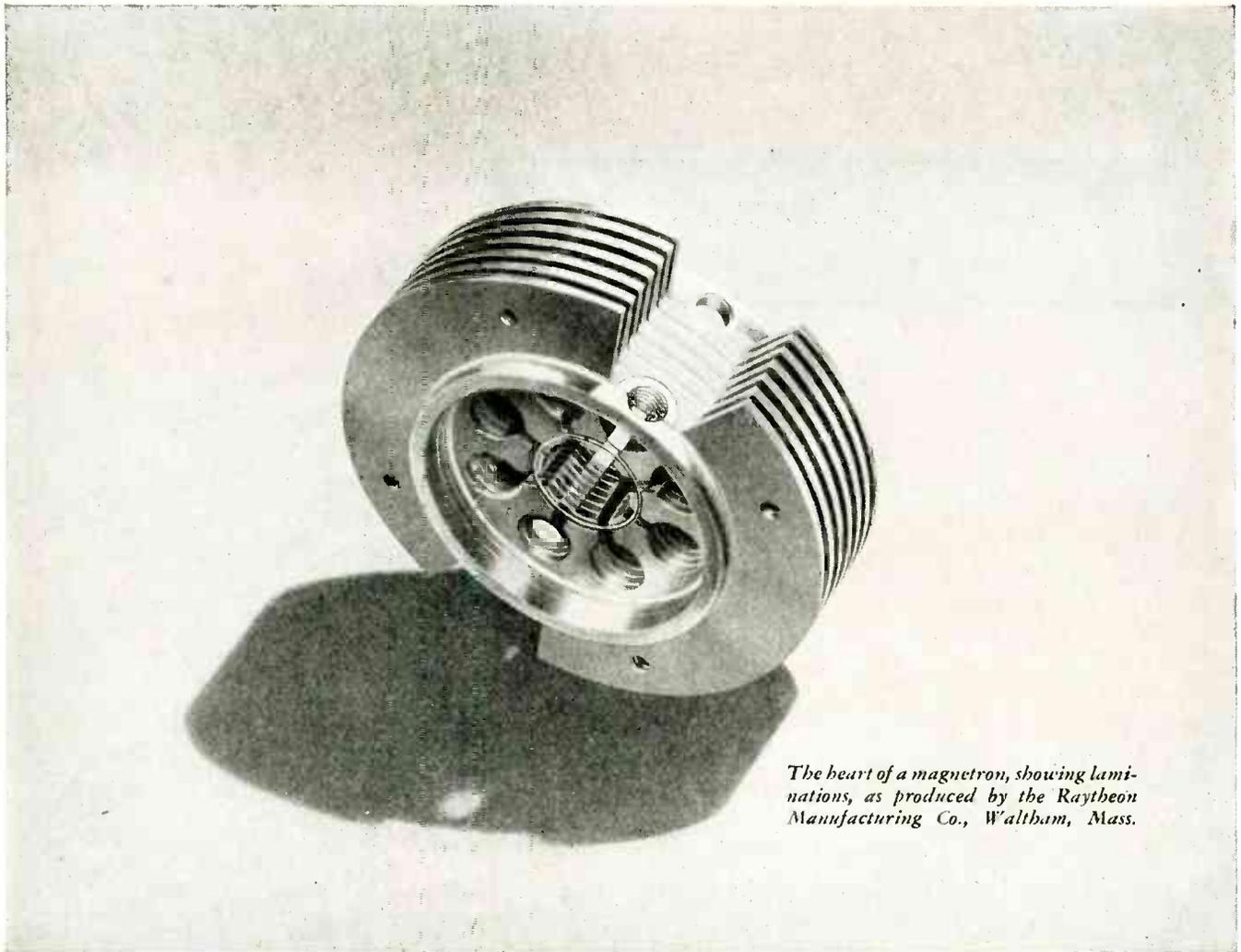
WRITE
FOR FULL
INFORMATION



ELECTRONIC DISTRIBUTOR AND
INDUSTRIAL SALES DEPARTMENT

MAGUIRE INDUSTRIES, INC.

936 N. MICHIGAN AVENUE · CHICAGO 11, ILLINOIS



The heart of a magnetron, showing laminations, as produced by the Raytheon Manufacturing Co., Waltham, Mass.

The **MAGNETRON** again proves that **Copper** Is the Metal of Invention

THE first magnetrons produced in this country were "hogged" out of solid OFHC copper bar, a difficult process because copper in this form does not machine freely. About 100 man-hours of expert machine work were required per piece, and rejections were high. The magnetron threatened to be an almost fatal bottleneck in the radar program.

At this point Raytheon stepped in with a new idea. OFHC copper may be difficult to drill and turn with great accuracy, but it can be easily punched. The idea was to build up magnetrons of punched laminations, stacked in precision jigs, and silver-brazed in an automatic conveyor furnace. This made it possible to increase production from 100 a day to 2500, and make better tubes as well. Revere supplied much of the copper strip used by Raytheon.

This remarkable accomplishment is another example of the fact that copper is indeed "The Metal of

Invention." It lends itself easily to brand new ideas.

Revere supplies copper in its six basic types, and in many different forms, and in addition produces brasses, bronzes, aluminum and magnesium alloys, and electric welded steel tube. The Revere Technical Advisory Service will gladly cooperate with you in selecting the proper metals for electronic uses.

REVERE

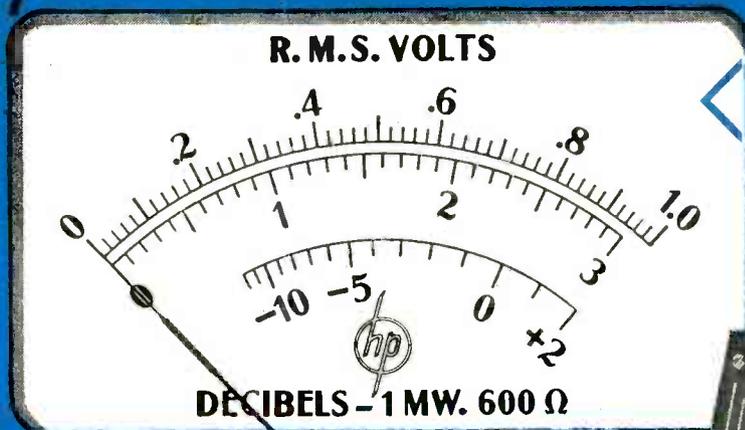
COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

*Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.;
New Bedford, Mass.; Rome, N. Y.—Sales Offices in
Principal Cities, Distributors Everywhere.*

Listen to *Exploring the Unknown* on the Mutual Network every Sunday evening, 9 to 9:30 p.m., EST.



MAXIMUM ACCURACY ON
THIS -hp- LINEAR SCALE

-hp- 400A VACUUM TUBE VOLTMETER



**Precise, Swift Measurements
between .005 and 300 volts,
10 cps to 1 mc.**

There's an almost limitless number of uses for this practical, wide-band -hp- voltmeter in today's laboratory, plant, production line, electrical or electronic installation. Power or carrier circuit voltages, capacity, hum and output level, amplifier gain, network response, audio to video voltages—this -hp- model 400A quickly and accurately measures them all. The simple panel control gives you instantaneous choice of 9 direct reading voltage and decibel ranges. Each decibel range is related to the next by a 10 db interval.

For greatest precision in voltage measurement, this -hp- 400A voltmeter has an open, easily-read linear scale. Because of generous overlap between ranges, it is always possible to make readings well up on the scale, thus minimizing meter frictional

errors. Tedious switching during a series of measurements can always be eliminated by selection of the proper range. The linear scale meter is exceptionally rugged, and will maintain its high degree of accuracy over a long period of time, despite hard knocks in the field.

The overall accuracy of the -hp- 400A voltmeter is within 3% to 100 kc; 5% to 1 mc. Variations caused by changing line voltage or aging tubes affect readings less than 3%. Input impedance of 1 megohm enhances exactness of measurement because circuits under test are not disturbed. And overloads 100 times normal do not appreciably affect performance of this light, compact instrument.

Write or wire today for further details. Immediate shipment can be made from stock.

These -hp- Representatives Are at Your Service

CHICAGO 6, ILLINOIS

Alfred Crossley
549 W. Randolph Street
State 7444

DENVER 10, COLORADO

Ronald G. Bowen
1886 South Humboldt Street
Spruce 9368

HIGH POINT, NORTH CAROLINA

Bivins & Caldwell
134 West Commerce Street
High Point 3672

HOLLYWOOD 46, CALIFORNIA

Norman B. Neely Enterprises
7422 Melrose Avenue
Whitney 1147

NEW YORK 7, NEW YORK

Burlingame Associates Ltd.
11 Park Place
Worth 2-2171

TORONTO 1, CANADA

Atlas Radio Corp. Ltd.
560 King Street West
Waverly 4761

HEWLETT-PACKARD COMPANY

1358A PAGE MILL ROAD • PALO ALTO, CALIFORNIA

Export Agents: Frazar and Hansen, 301 Clay Street, San Francisco 11, California, U. S. A.

Power Supplies • Frequency Standards • Amplifiers • Electronic Tachometers • Noise and Distortion Analyzers • Audio Signal Generators • Attenuators
Frequency Meters • UHF Signal Generators • Square Wave Generators • Audio Frequency Oscillators • Wave Analyzers • Vacuum Tube Voltmeters

THE TRUSTY TRIO FOR

Tough Jobs



**TURNER
99**



**TURNER
999**



**TURNER
U9S**

Severe operating conditions are a "push-over" for Turner Dynamic mikes. Their accurate pickup and smooth natural response to voice and music is not affected by climate or temperature. Built-in ruggedness enables them to stand up and deliver under abuse that renders an ordinary microphone useless. Typical of Turner Quality are Models 99, 999, and U9S. Professionals both in appearance and performance they will give added efficiency to your operations. Find out more about these Turner Dynamics.

MODEL 99 DYNAMIC

Used by broadcast stations, large city police departments, and specified as standard equipment by internationally known manufacturers. Will not blast from close speaking. Case fits any standard microphone stand and adjustable saddle gives semi- or non-directional operation. Response is flat within ± 5 db from 40-9000 cycles. Level: 52db below 1 volt/dyne/sq. cm. at high impedance. Gun metal type finish. Complete with 20 ft. removable cable set in a choice of 30-50 ohms, 200 ohms, 500 ohms, or high impedance.

MODEL 999 ^{BALANCED LINE} DYNAMIC

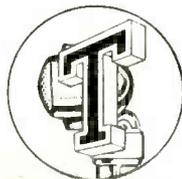
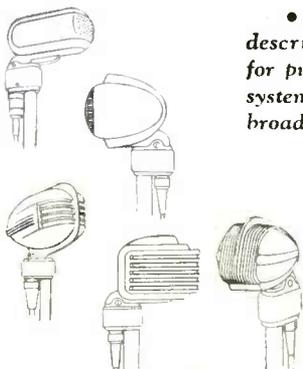
Same style and finish as Model 99. Equipped with Balanced Line features for critical applications and professional results under all conditions. Has voice coil and transformer leads insulated from ground and microphone case. Line is balanced to the ground. Response is flat within ± 5 db from 40-9000 cycles. Level: 52db below 1 volt/dyne/sq. cm. at high impedance. Complete with 20 ft. balanced line low capacity removable cable set with 3-pin polarized locking connection in a choice of standard impedances.

MODEL U9S DYNAMIC

Four Impedances at Your Fingertips

Whatever impedance you need—50 ohms, 200 ohms, 500 ohms or high impedance—you can get it quickly and easily with the turn of the switch on Turner U9S. This flexible unit handles toughest jobs. Same precision engineering and rugged construction as Model 999 with built-in multi-impedance transformer. Response is flat within ± 5 db from 40-9000 cycles. Level: 52db below 1 volt/dyne/sq. cm. at high impedance. Complete with 20 ft. removable cable set.

• Write for complete literature describing all Turner Microphones for public address, recording, call system, amateur and commercial broadcast, and special applications.



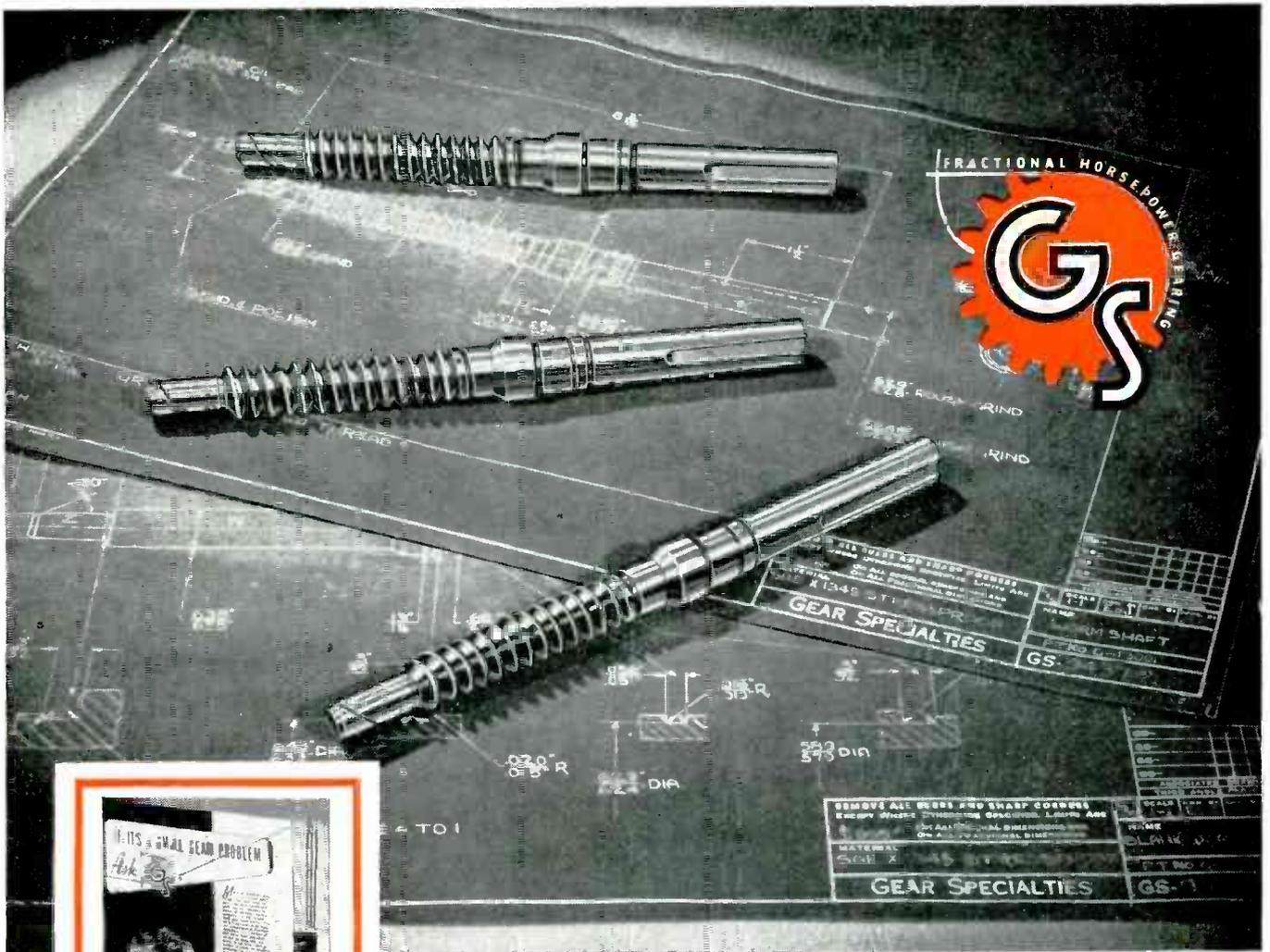
THE TURNER COMPANY

905 17th Street N. E. • Cedar Rapids, Iowa

Microphones **BY TURNER**

Licensed under U.S. patents of the American Telephone and Telegraph Company, and Western Electric Company, Incorporated.

HOW CLOSE MUST THE TOLERANCES BE?



The G.S. Catalog Bulletin describes many different types and applications of G.S. Small Gears. Please ask for a copy on company stationery. There's no cost or obligation.

If extreme precision is a factor in the small gears you need, better let "G.S." do the job. For, here, men, materials and machinery are coordinated to the intensively specialized operation of manufacturing FRACTIONAL HORSEPOWER GEARS exclusively. G.S. Gears from 12 to 96 D.P. are produced in volume with remarkable uniformity. Take advantage of this unusual Small Gear service, developed to its present high degree of efficiency thru a quarter century of experience with all different types and materials. G.S. engineers will gladly lend you every possible aid. Ask them today for suggestions, ideas and cost estimates.

G GEAR Specialties

Spurs • Spirals • Helicals • Bevels • Internals • Worm Gearing • Racks • Thread Grinding
2635 WEST MEDILL AVENUE • CHICAGO 47, ILLINOIS

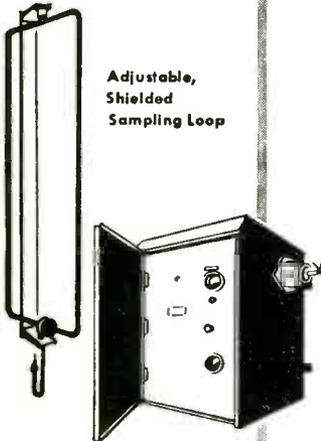
MEMBER OF



WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARS

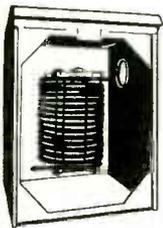
DIRECTIONAL ANTENNA EQUIPMENT FOR AM THE NEW "ISO-COUPLER" FOR FM

OTHER BROADCAST PRODUCTS



Adjustable,
Shielded
Sampling Loop

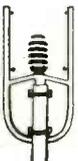
Coupling Unit



Isolation Filter



Tower Lighting Choke



Open Wire
Transmission
Line Support



JOHNSON

a famous name in Radio

Illustrated is a new phasing unit recently shipped to W G A C, Augusta, Georgia for use with their new 5 KW RCA transmitter. W G A C was the 60th station to choose JOHNSON for their directional system. This impressive total is growing at an accelerated clip—it's based on definite advantages. Your JOHNSON equipment will be more efficient because it is designed especially for your antenna system. Because it is not a "packaged" unit intended to solve everyone's problems there will be no unused components, nor will you have to add a few to meet your particular needs. JOHNSON-built cabinets will match the style and finish of your transmitter. Standardization is employed where it will not impair efficiency. For instance 90% of the major components are of standard design, and manufactured by JOHNSON. This permits an even flow of parts to your assembly job and careful control of their quality by JOHNSON engineers. No name of better reputation can appear on your phasing and antenna coupling units.

SAVE THE COST OF A SEPARATE FM TOWER!

If you are going to add FM to your existing AM facilities, quite likely you've looked at the price of a tower and wondered if the new antenna can go on top of an AM radiator. If the location is suitable and it's structurally possible, the answer is, it can and you'll never turn an easier several thousand dollars your way. The JOHNSON ISO-COUPLER announced in March of 1946 was the first commercial equipment offered to properly handle the two systems on one structure. It's designed for power up to and including 50 KW AM, and 10 KW FM. A heavy, weatherproof cabinet does away with the need of routine cleaning and uncertainties inherent in equipment exposed to the weather.

ONLY THE "ISO-COUPLER" OFFERS ALL OF THESE ADVANTAGES

1. Completely isolates AM and FM—no interaction possible.
2. Can be furnished with correcting network so that installation does not affect adjustment of present antenna coupling or directional equipment.
3. Easy to install and adjust.
4. Adjustments are efficient, broad, stable, and not affected by climatic changes.
5. Adjustments are possible at any time without disturbing coaxial lines.
6. Optimum impedance match possible for any FM frequency for 51.5 ohm line.
7. Standing wave ratio up to 2 caused by antenna can be eliminated between Iso-Coupler and transmitter.
8. Iso-Coupler can be used with any size and length of RMA standard FM line and any type of end terminal.
9. Coaxial line between Iso-Coupler and antenna can be fastened directly to AM tower, eliminating expensive line insulators and replacements.
10. Pressurizing maintenance independent of electrical adjustment.

The first ISO-COUPLER has already given many months of satisfactory service and we're in steady production.

Write to Department D for free Johnson literature today.

E. F. JOHNSON COMPANY • WASECA, MINNESOTA

Two rectifiers that emphasize

RUGGEDNESS!

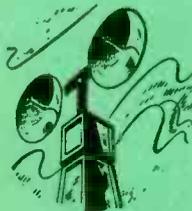
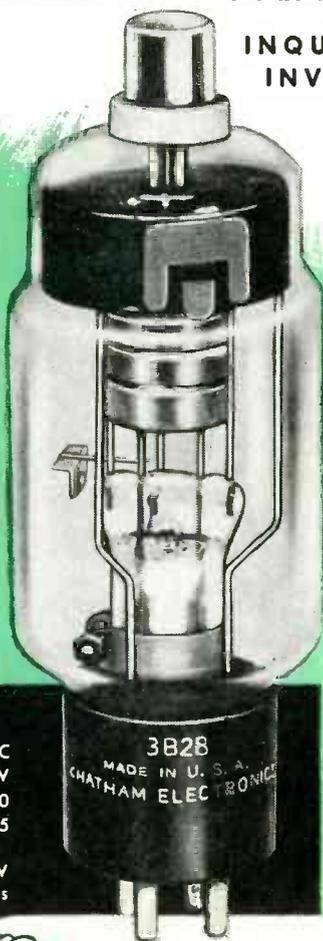


**AVAILABLE NOW FOR
QUANTITY DELIVERY**

These rugged Chatham rectifiers offer proven dependability under severe operating conditions. Xenon gas fill results in heavy current capacity, low voltage drop, and high peak inverse voltage rating. Another feature is very wide ambient temperature range. Chatham engineering provides immunity to shock and vibration. Both types are especially applicable to mobile, airborne and remote installations where extreme

temperature ranges are encountered. Types 3B28 and 4B32 operate dependably, and without auxiliary heaters, within a temperature range of -75°C to $+90^{\circ}\text{C}$. All ratings are conservative and ample overload capacity prevents failure under accidental overload. Further details will be furnished promptly on request.

INQUIRIES
INVITED



TYPE 3B28:

Filament Volts2.5AC
Peak Inv. Volts.....10.0KV
Peak Anode Amps.....1.0
Aver. Anode Amps....0.25
Voltage Drop Approx.
10V
Height6.38 Inches

3B28
MADE IN U.S.A.
CHATHAM ELECTRONICS

TYPE 4B32:

Filament Volts5.0AC
Peak Inv. Volts10KV
Peak Anode Amps.....5.0
Aver. Anode Amps....1.25
Voltage Drop Approx.
10V
Height7.88 Inches

4B32
MADE IN U.S.A.
CHATHAM ELECTRONICS



CHATHAM ELECTRONICS

475 WASHINGTON ST., NEWARK 2, NEW JERSEY

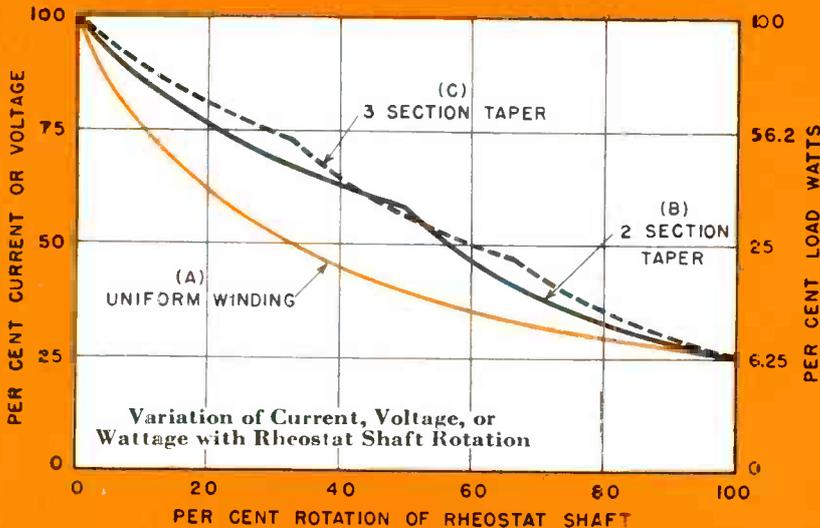
⚡ **More Uniform Current Control**

⚡ **Smaller Physical Size...with**

OHMITE

TAPER-WOUND

Rheostats



HOW A TAPERED WINDING PROVIDES MORE UNIFORM CONTROL

In a uniformly wound rheostat, each degree of rotation adds a constant number of ohms to a constantly increasing number of ohms. Hence, as the rheostat shaft is rotated, the resistance increases more slowly and the current decreases more slowly than before, as shown in Curve A of the chart above. A tapered winding (Curves B and C), by increasing the number of ohms per degree of rotation as the total ohms in the circuit increase, makes the rotation versus current curve more nearly linear.

Rheostat windings are sometimes tapered—that is, wound in two or more sections of diminishing wire sizes. This can be done because only the first turn of a rheostat carries the maximum current. Succeeding turns carry only a fraction of the maximum current. Thus, they can be of smaller wire size, permitting the use of a smaller rheostat—or a winding of higher resistance for a given size rheostat. Ohmite will design special tapered windings to suit individual needs. An extensive line of standard tapered rheostats is also available.

Write on company letterhead for Catalog and Engineering Manual No. 40.

OHMITE MANUFACTURING CO.
4816 Flournoy St., Chicago 44, Ill.



Be Right with

OHMITE

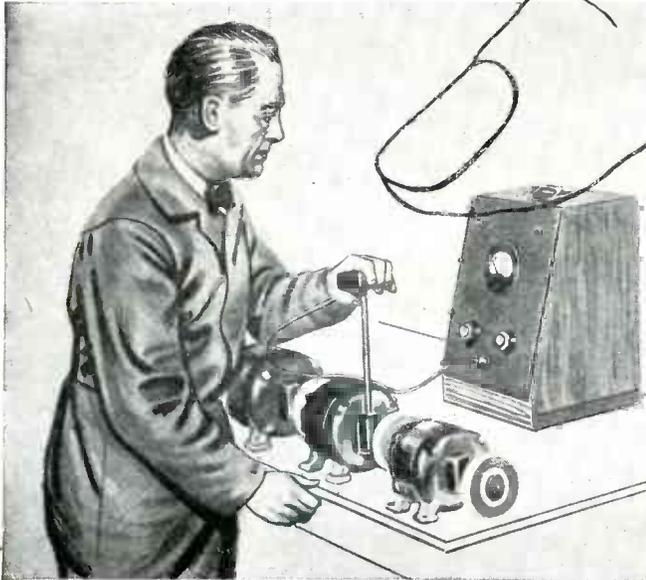
RHEOSTATS • RESISTORS

TAP SWITCHES



ELECTRIC VIBROMETER

"puts the finger
**ON WEAR
AND STRAIN**



The new Televiso Model 11-B Vibrometer provides a fast, accurate and easily used method of maintaining proper vibration limits in any manufacturing process or test procedure.

The Vibrometer has a frequency response of from 2 to 2,500 cps and indicates all three types of vibration measurement, i.e., displacement, velocity and acceleration.

Suitable for most industrial applications, the Vi-

brometer is of especial value in measuring the vibration characteristics of motors, gears, bearings, rotors, blowers and similar equipment.

The portability and rugged construction of the Model 11-B Vibrometer make it usable for field service, as well as for production and laboratory work.

Televiso Vibrometers are used by the foremost research and industrial institutions in America.

WRITE TODAY FOR VIBROMETER BULLETIN NUMBER 33

PRICE—\$235 F.O.B. Chicago

DELIVERY—within 30 days

GUARANTY—Unconditionally guaranteed for 2 years

Televiso



PRODUCTS CO.

7466 IRVING PARK ROAD
CHICAGO 34, ILLINOIS

YOU can problems like these...

there are 18 good reasons—18 “dag” colloidal graphite dispersions—why there need be no clumsy handling of a host of production and maintenance problems.

To bring you abreast of the many war-time and post-war applications for these versatile “dag” dispersions as they affect your operations, Acheson has prepared the full line of free booklets listed below.

Particularly, because it's brand new, we recommend that you request the new, completely illustrated bulletin No. 460—which is the complete general story of “dag” colloidal graphite dispersions.



dag colloidal products

ACHESON COLLOIDS CORPORATION, Port Huron, Michigan

This new literature on “dag” colloidal graphite is yours for the asking:

ACHESON COLLOIDS CORPORATION
PORT HURON, MICHIGAN DEPT. B-5

JMLCoA-B-1

460 A data and reference booklet regarding “dag” colloidal graphite dispersions and their applications. 16 pages profusely illustrated.

Please send me without obligation, a copy of each of the bulletins checked:

421 Facts about “dag” colloidal graphite for ASSEMBLING AND RUNNING-IN ENGINES AND MACHINERY.

NAME _____

POSITION _____

422 Facts about “dag” colloidal graphite as a PARTING COMPOUND.

FIRM _____

ADDRESS _____

423 Facts about “dag” colloidal graphite as a HIGHTEMPERATURE LUBRICANT.

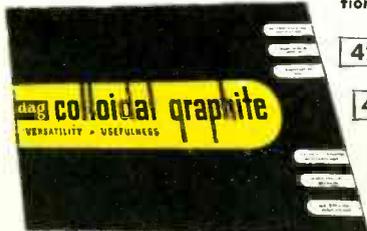
ZONE No. _____ STATE _____

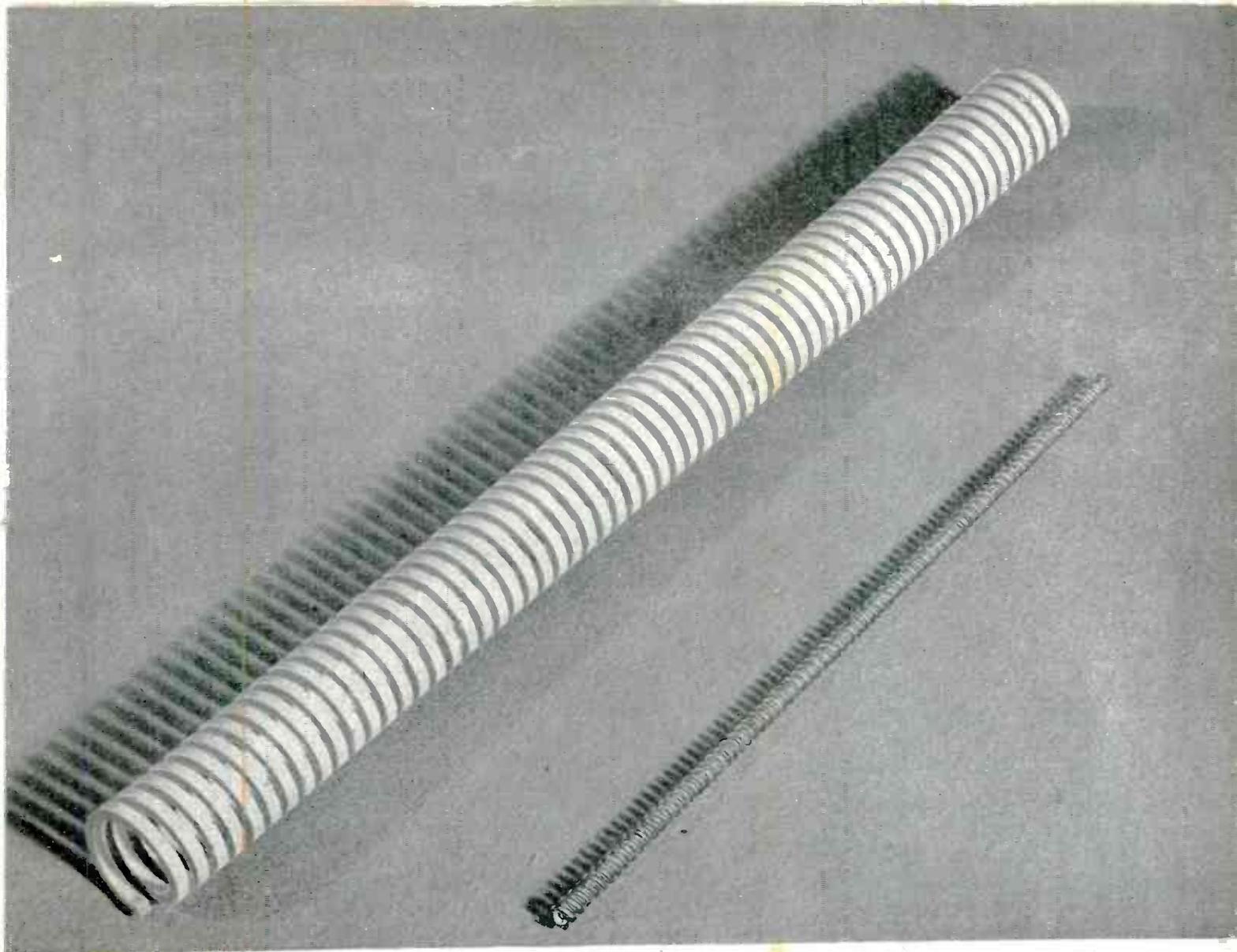
431 Facts about “dag” colloidal graphite for IMPREGNATION AND SURFACE COATINGS.

OUR PRESENT OIL SUPPLIER IS _____

432 Facts about “dag” colloidal graphite in the FIELD OF ELECTRONICS.

(Lubricants containing “dag” colloidal graphite are available from major oil companies.)





Have you a use for a **STEATITE SPRING?**

Illustrated above are steatite ceramic springs produced by the Research Division of American Lava Corporation. Pitches, lengths, inside and outside diameters can be varied within fairly wide limits. Compression and elongation limits vary only slightly with changes in size. Metallized surfaces can be supplied.

We do not know where this steatite spring may be useful. It is announced so that its availability may be known by research and engineering men in the electronic and electrical fields.

The development of this steatite ceramic spring results from American Lava Corporation's constant search

for better techniques and ceramics and new technical applications. American Lava Corporation was founded on research. Its Research Division has long been acknowledged as being far in the forefront of the industry. No other organization has such resources in trained technical men, research equipment, and facilities. No other organization has ceramic data comparable to that developed at American Lava Corporation in 44 years of constant research. Here, if anywhere, you will find the answer to any problem involving technical ceramics. We like tough problems and are ready to cooperate with you on your technical ceramic problems.

ALSIMAG
TRADE MARK REG'D. PROD'G. PAT. INT. OFFICE

AMERICAN LAVA CORPORATION
CHATTANOOGA 5, TENNESSEE
44TH YEAR OF CERAMIC LEADERSHIP

ENGINEERING SERVICE OFFICES: ST. LOUIS, Mo., 1123 Washington Ave., Tel. Garfield 4959 • NEWARK, N. J., 671 Broad St., Tel. Mitchell 2-8159 • CAMBRIDGE, Mass., 38-B Brattle St., Tel. Kirkland 4498 • CHICAGO, Ill., 5 Clinton St., Tel. Central 1721 • SAN FRANCISCO, 163 Second St., Tel. Douglas 2464 • LOS ANGELES, 324 N. San Pedro St., Tel. Mutual 9076



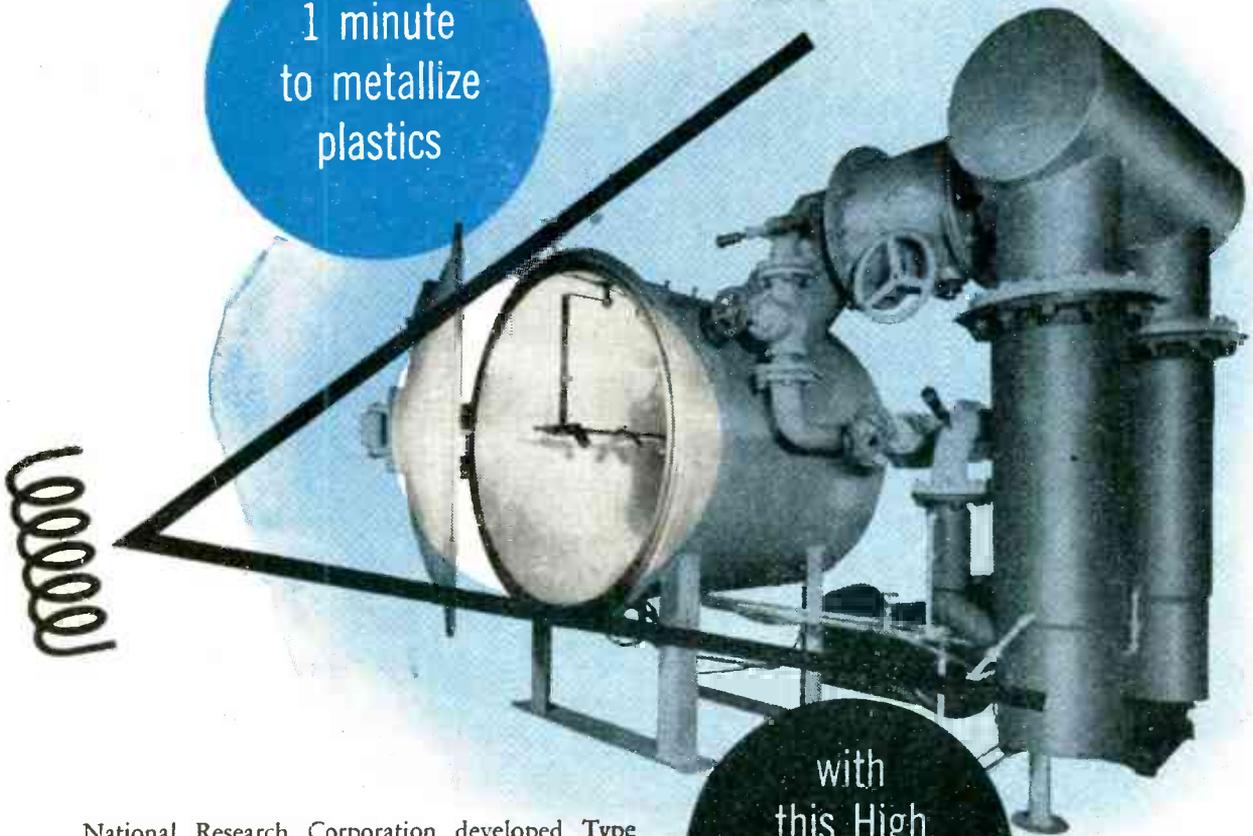
For true to life recording there has never been anything better than Presto Green Label Discs.



RECORDING CORPORATION • 242 WEST 55TH STREET • NEW YORK 19, N.Y.
Walter P. Downs, Ltd., in Canada

World's Largest Manufacturer of Instantaneous Sound Recording Equipment & Discs

1 minute
to metallize
plastics



with
this High
Vacuum
Evaporator

and
Callite's
heating
elements

National Research Corporation developed Type 3103 Evaporator, a 48" high-production unit, to provide a simple, quick method for coating plastics with precious metals and other metal finishes. Plastic articles to be coated are loaded into the vacuum chamber together with tungsten or molybdenum filaments on which the plating metal is placed, either wound on like wire or placed in boat-type containers. When the filament is heated electrically, the metal evaporates and coats the plastic in a few seconds.

To cut coating time, Callite prepared these special tungsten and molybdenum elements to vaporize plating metals at pressures of 1 micron or less. The heating cycle is so rapid that no distortion of the plastics takes place despite the high rate of heat transfer from the white-hot filaments.

Callite has aided industry *materially* to develop new processes, new products and better ways for producing old standbys. If your operation requires dependable components of standard or special metallurgy and shape — call on Callite first. Perhaps *your* specific application has been worked out *already* in the laboratory of our experience. Callite Tungsten Corporation, 547 Thirty-ninth St., Union City, N. J. Branch Offices located in Chicago and Cleveland.

Callite

METALLURGY

METALLURGY

Tungsten, molybdenum, silver, platinum, palladium and alloys of these metals.

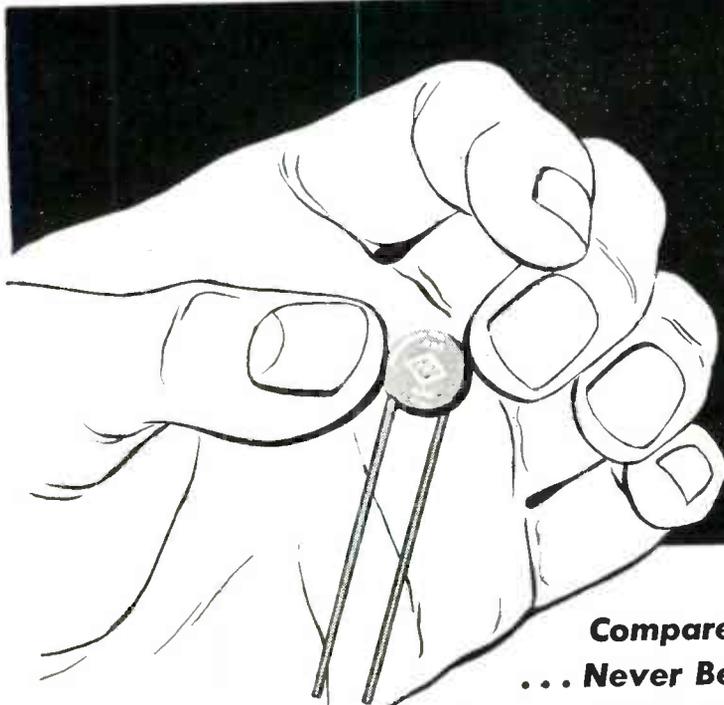


Calliflex Thermostatic Bi-Metals; Callinite Facing Material. Send for bulletins.

Announcing a brand new miniature capacitor

The "HI-KAP"

made with Centralab's original Ceramic-X!



Look at "HI-KAP" Performance, Ratings, Convenience of Design!

Diameter (Max. O. D.)	$\frac{5}{8}$ "
Thickness (Maximum)	$\frac{5}{32}$ "
W. V. D. C.	450
Guaranteed Min. Capac.	.005
Flash Test V. D. C.	900
Weight (Average)	1 gm. .035 oz.

Other capacity values available. Inquire now!

Compare these Exclusive "HI-KAP" Features ... Never Before Available in Small Capacitors!

Here it is—a sensational new quality line of miniature ceramic disc capacitors, developed and completely fabricated by Centralab! No other capacitor this size offers you the dependability, economy and versatility which these "Hi-Kap" features now make possible:

RELIABILITY: Permanent Ceramic-X stability assures utmost reliability in small physical size and low mass weight. Impervious to moisture.

CONVENIENCE: Convenient placement of 22-gauge leads permits low inductance connections on almost any appropriate capacitor application.

CAPACITY: "Hi-Kaps" are rated at a guaranteed *minimum* capacity for applications where close tolerances are unnecessary. Lowest minimum ca-

capacity will be exceeded by substantial amount on all units.

CONSTRUCTION: Pure silver electrodes bonded to permanent Ceramic-X with a tensile strength of 3000 lbs. per sq. in. High strength leads soldered directly to electrodes. Flat plate design assures low internal inductance.

INSULATION: Entire "Hi-Kap" unit is covered with a phenolic coating plus special impregnation to provide extra protection against voltage breakdown, mechanical damage and humidity. No further treatment required for export equipment (tropical use).

For complete information, write for Bulletin 933.

ACTUAL
SIZE
SHOWN
ABOVE



Ceramic Trimmers
Bulletin 630



Ceramics
Bulletin 720



Variable Resistors
Bulletin 697



Ceramic Capacitors
Bulletin 630



Selector Switches
Bulletin 722

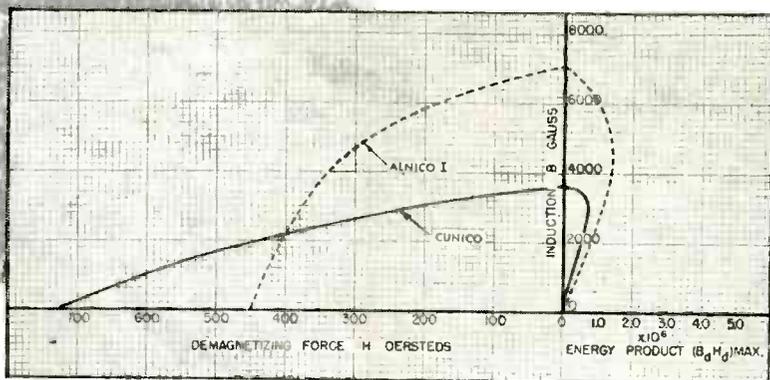
Centralab
Division of GLOBE-UNION INC., Milwaukee

Machineable CUNICO

GENERATOR ROTORS CAN BE OPERATED SAFELY AT 125,000 RPM

Cunico is the newest addition to the Arnold high quality permanent magnet line. It is a copper nickel cobalt alloy which has very high coercive force. Ductile, machineable and malleable, Cunico can be fabricated into a wide variety of simple and complex designs. Drawing, cutting, machining, punching and screw machine operations are practical.

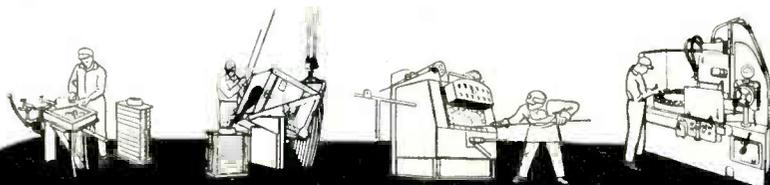
Cunico can be magnetized in any direction, and is most efficient where a large cross section is available to produce sufficient total flux. Generator rotors are a typical application. A relatively short length is required to maintain the flux because of its high coercive force.



CUNICO CAN BE PRODUCED IN THE FOLLOWING SHAPES AND APPROXIMATE SIZES:

- BARS— $\frac{1}{4}$ " to 1" square
- STRIPS—2" maximum width x .015" to .312" thickness
- RODS— $\frac{1}{4}$ " to 1" in diameter
- WIRE—No. 2 to No. 24 AWG sizes
- CASTINGS—Maximum section 1" thick

Write today for details.



THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

147 EAST ONTARIO STREET, CHICAGO 11, ILLINOIS

Specialists in the manufacture of ALNICO PERMANENT MAGNETS

ARNOLD'S TECHNICAL BULLETIN



"Permanent Magnets for Industry" suggests many ways in which the war-born improvements in permanent magnets can be most valuable to you. Send for it!

★ ANSONIA ★ Ankoseal

will not support Combustion



Continuous unfailing service is a prime requirement for industrial control cables, telephone cables, radio control cables, television cables and power cables. Ankoseal offers special protection for these types of cable against the ravages of fire, because it will not support combustion.

Because it chars, but does not readily drip or run from the cable when placed in direct flame, it often affords dielectric protection to vital circuits until replacements can be made in case of flash fires from short circuits, spontaneous combustion, or from other causes.

Ankoseal has many other desirable qualities — including resistance to a variety of other destructive agents, unusual flexibility, long life and versatility.

THE ANSONIA ELECTRICAL DIVISION

ANSONIA, CONNECTICUT *of*

NOMA ELECTRIC CORPORATION



WURLITZER

provides **BLILEY CRYSTAL** selection of the nation's top-flight bands and entertainers

The Wurlitzer automatic, electric phonograph, affectionately known as the juke box, is a proven source of top-flight entertainment on almost every highway and byway of America. Behind this assured performance lies a combination of electronic and mechanical ingenuity that could only be achieved by precision engineering.

In the new Wurlitzer instrument, selection of records may be accomplished by carrier current transmission of crystal controlled r-f pulses from the

remote selector box to a receiver in the reproducer. Design considerations called for reliable crystal starting and rapid, clean pulsing.

Bliley engineers were consulted concerning the crystal unit and associated oscillator circuit needed to meet these requirements. The problem was successfully solved and Bliley Crystals are now used in thousands of Wurlitzer installations.

Make it a habit to consult Bliley, first, on all frequency control applications. When you specify Bliley, you automatically select the creative engineering and production facilities that have built leadership in frequency control applications over the past fifteen years.



Write for Bulletin E-31

BLILEY ELECTRIC COMPANY • UNION STATION BUILDING, ERIE, PENNSYLVANIA

Drives TELEVISION FINAL STAGE ...and Excels because



New



v-h-f

POWER TRIODE GL-5513

ELECTRICAL CHARACTERISTICS

Filament voltage	6.3v
Filament current	32 amp
Amplification factor	87

Interelectrode capacitances:

Grid-plate	8.7 mmfd
Grid-filament	21.1 mmfd
Plate-filament	.11 mmfd
Type of cooling	forced-air

MAX RATINGS, CLASS B R-F POWER AMPLIFIER, VIDEO SERVICE, SYNCHR. PEAK CONDITIONS

Plate voltage	3,000 v
current	1.2 amp
input	3,300 w
dissip.	1,200 w

MAX RATINGS, CLASS C TELEGRAPHY

Plate voltage	4,000 v
current	1 amp
input	3,600 w
dissip.	1,200 w

- ★ Frequency (at max ratings) ranges up to 220 mc, covering both television video and FM bands.
- ★ Power output is substantial—see text below.
- ★ Designed directly for grounded-grid circuits, with high-mu characteristics that give high power gains.
- ★ Complete internal shielding, plus ultra-compact construction, result in low plate-filament capacitance—making neutralization easy, where required.
- ★ Thoriated-tungsten filament SAVES, calling for minimum filament power.
- ★ Forced-air cooling assures convenient station installation.
- ★ RING-SEAL terminals enable tube to be "plugged in" quickly—their generous contact area also promotes h-f circuit efficiency.

TYPE GL-5513 has a tube output in excess of 2 kw (Class C telegraphy), with power gain of approximately 10 when operated as a grounded-grid amplifier. In Class B video service, under synchronizing peak conditions, output exceeds 1 kw, with approximate power gain of 8 in grounded-grid service.

This capable new triode, besides its application to television transmitters for both the video and FM bands, is directly suited to dielectric-heating service employing the high and very-high frequencies. Here the tube's low filament-power requirements are of special value, contributing to simple, economical transformer and circuit design.

As a rule, the GL-5513 requires no neutralization in grounded-grid

circuits, but when this is needed, a small amount of cross-neutralization will suffice. Modern engineering is evident not only in the tube's electrical characteristics, but also in its compact structure—in its trim and efficient radiator design—in the fact that all external metal parts are silver-plated to provide better contact surfaces—and in the ring-type fernico metal-to-glass seals used throughout.

Help in applying G.E.'s new GL-5513 triode to new equipment now on your drawing-boards, gladly will be furnished by General Electric tube engineers. Telephone or write your nearest G-E electronics office, or communicate with *Electronics Department, General Electric Company, Schenectady 5, New York.*

GENERAL ELECTRIC

161-F1-8850

FIRST AND GREATEST NAME IN ELECTRONICS



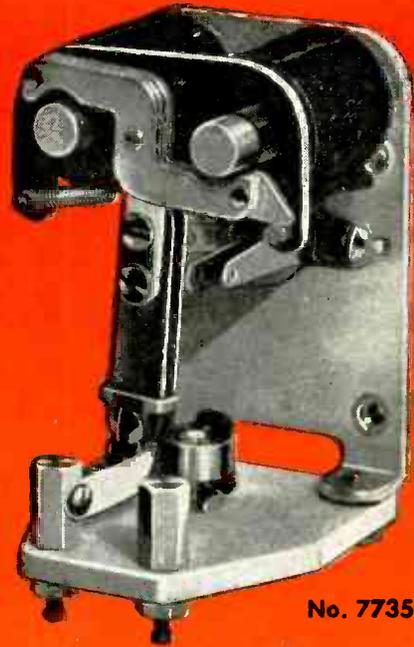
miniaturized RELAYS with Steatite Insulation

No. 11638



No. 12231

(SHOWN OVERSIZE
FOR CLARITY)



No. 7735

Originally designed for use in aircraft equipment, these **MINIATURE** relays give completely dependable operation under extreme conditions of vibration, humidity and temperature.

See A. R. C. Exhibit, Booths 40-41A, at I. R. E. Show

The Steatite insulation and general construction of these relays makes them inherently suitable for switching circuits requiring permanently low leakage, for switching certain high frequency circuits, and for any application where a compact, light weight, yet sturdy relay is required. Particular attention has been paid to design of relays that will not "chatter" under vibration even in the un-energized position.

The antenna changeover relay shown is of unique design and provides the wide contact spacing and positive action necessary for this special purpose, for a weight of only 0.2 lb.

The other small relays are provided in the contact combinations illustrated at right, with maximum overall dimensions of $1\frac{1}{4}'' \times 1\frac{1}{16}'' \times 1\frac{1}{4}''$ and a maximum weight of 0.07 lb.

A. R. C. NO.	RATED D.C. OPERATING VOLTAGE	D.C. RESISTANCE	CONTACT ARRANGEMENT
11975	14	90	
12232	28	300	
11914	14	90	
12231	28	300	
11638	28	300	
7735	28	112	



For price and delivery information, write

AIRCRAFT RADIO CORPORATION

BOONTON, NEW JERSEY



How you will benefit by using the Collins 30K-2

Ground Station Radio Transmitter



The new Collins 30K-2 embodies certain design features that are of outstanding benefit to owners who employ radio communication from point to point, ground to plane, or shore to ship. This 250 watt radio transmitter can be pretuned to any two frequencies between 2.0 mc and 30.0 mc. Relay operation of all r-f circuits, including antenna tuning, provides instantaneous frequency shift.

A speech clipper in the audio circuit raises the effective modulation level and emphasizes the speech sounds that produce intelligibility. The effectiveness is especially noticeable on congested frequency channels and under adverse atmospheric conditions. The 30K-2, when the speech clipper is in operation, has a signal output comparable to that of transmitters with normal modulation and a much larger power output.

Because the r-f carrier is fully utilized, the power consumption of the 30K is comparatively small for the results achieved. Maximum power demand is

approximately 1250 watts from a 115 volt a-c single phase power source. Nominal r-f power output is 300 watts on cw or 250 watts on voice transmission.

Installation of the 30K-2 is extremely simple. No time consuming, expensive operations are required. Just connect it to a power source and attach the antenna. The transmitter output network will accommodate a wide variety of antennae and transmission lines. A remote control unit is available. For complete details of this new and versatile radio transmitter, write for an illustrated bulletin.

IN RADIO COMMUNICATIONS, IT'S . . .



COLLINS RADIO COMPANY, CEDAR RAPIDS, IOWA

11 West 42nd Street, New York 18, N. Y.

458 South Spring Street, Los Angeles 13, California



Long Term
Dependability...

...for the equipment you build!

There's no more certain way to insure the efficient performance in your customers' hands of the machines or devices you build, than to equip their panels or controls with *trustworthy* instruments. And for that very reason, the name WESTON on a panel instrument helps build buyer acceptance and goodwill for the products on which they are installed.

WESTON instruments are available in all the types, sizes and ranges essential for panel or built-in requirements. Complete information, or engineering cooperation, is available on request. Weston Electrical Instrument Corporation, 618 Frelinghuysen Avenue, Newark 5, New Jersey.

Weston Instruments

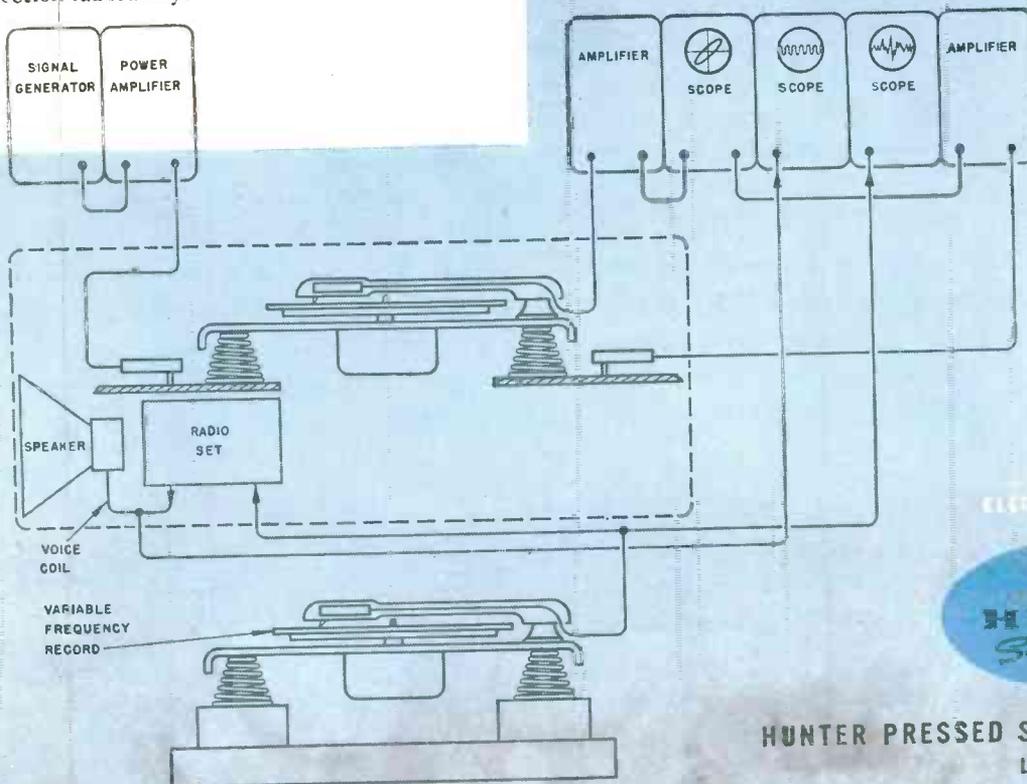
Albany · Atlanta · Boston · Buffalo · Chicago · Cincinnati · Cleveland · Dallas · Denver · Detroit · Jacksonville · Knoxville · Los Angeles · Meriden · Minneapolis · Newark · New Orleans · New York · Philadelphia · Phoenix · Pittsburgh · Rochester · San Francisco · Seattle · St. Louis · Syracuse · In Canada, Northern Electric Co., Ltd., Powerlite Devices, Ltd.

How to Discourage "Back Talk" from a Loud Speaker

In a phono-radio combination, loud speaker vibrations feed back through the mounting springs of the record player. Picked up by the tone arm, they are amplified over and over again, producing, unfortunately, noise . . . not music.

It is a tricky and interesting problem to design mounting springs capable of supporting the varying (1 to 10) record load yet of such flexibility that there will be little vibration over the usable audio range.

Though it is another matter to engineer (and often build) the complicated gadgets required for properly testing these springs—it's all in a day's work at Hunter. And here you see mounting springs on trial in the Hunter inspection laboratory.

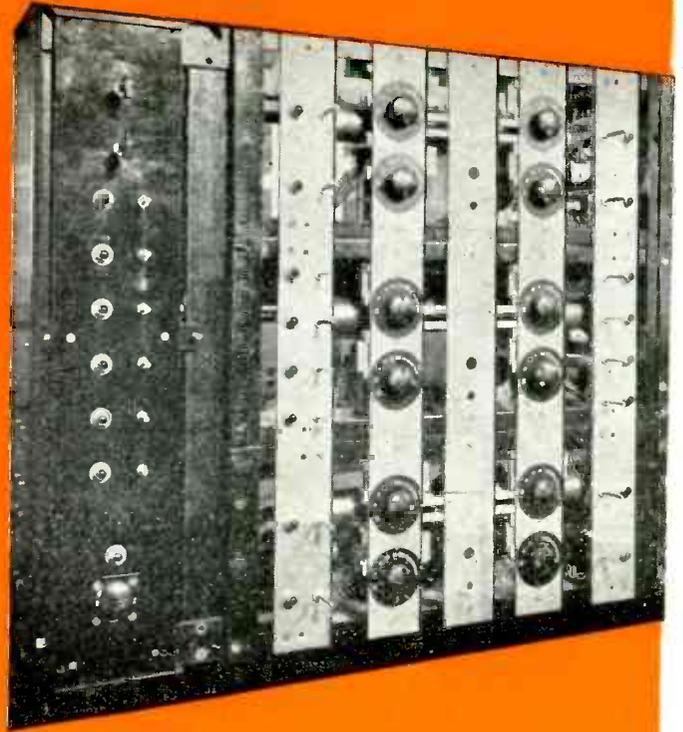


HUNTER PRESSED STEEL COMPANY
Lansdale, Pennsylvania

500 Times

IN ONE INSTALLATION

LAMICOID Provides Excellent Appearance, Structural Strength and Insulating Properties for Webster Control Panel



Over 500 pieces of LAMICOID help special-made Webster "Moderator" Control Panel provide automatic heat variation. Front and rear views of this 37-zone installation reveal the use of this thermosetting plastic laminate for dials, washers, and terminal boards.

This is a typical LAMICOID application where structural strength, appearance and electrical insulating properties are required. In fact, this unique combination makes LAMICOID so popular for such critical items as—panel boards, coil forms, threaded bushings, bus bar insulation, condensers, circuit breakers, terminal strips and blocks, rheostats . . . and many similar parts.

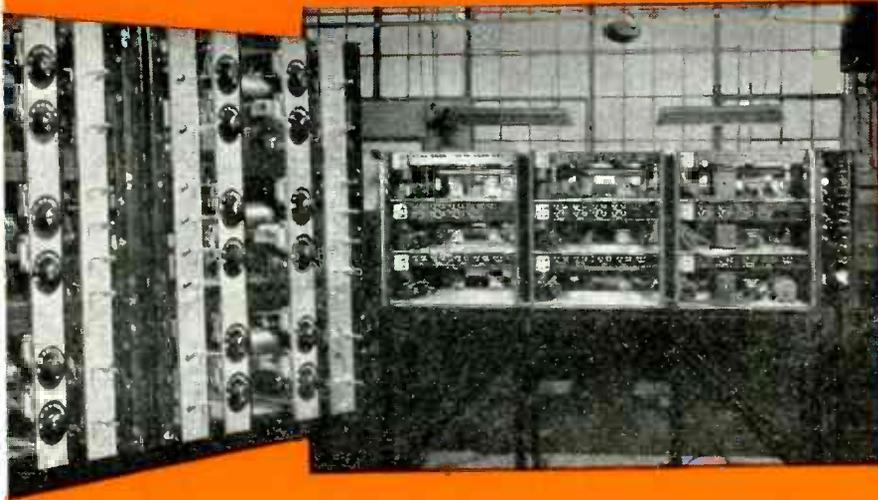
A tough dielectric, LAMICOID is suitable

for either high or low voltage applications. Its good compressive strength, low power factor and resistance to varying atmospheric conditions round out its useful qualities—help it perform satisfactorily on the toughest jobs.

LAMICOID is made in many different electrical and mechanical grades from a wide selection of choice fabric and paper bases. It is furnished in a variety of forms, too. Sheets, rods and tubes are readily sawed, punched or machined into intricate shapes.

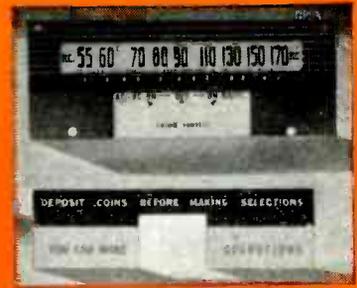
Because Mica Insulator Company manufactures a *complete* line of insulating materials—you can be sure of reliable, impartial recommendations as to the type best suited to your requirements.





Warren Webster & Company utilizes versatility of LAMICOID for hundreds of parts where both structural and insulating properties are required.

Easy to clean graphic LAMICOID makes distinctive and dignified panel for this Warren Webster "Moderator" control.



Attractiveness, legibility and permanence of translucent LAMICOID make it ideal for radio and instrument dials.



MICA *Insulator* COMPANY

Dept. 22, Schenectady 1, New York

Sales Offices and Fabricators in Principal Cities



Free!

Send for your copy of the revised 4-page booklet on LAMICOID. Lists electrical and mechanical specifications, and many suggested applications, colors and NEMA grades.

Mica Insulator Company,
P. O. Box 1076, Schenectady 1, New York

Gentlemen:

Please send me a copy of your 4-page bulletin on LAMICOID.

Name _____

Position _____

Company _____

Address _____

City _____ Zone _____ State _____

USE STANDARD PARTS — SAVE TIME AND MONEY



M O D E R N

The K-TRAN is modern in size, much smaller in all dimensions than old style I. F. Transformers.

The K-TRAN is modern in performance. Any old style I. F. Transformer can be matched by one of a few types of K-TRAN.

The K-TRAN is modern in price. More economical to purchase, more economical to stock, more economical to assemble than old style I. F. Transformers.

Be modern. Use K-TRANS.



MASS PRODUCTION COILS & MICA TRIMMER CONDENSERS

900 PASSAIC AVE.

EAST NEWARK, N. J.

* RICHARDSON MEANS *Versatility* IN PLASTICS



This is our "HOW-WHICH-WHY" department



How will it be used? Which INSUROK grade? Which type... molded, laminated, rubber or combinations of each? Why?

These men are *Richardson Plasticians* who specialize in asking... and answering... questions of this kind.

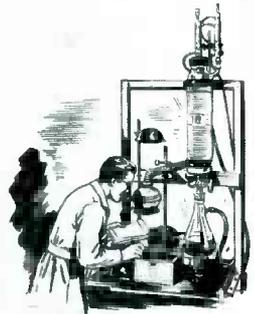
They're designers who scrutinize virtually every plastics order entering our door. Over drawing boards and under T-squares, they visualize and create. The impractical is sifted; the practical is found. And satisfaction results for all concerned.

This is efficiency the way we like to serve it up. This is *Richardson versatility*... whereby our customers receive all they expect—and more! It's a policy we've believed in and practiced for many years.

INSUROK *Precision Plastics*

The RICHARDSON COMPANY

Sales Headquarters: MELROSE PARK, ILL. FOUNDED 1858 LOCKLAND, CINCINNATI 15, OHIO
 NEW YORK 6, 75 WEST STREET ROCHESTER 4, N. Y., 1031 SIBLEY TOWERS BLDG.
 PHILADELPHIA 40, PA., 3728 NO. BROAD STREET MILWAUKEE 3, WIS., 743 NO. FOURTH STREET
 CLEVELAND 15, OHIO, 326-7 PLYMOUTH BLDG. DETROIT 2, MICH., 6-252 G. M. BLDG. ST. LOUIS 12, MO., 5579 PERSHING AVENUE
 Factories: MELROSE PARK, ILL. NEW BRUNSWICK, N. J. INDIANAPOLIS, IND.



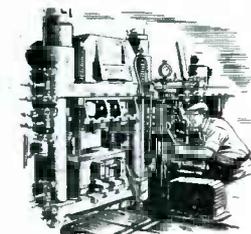
* RESEARCH
 ... a continuous transformation of possibilities into practical ideas in plastics.



* PRODUCTION
 ... Complete machine shop facilities for manufacturing our own dies, molds, tools.



* LAMINATING
 ... Sheets, rods, tubes. Standard NEMA grades; over 100 special grades.



* MOLDING
 ... Rubber and bituminous plastics; and synthetic resin plastics... Beetle, Bakelite, Durez, etc.



* FABRICATING
 ... Complete equipment for drilling, punching, sawing, turning, milling, etc.

STUPAKOFF

KOVAR-GLASS TERMINALS

Give Permanent....

Hermetic.... Pressure-tight Seals

Stupakoff hermetic seals are the answer where products must have permanently vacuum- and pressure-tight insulated electrical lead-ins. They seal against atmosphere, dirt, dust, fungus, and other foreign substances that normally cause failures.

Available from stock or specially made to suit your needs, Stupakoff metal-glass seals can be supplied

with single or multiple, hollow or solid electrodes.

The metal Kovar is available in sheets, rod, wire, tubing and special shapes for manufacturers having glass working facilities.

We will gladly send literature, recommendations and prices on your hermetic seal requirements. Write today.



Write for literature.

*Reg. U.S. Pat. Off.
Trade Mark No. 337962

STUPAKOFF

CERAMIC AND MANUFACTURING CO. • LATROBE, PA.

EXPORT DEPARTMENT
13 E. 40th St., New York 16, N. Y.
Cable Address ARLAB all codes.



hallicrafters PRESENTS THE

SX-42

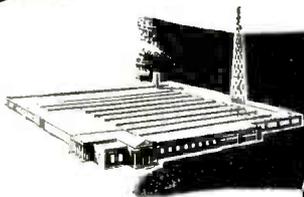
Another first!
Greatest continuous frequency coverage of any communications receiver — from 540 kc to 110 Mc

This is the long-awaited Hallicrafters SX-42, a truly great communications receiver. The tremendous frequency range of the SX-42, *greater than ever before available in a receiver of this type*, is made possible by the development of a new "split-stator" tuning system and the use of dual intermediate frequency transformers. Packed with advance features that every ham and every other radio enthusiast desires, the SX-42 clearly lives up to the Hallicrafters ideal of "the radio man's radio."

From now on watch Hallicrafters — the name that's remembered by the veteran, preferred by the radio amateur. See your distributor for demonstration of the SX-42 and for colorful literature describing this great set in complete technical detail.



Because of the precise and thorough engineering that must be done on the SX-42 and because the parts supply has not been continuous, top production peaks have not yet been reached. In the immediate future deliveries will necessarily run behind the demand, but the SX-42 is definitely worth waiting for.



hallicrafters RADIO

THE HALLICRAFTERS CO., MANUFACTURERS OF RADIO AND ELECTRONIC EQUIPMENT, CHICAGO 16, U. S. A.

Sole Hallicrafters Representatives in Canada: Rogers Majestic Limited, Toronto-Montreal

BUILDERS OF *Skyfone* AVIATION RADIOTELEPHONE

PUTTING ELECTRONICS TO WORK
with
Government Owned Surplus

To help you incorporate the many advantages of electronics in your business, the War Assets Administration is making available its enormous inventory of tubes and equipment now.

Qualified distributors all over the country have been appointed by WAA to represent it. In every field where electronic application has proved its worth, these distributors maintain inventories and have the technical "know-how" to service your needs.

Get in touch with your nearest distributor and see how government-owned war surplus can help you—electronically. Or—if it is more convenient—write to

ELECTRONICS DIVISION
OFFICE OF AIRCRAFT DISPOSAL

WAR ASSETS ADMINISTRATION

425 Second St., N.W.

Washington 25, D. C.



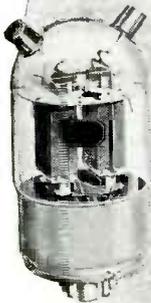
Millions and millions of electronic tubes are at your disposal. Pictured are some of the types which are available to you.



RECTIFYING
(NO. 866A)



CATHODE RAY
(NO. 3BP1)



TRANSMITTING
(NO. 815)

VOLTAGE REGULATOR
(NO. VR150)



RECEIVING
(NO. 6L6)



RECEIVING
(NO. 65K7)



tubes! tubes! tubes!

"NO ELECTRONIC DEVICE IS BETTER THAN ITS TUBE"

880



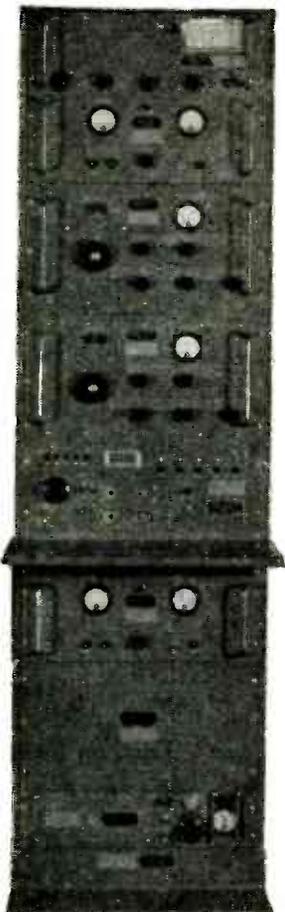
Transmitter

MODERN COMMUNICATION and PRODUCTION

depend on

Electronics

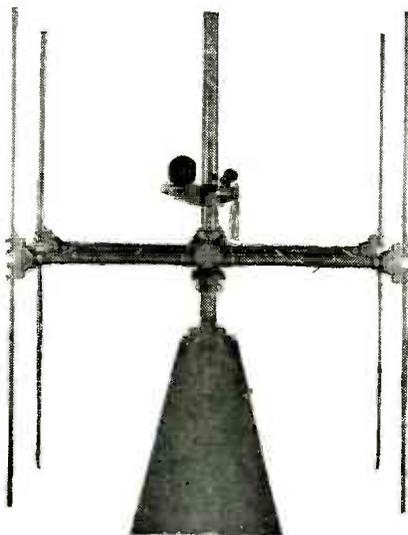
Today—virtually all methods of high-speed communication use electronic tubes. In the industrial field, heating, welding and various methods of control are being done better and faster because of electronics. From big broadcasting stations to tiny hearing aids—from induction heating to voltage regulation—the science of electronics is playing a major role in industry.



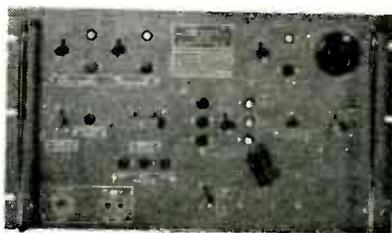
Receiver



Microphone



Matching Stub and Antennae



Control Unit



Headset

these Authorized Distributors will serve you:

Listed here are the names and locations of WAA appointed distributors. Not all of them will have complete stocks but it will pay you to consult them on your electronic problems.

Automatic Radio Mfg. Co., Inc.
120 Brookline Avenue
Boston 15, Massachusetts

Communication Measurements Laboratory
120 Greenwich Street
New York 6, New York

Tobe Deutschmann Corporation
Canton, Massachusetts

Electronic Corporation of America
353 West 18th Street
New York 19, New York

Electro-Voice, Inc.
Buchanan, Michigan

Emerson Radio & Phonograph Corporation
123 Duane Street
New York 7, New York

Essex Wire Corporation
1601 Wall Street
Ft. Wayne 6, Indiana

General Electric Company
Building 267-1 River Road
Schenectady 5, New York

Hammarlund Mfg. Company, Inc.
460 West 34th Street
New York 1, New York

Hoffman Radio Corporation
3741 South Hill Street
Los Angeles 7, California

Hytron Radio & Electronics Corporation
76 LaFayette Street
Salem, Massachusetts

E. F. Johnson Company
206 Second Avenue S. W.
Waseca, Minnesota

Newark Electric Co., Inc.
242 West 55th Street
New York 19, N. Y.

Majestic Radio & Television Corporation
125 West Ohio Street
Chicago 10, Illinois

Raytheon Manufacturing Company
60 East 42nd Street
New York 17, New York

Smith-Meeker Engineering Company
125 Barclay Street
New York 7, New York

Sylvania Electric Products, Inc.
Emporium, Pennsylvania

Technical Apparatus Company
165 Washington Street
Boston 8, Massachusetts

Tung-Sol Lamp Works, Inc.
95 Eighth Avenue
Newark 4, New Jersey

American Condenser Co.
4410 Ravenswood Avenue
Chicago 11, Illinois

WAR ASSETS ADMINISTRATION

A UNITED STATES GOVERNMENT AGENCY
FOR THE DISPOSAL OF SURPLUS PROPERTY

880



INFORMATION PLEASE!



Radio communication is as vital to the airways as rails are to the railroads. For high performance, dependability, and easy maintenance, WILCOX radio equipment has earned the confidence of airline personnel throughout the world. Solve your communication problems with Wilcox.

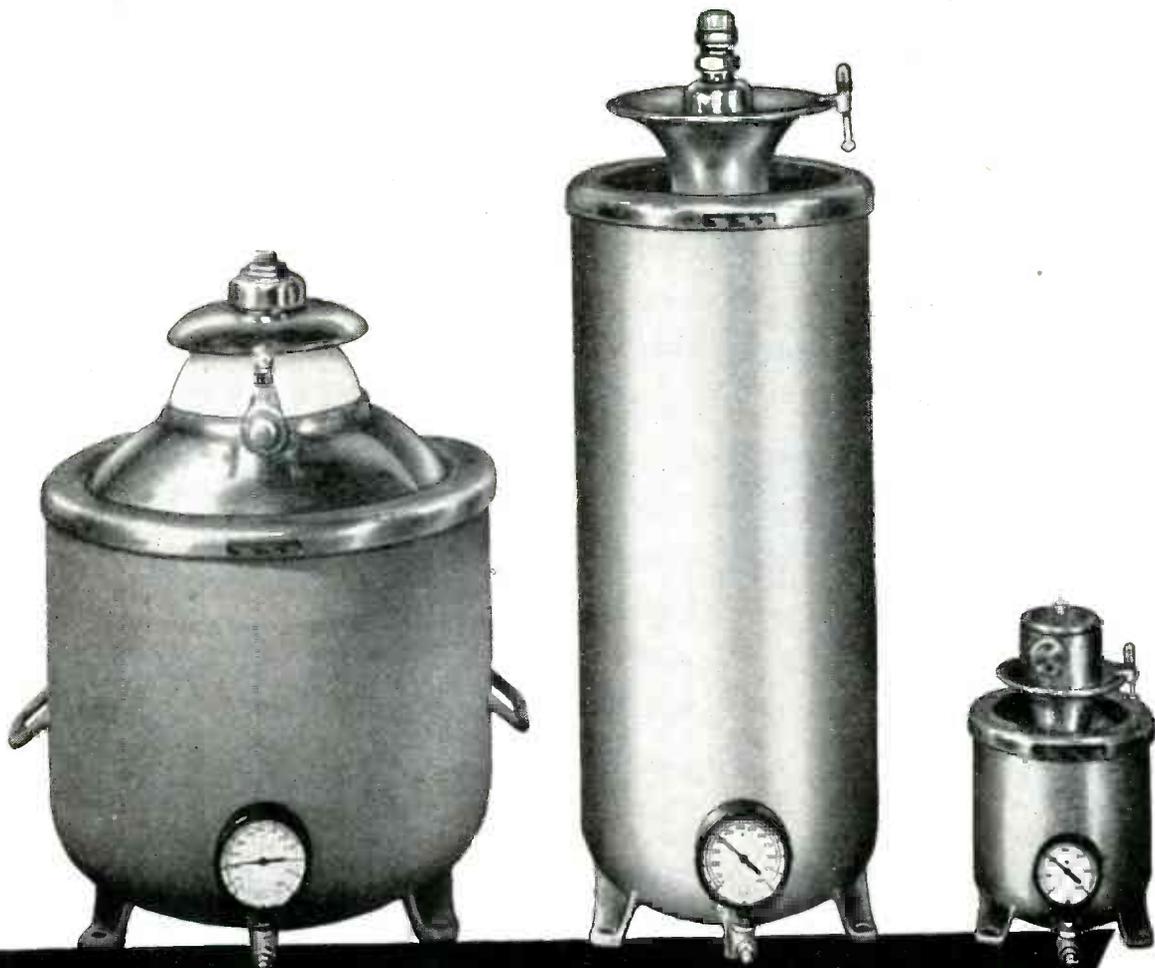
Check the Wilcox 2500 Watt 96C Transmitter For:

- 1. PERFORMANCE**—Transmitter units combine with modulator and rectifier to give either simultaneous transmission on a number of frequencies, or the selection of an individual frequency best suited to the immediate communication problem. Complete remote control.
- 2. DEPENDABILITY**—Research, engineering, and testing combined with highest quality materials result in a rugged product capable of sustained operation through all conditions of temperature, humidity, and weather.
- 3. MAINTENANCE**—All controls and components are completely accessible. Plugs and receptacles or clips make every major section readily removable. Fuses, power and telephone line terminals are located on convenient panels.
- 4. SAFETY**—The disconnect switch at base of transmitter cuts off all voltage and grounds components so unit can be serviced without affecting operation of adjacent channels.

A request on your letterhead will bring complete information

Wilcox Electric Company, Inc.
KANSAS CITY, MISSOURI





NO INCREASE IN PRICE

LAPP GAS-FILLED CONDENSERS AT PREWAR PRICES . . .

There's good news for designers and builders of high voltage electronic circuits who find themselves caught in an inflationary spiral of costs. No advance in prices has been announced—none is contemplated—for Lapp Gas-filled Condensers. Known as the most satisfactory source of high current and high voltage capacitance, these units offer non-deteriorating, dependable performance; impossibility of puncture;

lowest loss with consequent economy of power; constant capacitance under temperature variation; and compact, space-saving design. Variable, adjustable, and fixed units are available with current ratings up to 500 amperes R.M.S., power ratings up to 60 Kv peak. Units now in service range up to 60,000 mmf. (fixed units), 16,000 mmf. (variable and adjustable units).

Lapp

LAPP INSULATOR COMPANY, INC., LE ROY, NEW YORK

Amphenol

ALL-WAVE ANTENNA

GETS ALL THREE!

Purchasers of modern radios deserve good reception on all three bands—standard broadcast, short wave and frequency modulation. Until Amphenol engineers perfected this new all-wave unit, the only way to achieve this was to install three separate antennas, a costly and unsightly solution.

The FM section of this new 3-way antenna is a horizontally polarized dipole. It operates most efficiently between 88 and 108 mc.

A 65-foot length of Amphenol Polyethylene covered copper wire serves as the standard broadcast and short wave antenna. The polyethylene covering minimizes precipitation static and assures long life.

A specially designed series M derived low-pass filter automatically switches the energy from the proper antenna to receiver input.

Installation is simple. The mounting is a 1-inch steel mast 5-feet in length. All hardware is included. A guy clamp bolted to the mast provides for tripod guying.

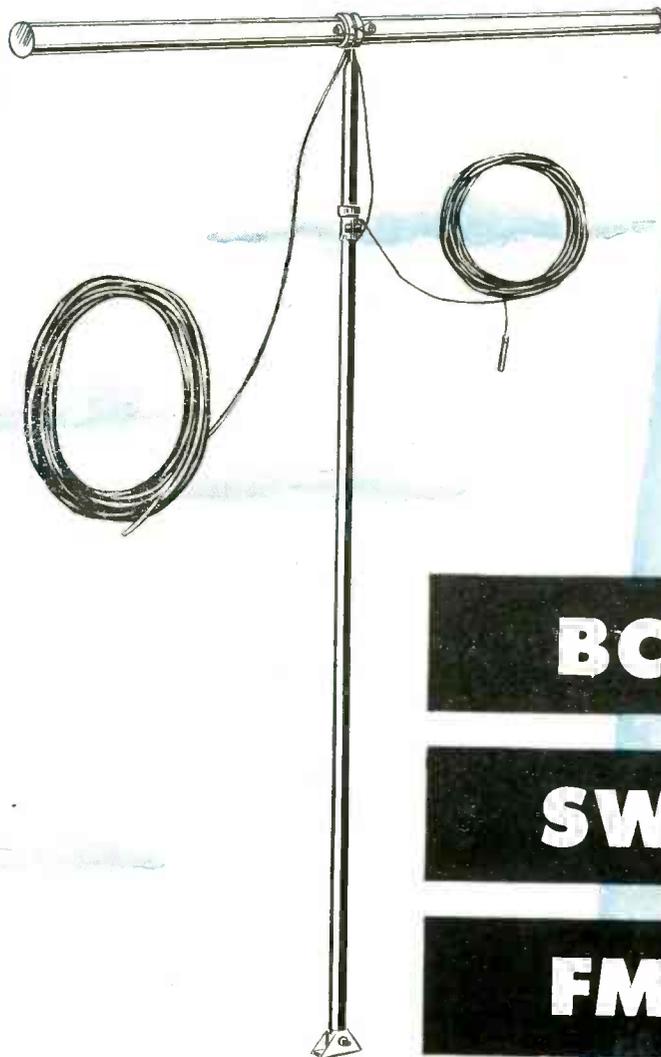
Vinyl-jacketed Amphenol 52 ohm coaxial transmission line serves as a low-loss lead in and eliminates interference from transmission line pickup. Noisy areas are not a problem with this antenna.

In a comparative test with the best available standard double doublet (with matching transformer) the Amphenol All-Wave Antenna proved far superior in gain—as well as being interference free.

Write for complete technical data, or see your jobber for full information.

AMERICAN PHENOLIC CORPORATION
CHICAGO 50, ILLINOIS

COAXIAL CABLES AND CONNECTORS • INDUSTRIAL CONNECTORS, FITTINGS AND CONDUIT • ANTENNAS • RF COMPONENTS • PLASTICS FOR ELECTRONICS



BC

SW

FM

AMPHENOL ALL-WAVE ANTENNA UNIT INCLUDES:

- ★ FM dipole with molded phenolic weatherproof filter housing
- ★ Steel mast 5-feet long with guy clamp and adjustable insulator
- ★ 50-foot Amphenol RG-5/U 52 ohm coaxial cable
- ★ Antenna wire polyethylene covered
- ★ Built-in M derived network

AMPHENOL

FRACTIONAL H.P. MOTORS

Designed and Engineered for

HEATING AND AIR CONDITIONING APPLICATIONS

73 series



PALMER MFG. CO.
SUSPENDED UNIT
GAS HEATER



MOTIONAIR COMPANY
INDIRECT AIR CIRCULATOR



WALTON LABORATORIES, INC.
HUMIDIFIER



★ **THREE STURDY, DEPENDABLE
POWER SOURCES**

TYPE NO.	TYPE	H. P.	SPEED
KP732L	SHADED POLE	1/30	1500
K711H	CAPACITOR (Ball Bearing)	1/20	3200
L732GC	CAPACITOR	1/15	1600

EAD motors meet the most rigid requirements of the heating and air conditioning industry. They are designed to give smooth running quiet performance at high efficiency with minimum size and weight. Replaceable "capsule" bearings with their large oil reservoirs assure long bearing life and trouble free operations. Consult our Engineering Dept. with your design and application problems.

EASTERN AIR DEVICES, INC.
585 DEAN STREET • BROOKLYN 17, N. Y.



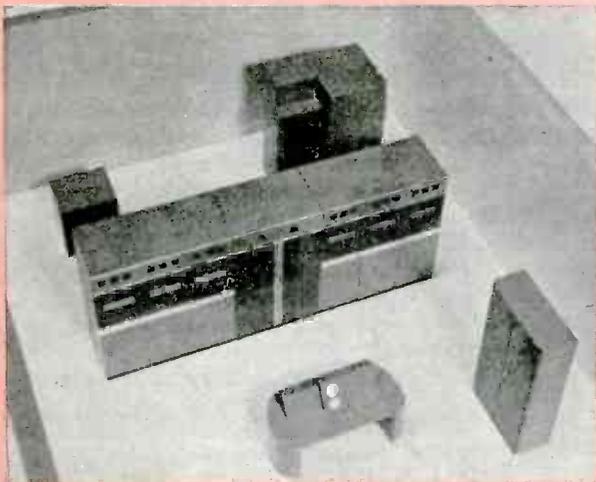
FM Sound Exciter Unit (also part of sound PA) Sound R-F Drive Unit (also part of sound PA)

Sound Rectifier Unit

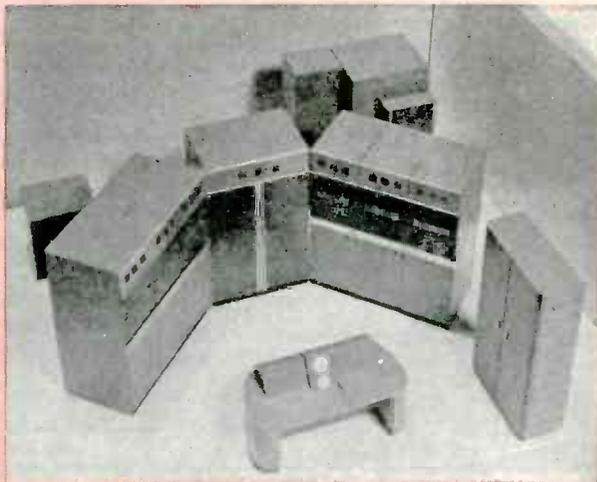
Power Control Unit

Picture Modulator Rectifier Unit

STRAIGHT-LINE Arrangement (over-all width 208 inches). Unit-construction permits flexible station layout, advantageous use of available floor space.



U-SHAPED Arrangement—several versions possible down to a minimum width of 150 inches. Transmitting equipment also includes console; sideband filter, diplexer, and dummy load (three units at right, rear); watercooling equipment (left, rear); and racks for test and other equipment (right, foreground).



Deliveries to begin soon on...



Picture Rectifier Picture R-F Driver—
also part picture PA Picture Modulator—
also part picture PA

THE FIRST POSTWAR ALL-CHANNEL TELEVISION TRANSMITTER

RCA's new 5-kw, 54 to 216 mc, Type TT-5A

**One transmitter . . .
one standard of quality . . .
for all 12 metropolitan channels**

This revolutionary, new RCA television transmitter, we believe, offers the last word in convenience, operating economy, and performance. Here, in one attractively styled group of cabinets, are all the necessary components of both the visual and aural transmitters.

Take a look at some of its features:

- Simplicity of operation . . . complete unification of control . . . no trick circuits . . . no neutralization of modulated power-amplifier stage required on any channel . . . only *one* easily adjusted modulated stage.
- Roomy, "walk-in" type construction . . . easy access to all parts through full-length front and rear doors . . . ease of handling and installation (each section only 25 by 36 by 80 inches).
- A revolutionary new tube used in both sound and picture power amplifiers—the RCA-8D21, a dual tetrode. Sets new records for stability, gain per stage, low grid current, linearity, and band-width by employing advanced principles of screening, cooling, and electron optics.
- The separate, sideband filter used in RCA's high-level system (i.e. only last stage modulated) means more straightforward circuits; eliminates complicated adjustments; assures better picture quality.
- "Reflectometers" incorporated in both the aural and visual output circuits. Basically these are uni-directional vacuum-tube voltmeters which provide an instantaneous check of the standing-wave ratio on the transmission line and peak power output; also used as safety devices to protect transmission line from power arcs.
- Manual or automatic sequence starting. In automatic position, a three-slot recycling sequence returns transmitter to the air three times in case of momentary overload.
- A special "hold-in" circuit. Provides *instantaneous* return to air after momentary power-line failure.
- Console provides four-position, push-button monitoring of visual signal—transmitter input, modulator output, sideband-filter output, and "off the air." (Third or fourth position measures percentage modulation of visual carrier.)

Outstanding features like these—of benefit to the station engineer, manager, owner, and audience—have been built into all the new items in RCA's complete television line. Deliveries on existing orders from 20 top broadcasters have already begun on such items as portable field equipment, synchronizing generators, and monoscope cameras. *Initial* shipments of transmitters and other equipment will be made this fall.

New RCA-8D21
Dual Tetrode specially developed
for television
broadcasting



**TELEVISION BROADCAST EQUIPMENT
RADIO CORPORATION of AMERICA
ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.**

In Canada: RCA VICTOR Company Limited, Montreal

breaking the back of the break-even point!

The break-even point in most businesses breaks the heart of management. Costs must come down. The race to be competitive is on in earnest.

If a steady flow of dependable capacitors to your assembly lines will help to put your break-even point in its proper place, call on C-D. We've specialized in capacitors for 37 years. We've made no less than 250,000 different types! Typical of this versatility are the capacitors illustrated below.

It's still possible that we've never made

the precise capacitor you require. But our engineers "can do". And they will! For a better product—for lower production costs—put our experience to work for you.

Catalog of standard types available on request. Your specifications for special capacitors are solicited. Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey. To meet your capacitor needs promptly and efficiently, C-D operates plants in New Bedford, Providence, Worcester and Brookline.

MICA • DYKANOL • PAPER • ELECTROLYTIC CAPACITORS

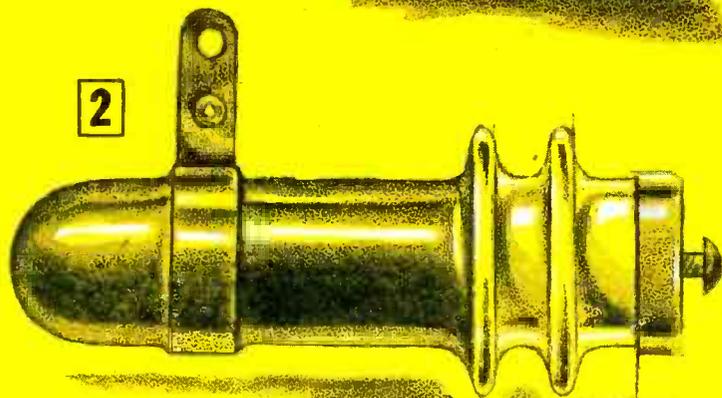


A FEW OF THE CAPACITORS WE HAVE MADE TO ORDER

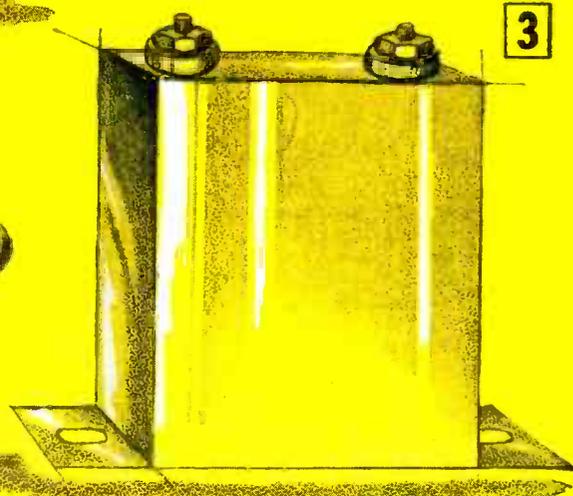
1



2



3



CAPACITOR #1—A series of capacitors designed for television requirements. Hermetically sealed, Dykanol impregnated and filled. Capacity range from .005 to .05 mfd. at voltages from 2,000 to 3,500 DC. Diameter remains 1", length varies with capacity.

CAPACITOR #2—This special capacitor is essentially for high frequency plate-blocking applications. Capacity ratings of 100 and 1,200 mmfd. at 10,000 V.D.C. Extremely high r. f. current rating with respect to its size. Ceramic construction with wide path base mounting terminal.

CAPACITOR #3—Designed and produced for a manufacturer of business machines. Capacitive-resistive type of spark suppressor unit. Dykanol impregnated. Hermetically sealed and provided with two insulated terminals for efficient assembly into parent equipment.



CORNELL-DUBILIER
world's largest manufacturer of
CAPACITORS

PICK YOUR JINNI!



A POTTER ELECTRONIC COUNTER FOR EVERY

**timing
control
counting
sorting
totalizing**

NEED



COUNTERS AND SCALERS

For straight high-speed counting and frequency dividing i.e. radiation counting-machine operations



DUAL PREDETERMINED COUNTERS

For controlling two sequential operations at high rates i.e. zipper manufacture

SINGLE PREDETERMINED COUNTERS

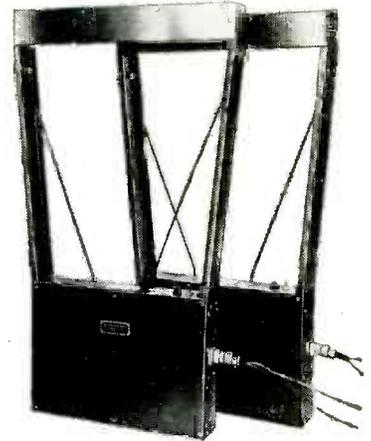
For high speed counting and grouping of items for processing or packaging i.e. packaging of pills, buttons, hardware, etc.

CHECK THESE IMPORTANT FEATURES!

- **Speed and Accuracy**
Will count at rates up to a million per second with absolute accuracy.
- **Versatility**
Can be used for measurement and control of discrete quantities, length, area, time, velocity and frequency. Can also be used to totalize counts from several sources occurring simultaneously and at random.
- **Flexibility**
Readily substituted for slower inaccurate mechanical controls—adaptable to all types of input actuations.
— Selection of any predetermined count made simply by dial switches. Easy to install and operate.
- **Reliability**
Sturdy construction using simple straight forward reliable circuits and high quality components. Assures maximum trouble free continuous operation.
— No moving parts to wear out —

If you have a specific application problem or wish additional information on Potter Electronic Counter Circuits, write Potter Instrument Company, Dept. 6A.

Photoelectric Screen for gating interval timer in projectile velocity measurements.



INTERVAL TIMERS

For measuring or predetermining intervals with micro-second accuracy i.e. projectile velocities—accurate time base generator.



POTTER INSTRUMENT COMPANY • 136-56 ROOSEVELT AVENUE • FLUSHING, N. Y.



4-WINGED DRIVER CAN'T SLIP OUT OF PHILLIPS TAPERED RECESS



RADIO
Builders and
Listeners
...Both Give Top Rating

to these Cost-Controlling,

Good-Looking AMERICAN PHILLIPS SCREWS

1. TOP RATING in Production Savings: Fast, fumble-proof, automatically straight-driving . . . American Phillips Screws make possible high-volume radio production where even the slightest surface-scratch means "reject." For at highest speeds, the 4-winged American Phillips Driver can't twist out to scar work-surfaces! *Speed . . . with complete safety both for work and workers . . .* that's the double advantage that makes American Phillips Screws the *lowest-cost fastening method on any job.* Whatever product you assemble, you will find that American Phillips Screws pay off with SAVINGS UP TO 50%.
2. TOP RATING in Sales Promotion: The decorative heads of American Phillips Screws are a customer-accepted mark of quality. And they're an added assurance of serviceability under incessant use. So standardize on American Phillips Screws throughout your assembly departments. Write:

AMERICAN SCREW COMPANY, PROVIDENCE 1, RHODE ISLAND
Chicago 11: 589 E. Illinois St. Detroit 2: 502 Stephenson Building

AMERICAN PHILLIPS

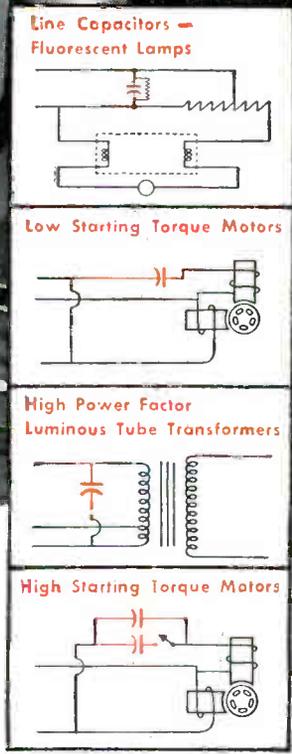
Screws



ALL TYPES
ALL METALS: Steel, Brass, Bronze, Stainless Steel, Aluminum, Monel, Everdur (silicon bronze)



A-C CAPACITORS



THEIR STRENGTH ADDS "STAYING POWER" TO YOUR PRODUCTS

Capacitors needn't be the weak link in your product—they can have just as much "staying power" as any other component in your equipment.

G-E capacitors have long life. One reason for this is that they are Pyranol* impregnated. Practically all moisture, air, and gas have been withdrawn from the capacitor before the Pyranol treatment takes place. The use of Pyranol also means that these capacitors can operate at high temperatures—up to 75 C (167 F) case temperature. This eliminates one of the main causes of capacitor breakdown.

Casings, available in all standard shapes, are double-rolled, or roll-crimped and soldered, sealing the capacitor hermetically. Plastic bushings, of high dielectric strength, bring out the hot-tin dipped soldered terminals.

If you are building a quality product, here's a quality a-c capacitor that you'll never have to worry about. They're available in a broad range of voltage ratings and capacities. Write for the latest Bulletin GEA-2027C. Apparatus Dept., General Electric, Schenectady 5, N. Y.

*Reg. U. S. Pat. Off.

Why Manufacturers Like G-E Capacitors

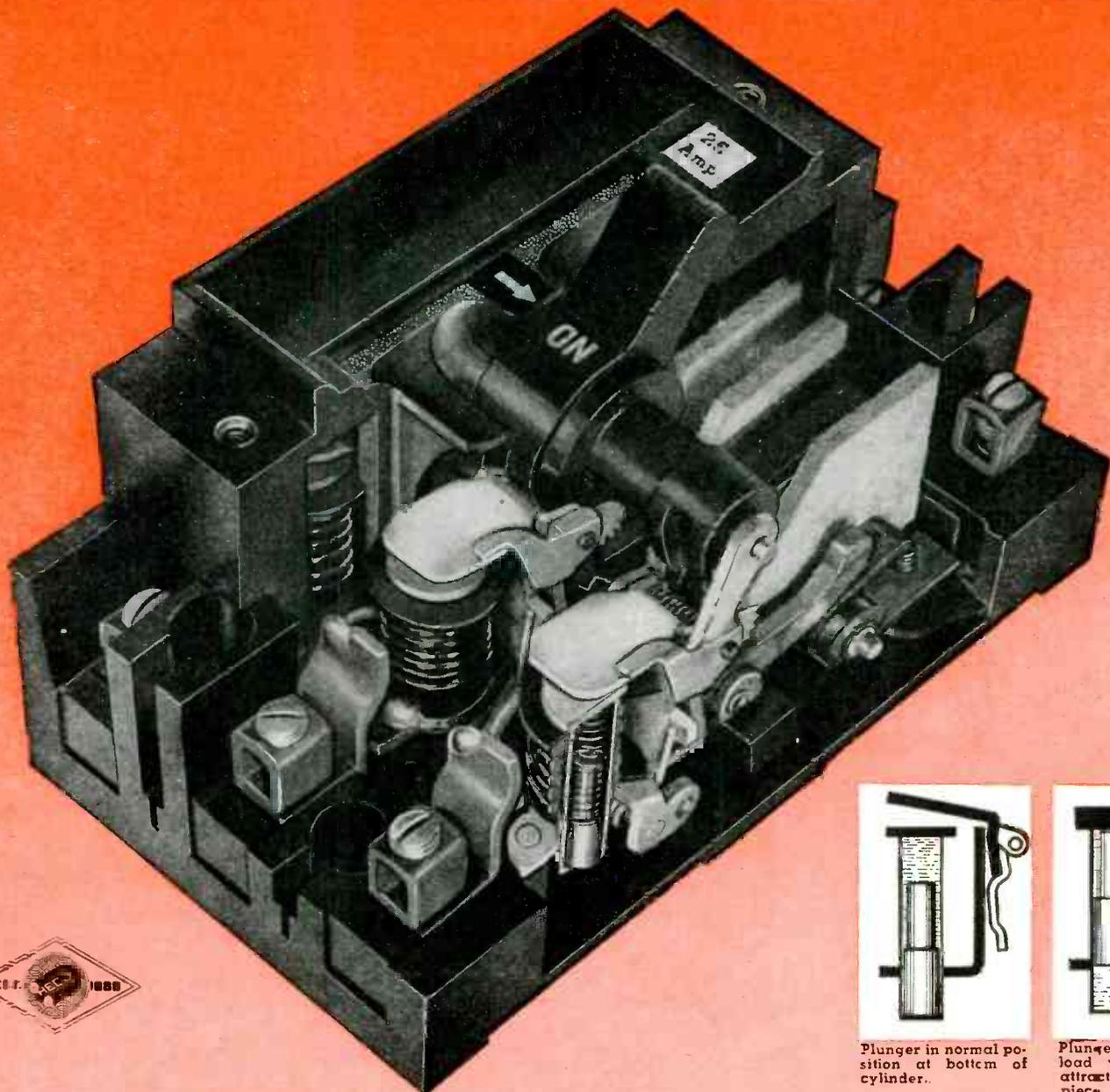
1. Their price is right.
2. You can get fast shipments.
3. The range of ratings is broad.
4. Designed for small size and light weight in all ratings.
5. Their quality is unexcelled.

GENERAL ELECTRIC

407-111-5700

"Inside" Dope
on

HEINEMANN MAGNETIC CIRCUIT BREAKERS



TIME DELAY ON OVERLOADS

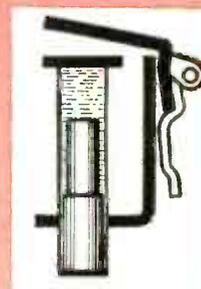
The magnet coil surrounds a hermetically sealed and liquid filled cylinder which contains an iron plunger. This plunger, while normally not in the magnet field, moves into the field on overloads with the liquid controlling the speed at which the plunger moves. The magnetic flux increases as the plunger rises, attaining its maximum when the plunger reaches the top of the cylinder. At this point the trip armature is attracted to the pole piece and operates the latch mechanism which opens the contacts. Various time delays can be obtained by the use of liquids of different viscosities.

INSTANTANEOUS ACTION ON SHORT CIRCUITS

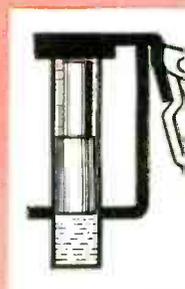
Short circuit currents energize the pole piece with sufficient speed to attract the armature before the plunger moves.

BLOWOUT ACTION AT CONTACTS

Magnetic blowout contacts mounted in individual arcing chambers add speed to the arc interruption. As the value of the current to be interrupted increases the quenching effect becomes greater due to the intensified magnetic blowout field.



Plunger in normal position at bottom of cylinder.



Plunger after overload with armature attracted to pole piece, opening contacts.

HEINEMANN ELECTRIC COMPANY

Established 1888

97 PLUM STREET

TRENTON, N. J.

The remarkable current-generating efficiency of *Western Electric* SOUND-POWERED TELEPHONES is based on critical electronic positioning of magnetic elements visually indicated by the...



▶ In the manufacture of Sound-Powered Telephones, made for our Army and Navy by Western Electric during the war, one of the most difficult operations was the positioning of the armature in the exact center of the magnetic circuit. The balanced armature design means that the armature must be balanced magnetically among four air gaps.

During the early years of manufacture, this adjustment was done by means of feeler gauges. This method, however, did not always yield the true magnetic center because of slight differences in magnetic materials. Many units would be rejected in subsequent tests.

To overcome this condition, production engineers at Western Electric devised a method whereby the armature can be accurately located magnetically, with the aid of the cathode-ray oscillograph. This ability to see electronically what goes on in these air gaps has been of considerable assistance in overcoming one of the most difficult operations associated with the production of Sound-Powered Telephones.

And so another cathode-ray oscillograph application. Surely in your own production and inspection routine, or in maintenance or servicing, or again in research and engineering, you can use this "electronic seeing" to profitable advantage

▶ Submit your problem.

NO BATTERIES REQUIRED!

As the name implies, Sound-Powered Telephones require no external source of power. The feeble sound power of the voice is converted into electrical energy. Telephonic communication up to 10 miles is feasible over ordinary Army field-telephone wires, and up to 100 miles under laboratory conditions. Such equipment was extensively used by our armed forces afloat and ashore.

© ALLEN B. DUMONT LABORATORIES, INC.

DUMONT

Precision Electronics & Television

ALLEN B. DUMONT LABORATORIES, INC., PASSAIC, NEW JERSEY • CABLE ADDRESS: ALBEEDU, PASSAIC, N. J., U. S. A.

STRUTHERS-DUNN

HEAVY-DUTY RELAYS



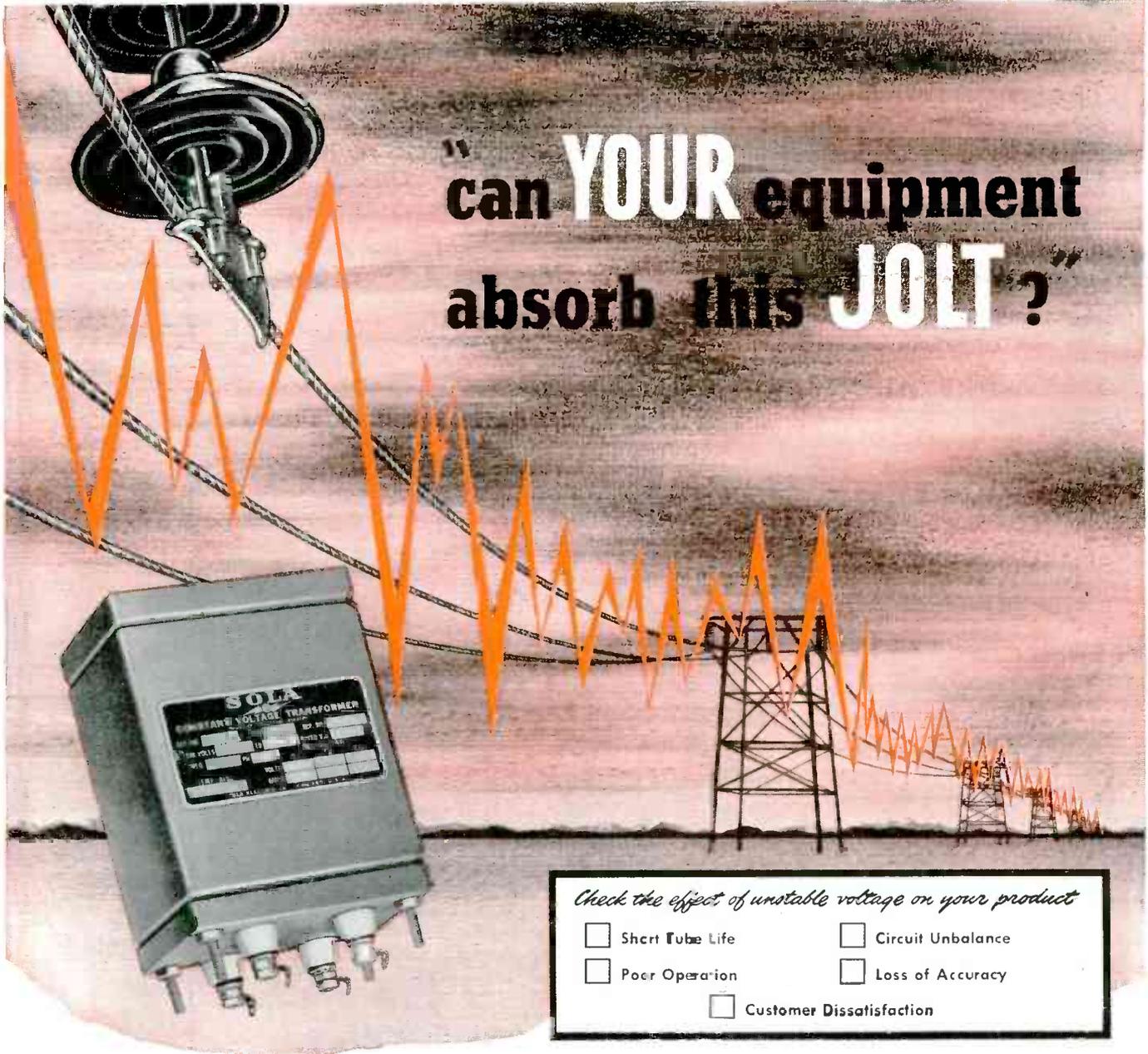
In addition to many standard types of large power relays, Struthers-Dunn can supply adaptations for applications involving high inrush loads, radio-frequency or high-voltage insulation, extra long life, and other special service conditions. All units include three point armature support for exceptionally quiet operation, wiping action on the fine silver contacts and numerous other features.

Write for Data Section 4671 for detailed information on both standard and special types.



STRUTHERS-DUNN, INC., 146-150 N. 13th St., Phila. 7, Pa.

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



**"can YOUR equipment
absorb this JOLT?"**

Check the effect of unstable voltage on your product

<input type="checkbox"/> Short Tube Life	<input type="checkbox"/> Circuit Unbalance
<input type="checkbox"/> Poor Operation	<input type="checkbox"/> Loss of Accuracy
<input type="checkbox"/> Customer Dissatisfaction	

THERE ARE NO VOLTAGE PROBLEMS WHEN A SOLA CONSTANT VOLTAGE TRANSFORMER IS A "Built-in Component"

Check! . . . before the equipment leaves your plant. Can it stand violent voltage fluctuations, sometimes as great as 30%, and still perform as you intended it should?

It is not necessary, you know, to saddle your customer with the responsibility of providing stable operating voltage. You can do it for him at an actual saving, both in original cost and maintenance, by including a SOLA Constant Voltage Transformer as a "built-in" component.

There are 31 standard types of SOLA Constant Voltage Transformers, several specifically designed for chassis mounting, available in capacities from 10VA to 15KVA. If none are adaptable to your requirements, special units can be custom designed to your exact specifications.

Whether your product is designed for home, science or industry—Constant Voltage is your problem. May we recommend the solution?



This book provides the answer to your Constant Voltage problem.
Ask for Bulletin DCV-102

SOLA *Constant Voltage* **TRANSFORMERS**

Transformers for: Constant Voltage • Cold Cathode Lighting • Mercury Lamps • Series Lighting • Fluorescent Lighting • X-Ray Equipment • Luminous Tube Signs
Oil Burner Ignition • Radio • Power • Controls • Signal Systems • etc. **SOLA ELECTRIC COMPANY, 2525 Clybourn Avenue, Chicago 14, Illinois**
Manufactured in Canada under license by FERRANTI ELECTRIC LIMITED, Toronto

THE IMC ENGINEER IS

On Your Staff



but not on your payroll

**TUNE IN THE
ELECTRICAL
INSULATION
HEADQUARTERS**



Because your IMC engineer represents not just one, but most of the recognized leading manufacturers of electrical insulation—each specializing in his own particular product—his experience in the insulation field is more complete. As a specialist in electrical insulation, he and the IMC organization behind him are qualified to . . .

1. Assist you in the selection of the best insulating materials for the job.
2. Familiarize you with their proper application.
3. Suggest ways to eliminate waste.
4. Increase your production.

PRODUCTS LIST: Macallen Mica Products—Vartex Varnished Cloths and Tapes—Varslot Combination Slot Insulation—Fiberglass Electrical Insulation—Manning Insulating Papers and

Pressboards—Dow Corning Silicres—Dieflex Varnished Tubings and Saturated Sleeveings—National Hard Fibre and Fishpaper—Phenolite Bakelite—Permacel Adhesive Tapes—Asbestos Woven Tapes and Sleeveings—Inmanco Cotton Tapes, Webbing, and Sleeveings—Pedigree Insulating Varnishes—Wedge Brand Wood Wedges.

INSULATION

MANUFACTURERS CORPORATION

*CHICAGO 6
565 West Washing-
ton Blvd.



*CLEVELAND 14
1231 Superior
Ave., N. E.

Branches in: MILWAUKEE 2, 312 East Wisconsin Avenue; DETROIT 2, 11341 Woodward Avenue; MINNEAPOLIS 3, 1208 Harmon Place; PEORIA 5, 101 Heinz Court; and other cities

THE CLOSED SHOP

Key to Labor Monopoly

IF THE PEOPLE of the United States are to loosen the monopoly control now exercised by some segments of union labor and recapture the power to control their own economic and political destiny, they must come to grips with the problem of the closed shop. A satisfactory solution of that problem is as vital to the interests of the wage earner, who should be fully protected in his right to organize and bargain collectively through representatives of his own choosing, as it is vital to the interests of the nation as a whole.

By the closed shop, which unfortunately is a term that seems to shed more heat than light, I mean any shop in which the worker must make his peace with a union in order to have a job. There are approximately 13½ million union members in the United States. Of these about 10 million are governed by arrangements calling for "closed" shops, union shops, maintenance of membership provisions and similar devices which make good standing in a union a condition to holding a job.

Such arrangements raise serious issues about what is commonly presumed to be the basic American right to work. Also, closed shop arrangements lie at the root of the dominant economic power now exercised by some labor leaders.

The problem of reducing the power of these labor leaders to proportions that make it safe for democracy is the age-old problem of monopoly. In an earlier era this problem was created largely by businessmen who sought to escape the restraints of competition by combinations or agreements to control prices and production. Such efforts are still attempted and must be curbed by law.

Union Labor Monopoly

But, after more than a decade during which a monopoly position for organized labor has been aggressively promoted by the federal government, the major monopolists today are those labor lead-

ers who wield the power of enormous nationwide unions. About 90% of the soft coal miners do the bidding of John L. Lewis. A like percentage of the auto workers are represented by the United Automobile Workers of the C. I. O. About 80% of the production workers in steel are members of the United Steel Workers, C. I. O. No single corporation has more than a fraction of the economic power that is concentrated in these unions. And if corporations were to combine their power to cope effectively with that of these union monopolies they would unquestionably find themselves charged with violating the federal anti-trust laws.

In its national sweep, the monopoly power of unions rests largely on their exemption from the federal antitrust laws. My previous editorial in this series (the 53rd) discussed the desirability of removing that exemption. The local roots of this monopoly power are often embedded in closed shop arrangements.

Closed Shop in Coal

An illuminating case in point is provided by the United Mine Workers, whose leader John L. Lewis has graciously given the country a 3½-month reprieve from "the hysteria and frenzy of an economic crisis," as he himself termed it. During that latest crisis the dispatches from the soft coal fields reported that the miners were standing behind John L. Lewis almost to a man. And the implication usually was that the driving forces of the strike were loyalty to Lewis and the prospect of economic gain.

Underlying that performance, however, and basic to it was an agreement in the soft coal fields providing that "as a condition of employment all employees shall be members of the United Mine Workers." Hence to hold a job in 90% of the soft coal industry which is governed by contracts with the United Mine Workers, a miner must not offend the union. To avoid offense the union member must even be careful in criticising what his union

does. *Suspension from the union for six months, and hence from the right to hold a job*, is the penalty imposed by the United Mine Workers constitution for circulating a statement "wrongfully condemning any decision rendered by any officer of the organization."

The willingness of the miners to follow Lewis until the country froze over was not, of course, exclusively a product of the agreement limiting jobs in the coal fields to union members of good standing. Some of it originated in bad handling of employee relations in the coal fields in years gone by. But the fact remains that Lewis' soft coal monopoly has as one of its principal foundations an agreement which gives the United Mine Workers a job-or-no-job hold on 90% of the soft coal miners.

In its extreme form, the closed shop not only makes union membership a condition of employment but narrowly limits the numbers admitted to union membership and hence to the opportunity to work. In this way it is used to enforce restriction of output and working rules which would never stand up under free competition.

Fair Dealing

The closed shop raises major issues of personal freedom and fair dealing between individuals. As matters now stand, closed shop agreements require employers to discharge workers who lose their good standing in the unions involved. At the same time they frequently impose no requirement on unions to grant membership to law abiding and technically qualified persons. Many unions with closed shop agreements refuse to grant membership on the basis of competence. Thus, qualified workers are denied a fair chance to hold a job.

In its dealings with the closed shop issue the federal government has been pushed into a self-contradictory position. The National Labor Relations Act (the Wagner Act) provides, and properly, that "employees shall have the right . . . to bargain collectively through representatives of their own choosing." In furtherance of that basic proposition, the Wagner Act also provides that "It shall be an unfair labor practice for an employer . . . by discrimination in regard to hire or tenure of employment to encourage or discourage membership in any labor organization . . ." Standing alone, the provision would clearly outlaw the closed shop.

But then, to favor the closed shop, the Wagner Act turns right around and provides that "nothing in this Act . . . shall preclude an employer from making an agreement with a labor organization . . . to require, as a condition of employment, membership therein," provided that certain conditions of representation are fulfilled. This places the National Labor Relations Board in the impossible position of trying to administer a law which simultaneously points in opposite directions.

In successfully contending that there should be no closed shop arrangements on the railroads, the late Joseph Eastman, Federal Co-ordinator of Transportation, said, "If genuine freedom of choice is to be the basis of labor relations under the Railway Labor Act, as it should be, then the yellow dog contract and his corollary, the closed shop . . . have no place in the picture." The so-called yellow dog contract, which requires a worker to agree not to join a union as a condition of employment, has long since been outlawed.

At the time the closed shop was defended as a protective device for feeble young unions struggling against predatory employers. But a mere glance over the current economic scene discloses that the time when that argument was supported by the facts is past. Now it is the labor leaders who frequently exercise decisive economic power.

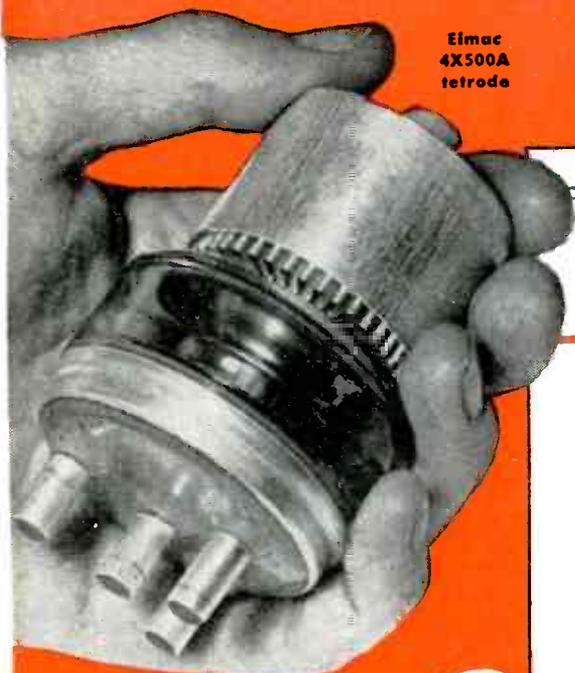
At elections in November three more states, Arizona, Nebraska and South Dakota, passed constitutional amendments outlawing the closed shop. In doing so, they joined six other states, which, in one way or another, have restricted the closed shop. The South Dakota amendment presented the basic issue created by the closed shop in simple and direct terms when it declared that "The right of persons to work shall not be denied or abridged on account of membership or non-membership in any labor union, or labor organization."

That issue must be squarely faced by the new Congress if its first order of business, the labor crisis, is to be resolved.

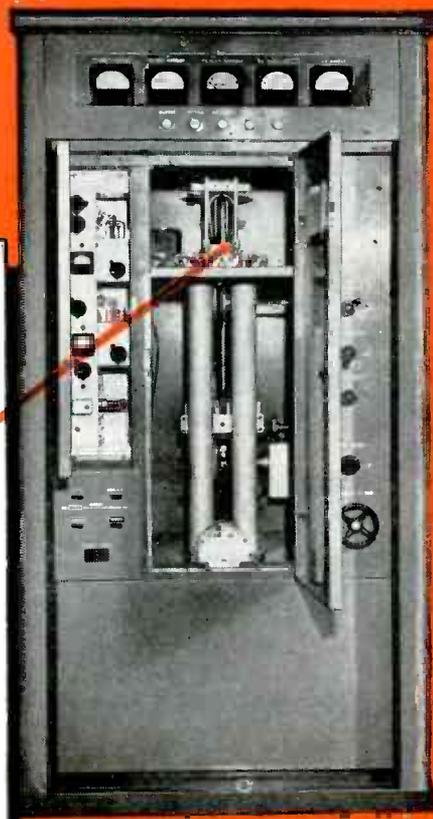
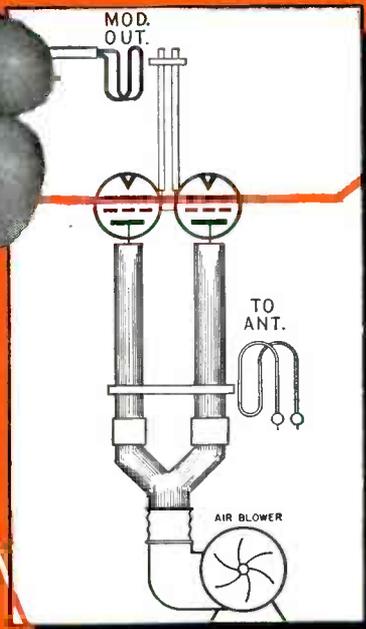


President McGraw-Hill Publishing Company, Inc.

Chosen for Performance



Eimac
4X500A
tetrode



REL 1000-watt f-m transmitter

f-m

REL... the pioneer manufacturer of f-m transmitters, has been engineering gear around Eimac Tubes ever since 1939.

One of their latest designs is illustrated above at the right—the 1000-watt unit with Armstrong dual-channel direct-crystal-controlled frequency modulation. For the power amplifier, shown in the center, REL chose a pair of Eimac 4X500A tetrodes because of their remarkable power gain, stability to frequencies above 110 mc, and efficiency. Actually, 70 per cent of the input to the final amplifier is delivered to the load.

In the REL transmitter, less than 20 watts of drive produces the rated kilowatt. In fact, a pair of Eimac 4X500A's can deliver 1750 watts of useful output with only 25 watts of drive; while four tubes in push-pull parallel, taking 50 watts on the grids, put out 3500 watts.

Unwavering stability is achieved in these tubes by combination of exclusive Eimac emission-controlled grids and a concentric-ground-plane ring terminal for the screen grid. Visible in the accompanying illustration, this ring permits finger contact with chassis ground and effective isolation of input and output circuits. Self oscillation is minimized and neutralization, if necessary, is made simple.

FURTHER POINTS

GRIDS...Special treatment suppresses primary emission and controls secondary emission to add efficiency to stability. One hundred per cent useful structure, without interfering supports, and precise alignment between control grid and screen give maximum plate efficiency and low grid current.

FILAMENT...Special thoriated tungsten provides high electron emission at low temperature.

EIMAC 4X500A POWER TETRODE

Electrical Characteristics

Filament: Thoriated tungsten	
Voltage	5.0 v
Current	13.5 amp
Direct Interelectrode Capacitances (Average)	
Grid-plate	0.05 μ f
Input	12.8 μ f
Output	5.7 μ f

Maximum Ratings

Plate voltage, d-c	4000 v
Plate current, d-c	350 ma.
Plate dissipation	500 w

Ask for full details on these and other Eimac tubes for f-m, a-m, television, and industrial applications in a comprehensive range of power and frequency capabilities.

EITEL-McCULLOUGH, INC.
1367E San Mateo Ave., San Bruno, Calif.
Export Agents: FRAZAR AND HANSEN
301 Clay Street, San Francisco 11, California, U.S.A.

Follow the leaders to





**Speakers make
the
DIFFERENCE**

**... and what a
DIFFERENCE!**

General Electric Speakers are built to be different—better. For warm, live, pulsating radio and record reproduction, specify speakers by General Electric.

- Better tone quality
- High wattage handling capacity
- No warping of voice coil
- Greater design possibilities
- Overall greater efficiency
- Better controlled air gaps
- Rigidity, strength, durability

Consult General Electric now for your Speaker requirements. Write to: *General Electric Company, Electronics Department, Syracuse 1, N. Y.*



168-FM

GENERAL  ELECTRIC

BUSINESS BRIEFS

By W. W. MacDONALD

Redesign is the topside topic of the month. Object: to hold product prices down and quality up, or at very least to embody a sufficient number of improvements to justify higher prices.

Reported in January, the fear is growing among manufacturers that high labor and material costs might result in the pricing of some electronic equipment right out of the market. One hears it expressed everywhere. We heard it, for example, even amid the party atmosphere of a recent Sales Managers Club shindig at the Hotel New Yorker.

Incidentally, there was a very good magician among the entertainers. The thought occurred to us, in view of the current pressure for redesign, that he might make a worthwhile addition to somebody's engineering staff.

Chassis Makers note a tendency on the part of their customers to specify elongated and other weird-shaped holes which will accept component parts of different makes. (NEMA and ASA officials say the trend toward standardization of parts is speeding up, much as it did after the first world war.) Also noted is the more frequent inclusion of mounting brackets of various kinds which slightly increase chassis costs but materially reduce subsequent assembly time.

J. H. Scheinman of Minute Man Products came in the other day to suggest that radio engineers consult with their metal stampers early in the design stage so that the latter can suggest possible economies. One of his customers uses one die and movable gages to knock out five, six and seven-tube chassis.

Distributors of electronic equipment, and particularly those handling radio receivers, report that they are already encountering serious resistance to higher prices, substantiating manufacturer misgivings. We get this from O. Fred Rost, editor of *Electrical Wholesaling*, who says that the second

most disturbing problem faced by the group he knows so well is unbalanced inventories. In this respect distributors and manufacturers appear to be in the same boat.

Consumer Resistance to the high prices initially placed on table model radios has now built up to the point where many such sets are going begging for buyers. We predicted trouble on this score last month.

A certain well-known brand is selling in the midwest for (to coin a trick merchandising phrase) cost plus 20 percent loss.

Mobile Radiophones are rolling up impressive installation totals in new fields. Taxicab companies alone bought more than \$4,000,000 worth in 1946 and FCC applications at present point to a weekly sales potential of \$100,000. We have no figures on actual installations, but telephone company applications filed in Washington during the year represented a proposed investment of \$2,760,000.

Component Inventory reports are now flowing into RMA offices weekly from set manufacturers. Items on which they are short as well as those on which they are long are listed, facilitating the completion of merchandise by swapping among members. Names are held confidential by the Association.

We wired Bond Geddes just be-

STOCK PRICES	
(Percent decrease, as of Dec. 26, from 1946 high)	
Bendix	-36%
Cornell-Dubilier	-39
Farnsworth	-59
GE	-32
Magnavox	-18
Noblitt-Sparks	-22
Philco	-47
RCA	-51
Sperry	-51
Sylvania	-42
Union Carbide	-26
Westinghouse	-37
Zenith	-54
Dow-Jones Industrial Average	-18%

INVESTIGATE ...

Airloop

... THE BUILT-IN LOOP ANTENNA AND CABINET BACK

one of a battery
of presses die
stamping AIRLOOPS
out of flat
sheet copper
at 1400 per hour

PRODUCING PRECISION
MADE AIRLOOPS WHICH
PROVIDE BETTER
PERFORMANCE
AT LOWER COSTS

patent #2,401,472

FRANKLIN



CORPORATION

43-20 34th ST. LONG ISLAND CITY 1, N. Y.

Compare
AIRLOOPS
with
conventional
loops ...
you'll agree
no set
builder can
afford to
overlook the
significance
of the
AIRLOOP

AIRLOOPS

- are lower in cost
- increase sensitivity
- have high uniform "Q" over entire band
- have low distributed capacity
- have 27% greater effective loop area
- have electrical and mechanical stability
- are back panel and loop in one
- eliminate individual loop adjustment on assembly line
- effect maximum space utilization
- eliminate haywire
- are air dielectric throughout their entire length.

..tagged for the big jobs!

HEXA CON ELECTRIC SOLDERING IRONS

Western
Electric

STROMBERG
CARLSON

Bendix

MINNEAPOLIS
HONEYWELL

Westinghouse

Follow the leaders—and you'll use HEXACON! For rugged, heavy duty work or for light, intricate work . . . for continuous production or hard-to-get at Work . . . here's the answer. One reason is "Balanced Heat"—dissipating excessive element-impairing heat—and minimizing element burn-outs and tip replacements. Another, is their light weight, efficiency and dependability.

LITERATURE AVAILABLE—The complete HEXACON line of screw tip and plug tip irons from 40 to 700 watts, and with tip diameters ranging from 1/4" to 1 3/4", is fully illustrated and described. Write today; no obligation.

HEXA CON ELECTRIC CO.
130 W. CLAY AVENUE, ROSELLE PARK, N. J.

HEXA CON

HIGH-QUALITY, LONG-LASTING SOLDERING IRONS



TYPE P-150

This production iron provides a large reserve of heat at the right temperature for sustained production.

fore presstime and asked him to list current shortages for us in order of importance. Back came a telegram reading as follows: Principal current shortages are cabinets, tubes, speakers, volume controls and some condensers. Major materials short lead, copper and certain steel plate stampings.

CAA has announced that lack of funds will close 57 aeronautical communication stations and three airport control towers. This dark cloud exhibits some silver lining, however.

There is no indication of cuts in the Authority's radio research and development program. It will ask for \$180,000 in the year ending June 1947, as against \$80,000 in the previous 12 months. \$900,000 is the figure in mind for the year ending June 1948 but our Washington informant thinks this will be cut somewhat by the Budget Bureau before it gets to Congress.

Radio Receiver Production should run somewhere between 13 and 18 million sets for 1947, think industry leaders. Around 20 percent of them may include f-m.

Radio Exports totalled \$27,000,000 in the first eight months of 1946, Brazil taking one fifth and being our best customer. Canada, Mexico, Argentina, China and the Union of South Africa were next in line, in this order.

Egg And Chicken Question that puzzled our ancestors had to do with which came first. Modern counterpart involves f-m and television, and until recently there was a lot of speculation as to which one would come first commercially.

Now an answer appears to be emerging from the engineering and economic mists. They seem to be coming along together. Television is being aggressively pushed into the limelight by a few big companies whose production lines are at long last starting to roll. But f-m is likely to make up for its comparative lack of flash in 1947 by virtue of the fact that a larger number of manufacturers will produce and promote it.

F-M Applications filed with the FCC between January 1939 and October 1946 break down as follows: 70.8 percent from owners of a-m stations (some with newspaper interests), 12.3 from non a-m newspaper interests, and the remaining 16.9 from people having neither a-m station nor newspaper interests.

Television Receiver Production should hit between 320,000 and 360,000 in 1947, thinks RMA's R. C. Cosgrove. (RCA is set up to produce 160,000 sets at an average list of about \$400, according to George Beers. \$600,000 worth of testing facilities have already been set up.)

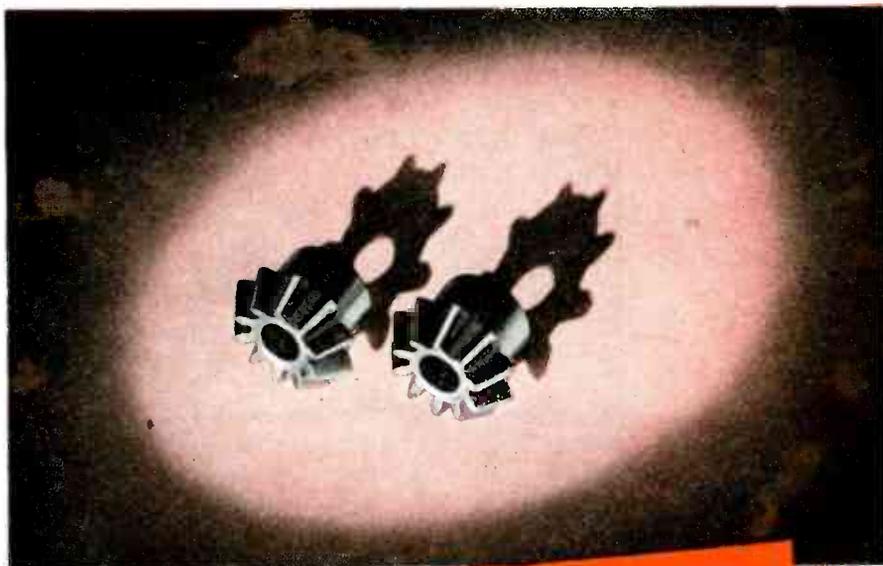
Speaking Of Color, a roofer for black-and-white television remarked the other day at an off-the-record meeting that the word red is frequently coupled with the word herring.

Receiving Tube Sales for 1946 totalled between 193 and 195 million, says M. F. Balcom, chairman of RMA's tube division, who thinks production and demand will be substantially in balance by spring. Current production is running about 40 percent better than in 1941.

Broadcast Networks total 38, the number of affiliated stations ranging from 384 in the case of Mutual down to three. American has 238, Mississippi Valley 78, Don Lee 39, Yankee 23, Quaker 18, Texas State 16, Wolverine 14, Northwest 12 and Arkansas 10.

Employable Veterans available through the New York offices of the Veterans' Administration alone total several hundred at the present time. L. S. Krull of the Rehabilitation Training and Education Subdivision (252 7th Avenue) dug out the following facts about men anxious to secure technical jobs in the electronics field for us:

Average age 24, two years high-school, attended some civilian radio school. About 1 percent have some pre-war radio experience, 20 percent were radio technicians in the services, 2 percent have had some practical radio experience since.



Need **FINE PITCH BEVEL GEARS?**

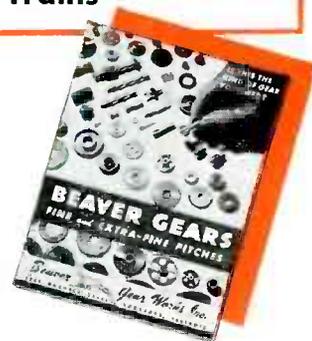
Experience and skill are heavy factors in correctly producing fine pitch straight bevel gears. Teeth with proper bearing — minimum runout — accuracy of form and bevel — all of these involve special experience which Beaver Gear Engineers have gained in developing straight bevels up to 64D.P., and finer in some cases. Highly specialized production methods and inspection equipment insure gears made to exact specifications.

For assistance with your problems on straight bevel gears, write or phone us for recommendations. No obligation of course.

Spurs, Helicals, Straight Bevels, Sprockets, Racks, Worms, Worm Gears, Thread Grinding Complete Gear Trains

Write Today for this FREE BULLETIN

Describes Beaver Gears facilities and methods, also includes table of gear tooth parts.



Beaver Gear Works Inc.

1021 PARMELE STREET, ROCKFORD, ILLINOIS

What? Hospital Gauze Not Good Enough?

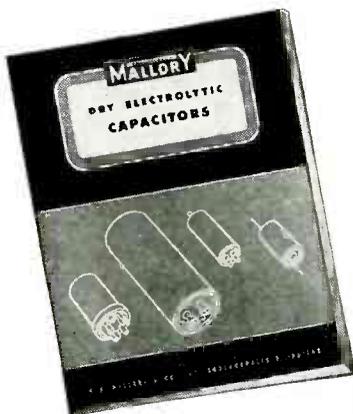


Not For This MALLORY Capacitor!

Gauze, such as is used in making "fabricated plate" for Mallory FP capacitors, must be of the highest purity obtainable. Believe it or not, the best gauze used in hospitals falls far short of the purity required for Mallory fabricated anode plate.

To be sure, hospital gauze is sterile. But it contains chlorides and other adulterants that play havoc with capacitor performance. The chloride content of the gauze used by Mallory is *less than one-half of one part per million*. Extra watchfulness and constant co-operation between plant and supplier are required to maintain such standards.

It is because of Mallory's vigilance in small details that dependability and Mallory capacitors are synonymous.



Everything you want to know about Mallory electrolytic capacitors—types, sizes, electrical characteristics—even data on test measurements and mounting hardware. Write today for a free copy.

P. R. MALLORY & CO. Inc.
MALLORY CAPACITORS
(ELECTROLYTIC, OIL and WAX)

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



CROSS TALK

► **WANTED** . . . The third of a billion dollars spent on research by OSRD during the war, most of it in the field of electronics, failed to uncover the answers to certain problems posed by the Air Forces. Major J. G. P. Callahan, speaking at the Carnegie Institute of Technology, listed them as follows:

1. The measurement of and indication of true air-speed of aircraft from 0 to 1,000 miles per hour and of missiles up to 4,000 miles per hour.
2. The measurement and indication of true height of aircraft above the sea level datum up to 80,000 feet and of missiles up to 80 miles.
3. A method of determination of the vertical in maneuvering aircraft.
4. A celestial ground-position indicator for use in aircraft during day and night with an accuracy of ± 3 miles.
5. Methods of polar navigation.
6. Automatic indication of load balance in aircraft.
7. A simple remotely-indicating system for engine rpm, pressure and temperature in aircraft.
8. A system of measurement of fuel and oil quantity, especially accurate when the quantity is small.

These needs are still unsatisfied. The solutions have immediate application to commercial, as well as military, aviation. Electronic methods of navigation and instrumentation are indicated. Any answers?

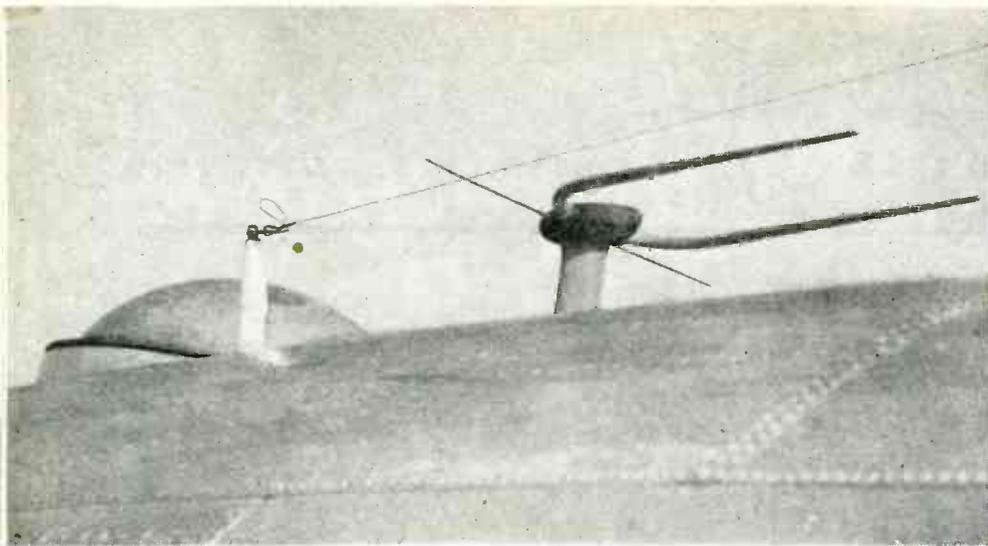
► **ULTRASUPER** . . . Our editors, concerned with consistent style, are plagued by the words "ultrasonic" and "supersonic". They are used interchangeably and apply with equal vagueness to velocities (higher than that of sound) and frequencies (above the audible range). Inquiry reveals that the preferred usage, among those working with both quantities, is supersonic for velocities and ultrasonic for frequencies. This is an arbitrary choice, since the words themselves give no clue (super and ultra mean above and beyond, respectively). So, with us at

least, it's supersonic for aircraft and missiles, and ultrasonic for vibration.

We try also, and recommend the practice to engineering writers, to avoid the adjectives above or below when referring to wavelengths and frequencies. Higher or lower for frequencies. Longer or shorter for wavelengths. Class dismissed.

► **COLUMBIUM** . . . The unassisted reception of WBAL's radio programs by a piece of very cold columbium nitride, reported by Johns Hopkins University, is the first authenticated version of a long line of reports, starting with the lad who persisted in receiving WOR on the filling of a tooth. The nitride incident is covered in *Electron Art* (p 142, this issue). The Johns Hopkins people state no theory of how it works, but we picked one up from an old friend who has worked with columbium for, lo, these many years: The nitride reaches the superconductive state at a certain temperature (about 14 degrees above absolute zero) and its resistance suddenly drops. Moreover if its temperature varies in the vicinity of the critical temperature, its resistance varies accordingly. The sensitivity is enormous and the material can go in and out of superconductivity at a rate of hundreds of kilocycles per second. When nearby WBAL produced an r-f field in the nitride, each half of each r-f cycle heated the material, and the resistance changed proportionately to the depth of modulation. A high-gain audio amplifier and loudspeaker attached to said nitride did the rest. We can't vouch for this, but it sounds good. The man with the filling had no theory at all. He was just sore.

Watch this superconductivity business. Superconductive microwave cavities, made of lead immersed in liquid helium, can display circuit Q's far above those of room-temperature circuits or crystals. Theory points to Q's in the millions. And the ice-box technique is not so difficult as it might appear.



Antenna installation on aircraft for utilizing instrument landing system recommended by PICAQ. Glide-path signal is picked up by dipole, while streamlined nondirectional ram's-horn antenna receives localizer signals

International Plan for Air Navigation

PICAQ group picks CAA instrument landing system for international airports. Radar distance-measuring beacons and vhf omnidirectional radio ranges were recommended for short-range navigation, with low-frequency loran as an interim long-range navigation aid

THE Provisional International Civil Aviation Organization (PICAQ) has recently been considering existing and proposed systems of radio navigation and communication for world-wide standardization¹. Delegates from 29 of the 46 member nations attended meetings of the Special Radio Technical Division of the PICAQ Air Navigation Committee, held at Montreal between October 30th and November 23rd, and made recommendations to the council which, if adopted, will become mandatory for the member nations.

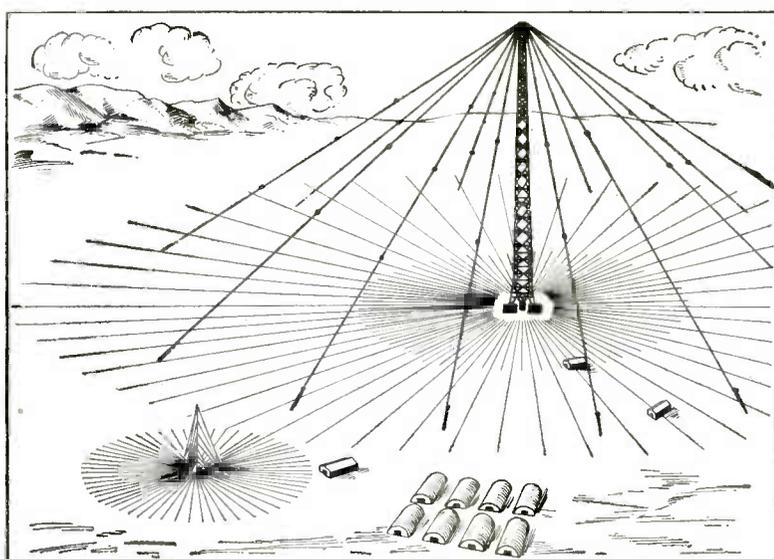
Operating Specifications

Before any recommendations could be made, it was necessary to agree on a set of quantitative operational requirements for the various aspects of air navigation and traffic control. Once this had been achieved, recommendations on existing systems for immediate standardization were soon made. Later, attention was turned to systems still in the experimental stage and a number of techniques were recommended for further

development. This work now gives the development engineer a most valuable background on which to plan his program.

The most pressing problem in airline operation today is the land-

ing of aircraft under conditions of poor visibility, at a rate equal to that at which the air traffic control organization can feed them into the approach zone. It was, therefore, recommended that at all interna-



Layout of low-frequency loran station recommended by PICAQ as international aid to long-range air navigation. Radiator tower is 625 feet high, with top-loading umbrella of twelve 325-foot radials for efficient radiation at 180 kc. In foreground is small antenna for receiving synchronizing pulses from master station, along with Quonset huts for housing equipment and stores

By D. H. PAIN

Staff Engineer
RCA International Division
Radio Corporation of America
New York, N. Y.

tional airports a standard instrument landing system (ILS) should be installed as soon as possible and certainly not later than January 1st, 1951.

Instrument Landing

The system chosen for standardization includes a localizer, a glide path, and marker beacons. Basically it is the CAA system², but eventually will incorporate a new type of localizer developed by the CAA in which 90 and 150-cps modulation is no longer used. Instead, 30-cps sideband patterns are radiated in such a manner that the phase of the resultant received 30-cps modulation reverses as the on-course line is crossed. Then by radiating a nondirectional reference phase signal as 30-cps frequency modulation on an ultrasonic subcarrier, it is possible to derive course indication in the aircraft by phase-comparison techniques.

A principal advantage of this system is that it enables a single aircraft receiver and indicator to be used for both instrument landing and short-range navigation, as described later. For this reason it was recommended that a change-over to phase-comparison localizer equipment should begin in 1951.

In many countries U. S. AAF surplus type SCS51 instrument landing equipment, although not complying completely with PICA standards, will probably be kept in operation as a temporary expedient.

In order to give the pilot a continuous indication of distance from the touchdown point, it was recommended that by 1952 the markers

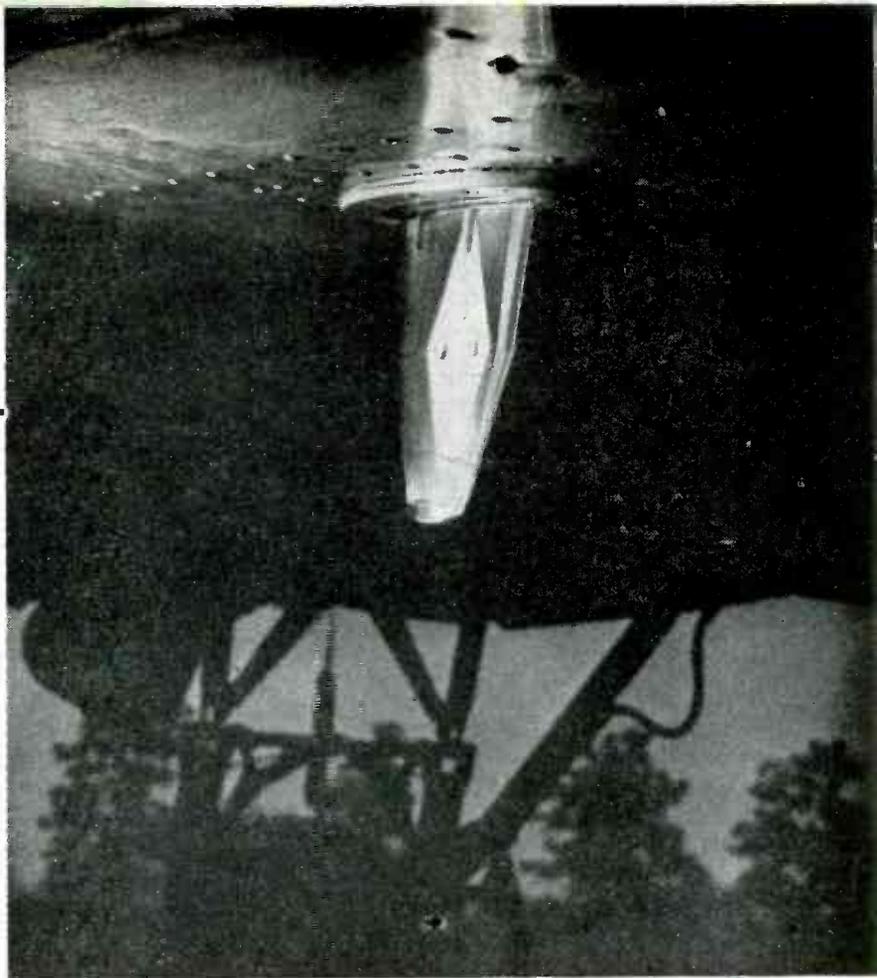
should be supplemented by a short-range beacon to give this information to aircraft equipped with radar distance-measuring equipment (DME). This makes use of the well-known interrogator-responder technique, and the various ground transponder beacons are to be identified by coding the reply pulses.

Short-Distance Navigation

In the short-range navigation area where high accuracy is required for precise traffic control, the group decided to recommend a vhf omnidirectional radio range³, used in combination with a DME beacon on the same site. This system presents position information in the form of azimuth and range, and is commonly known as an R- θ system. In the particular case of Europe, where routes are not necessarily along well-defined airways, a regional conference will be held to consider whether the R- θ facilities to be installed at terminals of long-distance routes

should be supplemented by the British-sponsored Gee system. Chains of Gee stations installed during the war already cover most of western Europe with a lattice of hyperbolic position lines. These are provided in the same manner as in the standard loran system⁴, but transmissions are made in the vhf band.

The principle of the vhf omnirange depends on the production of a heart-shaped polar diagram which is effectively made to rotate in space at 1,800 rpm. This is achieved by feeding a five-element quincunx antenna array through a rotating capacitance goniometer. The received signal then varies in amplitude at 30 cps and the phase of this signal depends on the azimuth bearing of the receiver. In order to determine this variable phase, another signal which carries a fixed 30-cps reference phase as f-m on an ultrasonic subcarrier is radiated by the central nondirectional antenna only. By making these two 30-cps signals coincide in phase in



Experimental CAA installation of distance-measuring-equipment antenna on belly of DC-3. Though 1,000 mc was used for this radar interrogator-responder beacon in U. S. development work, PICA has requested a 40-mc band between 200 and 300 mc to make propagation characteristics correspond to those of other recommended radio aids



Experimental search radar installation at CAA control tower in Indianapolis. PICAQ encourages further development, to solve such problems as obtaining a sufficiently bright ppi presentation for reliable observation in a brightly illuminated control tower

a direction due North of the station, the azimuth of a receiver lying in any other direction becomes equal to the phase difference measured in degrees.

Long-Distance Navigation

In considering the long-range navigation problem it was immediately appreciated that standard loran was already providing sufficiently important coverage over certain vital areas to warrant additional installations as the demand arose, but that full transoceanic coverage was not feasible with the limited ground wave propagation characteristics of the present 2-mc frequency band. By using a frequency of 180 kc it is hoped to provide the required reliable range of 1,500 miles with the l-f loran system, though at some sacrifice in accuracy resulting from the necessarily longer pulses (300 microseconds). Since the l-f signals can be received on the standard loran receiver with the aid of a simple frequency adaptor, this system was considered as showing the most promise of satisfactorily complementing the existing facilities.

Accordingly it was proposed to set up a PICAQ commission to be responsible for trial installations in certain difficult coverage areas, on a schedule including the North Atlantic in 1949 followed by S. E. Asia, Africa, Australasia, Pacific, and South Atlantic by 1952.

Realizing that such proposals could probably never satisfy all the requirements, particularly in respect to accuracy (10 miles at maxi-

mum range), further development was encouraged on other systems such as Consol, and satisfaction was expressed over the intention of the CAA to complete its trials of the l-f omnidirectional radio range.

Whether for long or short-range navigation, an immediate requirement was seen for a system providing for flight along any desired track which would not necessarily be coincident with the guides naturally laid down by either an R- θ or a hyperbolic system. For this requirement encouragement was given to the development of computers which would derive information from the basic radio system and guide the aircraft either automatically or by providing the pilot with the right kind of information. Another suggestion particularly applicable to long-range navigation was for a dead reckoning computer which would periodically correct its indications by reference to the radio system.

Although installations of the

standardized ILS are to proceed immediately it was realized that the system has serious limitations. Principal among these is the inability to provide for simultaneous approaches on multiple parallel runways; in such installations the areas of permissible error in azimuth associated with each runway will overlap at some distance from the airport. To overcome this trouble the development of a system was suggested, which would provide hyperbolic approach tracks diverging with increasing distance from the runway. Such a system would offer little improvement over the standard ILS in respect to course errors due to reflections, and for this purpose some form of narrow-beam microwave system was recommended. It was considered, however, that real promise of striking improvement lay only along some more original approach to the problem.

Future Possibilities

With improvements such as these a new bottleneck was expected to develop in the control of traffic on the surface of the airport, particularly in the clearance of runways. A promising solution to this problem was thought to lie in the development of high-resolution surveillance radar, possibly supplemented by wheel-actuated detectors and induction-leader cables.

Surveillance radar was also discussed for use in air traffic control. The desirability of presenting the same type of traffic picture to both the ground controller and pilot was stressed. Precision-approach radar of the type used in GCA (ground-controlled approach) was advocated to monitor and possibly supple-

Table I—Frequency Allocations Desired by PICAQ

Requests for the following frequency bands, required now or likely to be needed in the future for air-navigation systems, may be filed by PICAQ member states with the International Telecommunications Union:	
VHF Omnicast	112-118 mc
Distance-Measuring Equipment	40-mc band between 200 and 300 mc
ILS Localizers	108-112 mc
ILS Glide Path	328.6-335.4 mc
ILS Markers	75 mc
Microwave ILS	5,000-5,250 mc
GCA Precision Radar	8,500-10,000 mc (9,300-9,320 reserved for transponder beacons)
Surveillance Radar	2,700-3,000 mc (3,216-3,266 reserved for transponder beacons)
Standard Loran	1,800-2,000 mc
L-F Loran	20-kc band near 180 kc

ment instrument landing system facilities. The other half of the air traffic control problem was seen to lie in improving the efficiency of the short-distance ground-air communication facilities. For this purpose some form of visual message presentation was advocated as a solution which would also help solve the language difficulties associated with international operation.

For long-distance communication two-way radiotelephony with aircraft was seen as a requirement to replace the present c-w code transmissions, but it was realized that this could not be done by the mere expedient of increasing the transmitter power, owing to the limit set by corona discharge from the antenna at high altitude. To overcome this difficulty it was suggested that the possibilities of narrow-band frequency modulation and single-sideband transmission should be investigated.

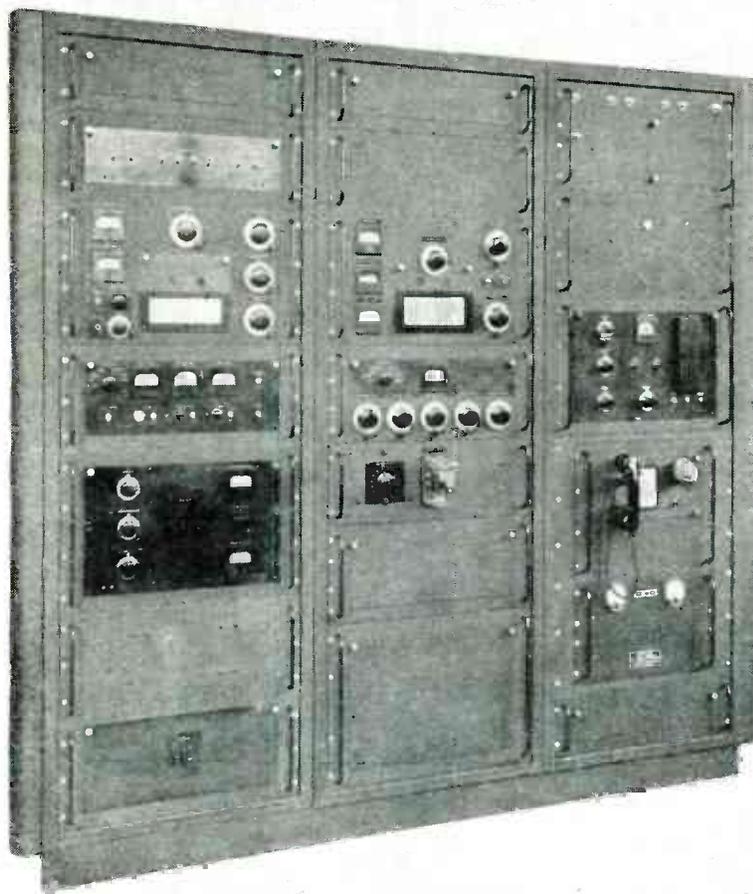
The recent tremendous increase in the number and importance of long-range flights has also given rise to a new technique known as pressure pattern flight. This technique makes use of an accurate knowledge of the weather in order to take full advantage of the upper atmosphere winds, and usually involves flying along an isobaric track. In order to do this it must be possible to detect in flight any change in the atmospheric pressure pattern which may occur after takeoff. It was foreseen that this might ultimately be accomplished by the periodic transmission of weather maps by radio facsimile, but for the immediate future the continued use of the present method was envisaged. Here a change in pressure is detected by comparing the reading of the barometric altimeter with that of a radio altimeter.

The radio altimeter also received consideration in connection with

the special difficulties encountered in the siting of an instrument landing system for water landings of flying boats. The low-altitude f-m altimeter used throughout the war as the AN/APN-1 functions ideally over the plane surface of water and, in conjunction with radar distance-measuring equipment, could provide the basis for an entirely synthetic glide path generated in the aircraft by a computing device.



Dual-range indicator of experimental airborne radar distance-measuring equipment, to be used with instrument landing system and with vhf omnidirectional radio range to indicate distance from beacons



Basic vhf navigation equipment. Interchanging a single panel of this ground station unit will make it conform to PICA0 standards for the vhf omnidirectional radio range or either the equisignal or phase-comparison type of localizer for the instrument landing system

Throughout the discussions in Montreal, it was obvious that great benefit was derived by the interchange of information and opinions which was possible at such an international gathering. Before dispersing, therefore, the Radio Technical Division recommended that a permanent group within PICA0 should be set up to observe, encourage, and guide the future development of radio aids to navigation of all types, as well as to disseminate their findings among all the member nations. Provisions were also made for initiating requests now for frequency allocations likely to be needed in the near future, as summarized in Table I.

REFERENCES

- (1) U. S. Demonstrates Radio Aids to Air Navigation, *ELECTRONICS*, p 280, Dec. 1946.
- (2) Caporale, Peter, Civil Aeronautics Administration Instrument Landing System, Part I—p 116, Feb. 1945; Part II—p 128, March 1945.
- (3) Luck, D. G. C., An Omnidirectional Radio Range System, *RCA Review*, Part I—July 1941; Part II—Jan. 1942; Part III—March 1946.
- (4) The Loran System—Part I, *ELECTRONICS*, p 94, Nov. 1945; Loran Receiver-Indicator, *ELECTRONICS*, p 110, Dec. 1945; Loran Transmitting Stations, p 109, March 1946.

MIDGET ELECTRONIC EQUIPMENT

MIDGET electronic equipment, small enough to be carried comfortably in one's pocket, is no longer uncommon. Wearable broadcast receivers are in production. That some personalized receivers will be nothing more than novelties is to be expected. However, they do have useful applications. At ball parks, for example, announcements are frequently more intelligible over the radio than over the public address system.

A wearable radio would be a definite contribution to such isolated individuals as the forest ranger, rancher, surveying crew, and lumberman. Compact, low power drain, light weight electronic equipment, operating in the Citizens' Band, could put outdoor people in immediate communication with their base camps.

The FCC has a one-tube field intensity meter, called a Sniffer, that is small enough to be held in the palm of one's hand. From time to time people illicitly using radio transmitters and receivers concealed about their persons, or built into unobtrusive camera-sized boxes, have been caught. Most frequent use of such sets has been to relay horse-race results to bookies or gamblers for placing late bets after a race was over but before the results were generally known.

Applications

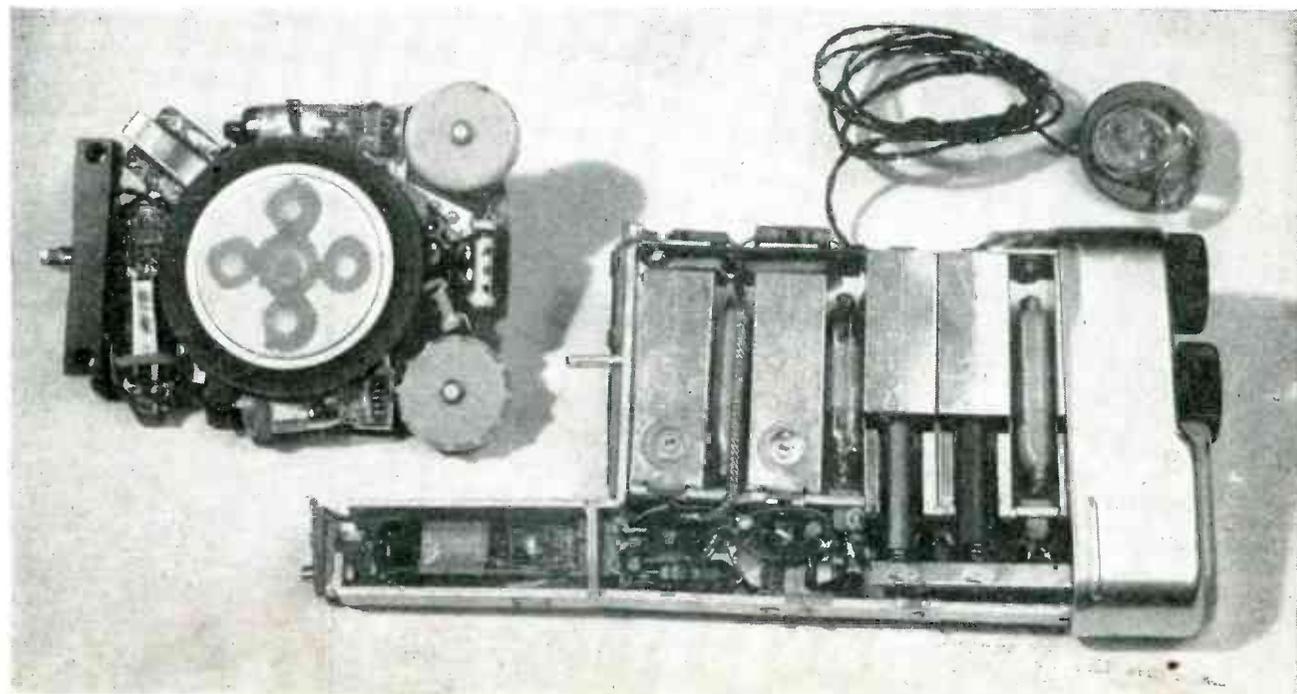
Hearing aids are the most familiar application of electronic equipment built to wearable dimensions. Subminiature tubes and midget components have been developed over the years for use in hearing aids. Much progress has

been made in improving the performance of hearing aids and in reducing their size.

That the conflicting requirements of compactness and reliable performance can be simultaneously satisfied is illustrated by the use of wearable radios during the war. Using parts and techniques developed previously for hearing aids, pocket communication equipment was designed for advance troops who, if they carried bulky radio equipment, were singled out as key men and made the first target of snipers.

During their activities in Germany, OSS men used a wearable transceiver for communication with airplanes which flew overhead on pre-arranged schedules to receive reports and transmit instructions. The set consisted of a 3A5 miniature high-frequency duotri-

In the upper left is a hearing aid assembly with the battery clip detached. The microphone is in the center with the tubes and components disposed where space permits. In the foreground is a five-tube superheterodyne pocket broadcast a-m receiver. The batteries go in the space to the left of the chassis. Inductive tuning is used



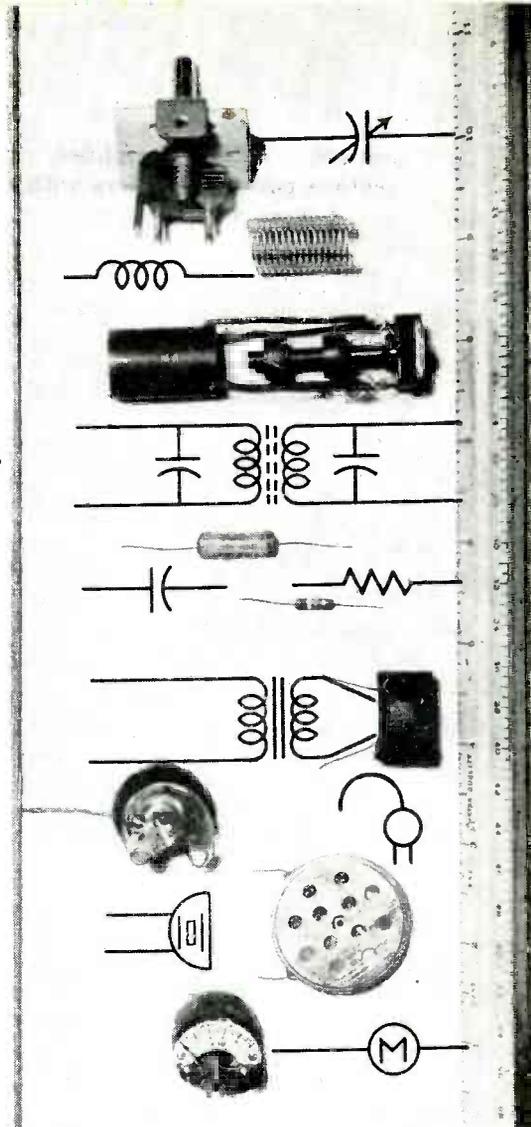
Using subminiature tubes and comparably small circuit components, one can build electronic equipment small enough to be comfortably carried in a suit pocket. Design data, types of components that are available, and possible applications are presented

ode and two CK507AX's. One section of the 3A5 was connected as a grid-modulated oscillator for transmission. For reception the circuit comprised a separate squelch oscillator and a super-regenerative detector, two stages of audio amplification, and an insert-type magnetic receiver. The antenna for operation between 250 and 300 mc was a dipole at the end of a two-wire line which plugged into the top of the case. The set had a range of a mile, a battery life under

continuous operation of 12 hours, and a weight of 2.5 lb. A radio built along these lines for operation in the Citizens' Band would fill some of the previously suggested applications nicely.

A boon to reporters and others who must record verbatim what is said will be a portable wire recorder now in development. Wire and tape recording can be done under conditions of vibration for which disc recording is not feasible, and without any other adjustment than maintaining the proper volume level to the recording head. In the particular developmental unit referred to, the wire, run at as slow a rate as is consistent with intelligible recording of speech, is driven by a 2-volt permanent-magnet motor. A spool carries wire for recording 30 minutes. The unit is powered by a rechargeable 2-volt battery having 2-hours' life, and a 45-volt B-battery having upwards of 100-hours' life. The electronic circuit uses four subminiature tubes, types CK503AX, CK505AX, and CK510-AX. The unit has a frequency response within plus or minus 5 db from 100 to 3,000 cps.

An inch-long Geiger counter tube of such small diameter that it can be inserted in one's veins to meter passage of radioactive tracers whose activity is insufficient to produce measurable radiation outside the body has been developed at the University of California. Such a small tube, combined with other midget components, makes possible a wearable radiation counter that could be carried concealed on one's person to locate illicit manufacture of fissionable materials.



Small components illustrate the reasons why equipment can be built to small dimensions

Other applications of the extremely small units that can be built using these techniques include improved radiosonde sets carried aloft by balloons for weather observation, telemetering equipment in rockets projected into the ionosphere for high-altitude studies, geophysical sounders more readily lowered into oil wells a mile below the earth's surface, portable radar-type aids for the blind (now undergoing tests), and airborne telemetering and control equipment. Much impetus was given to these developments by the radio proximity fuze.

Tubes

There are commercially available in subminiature size most of the major types of electronic tubes, such as the sharp-cutoff radio-frequency pentode, the triode-heptode frequency converter, a diode-

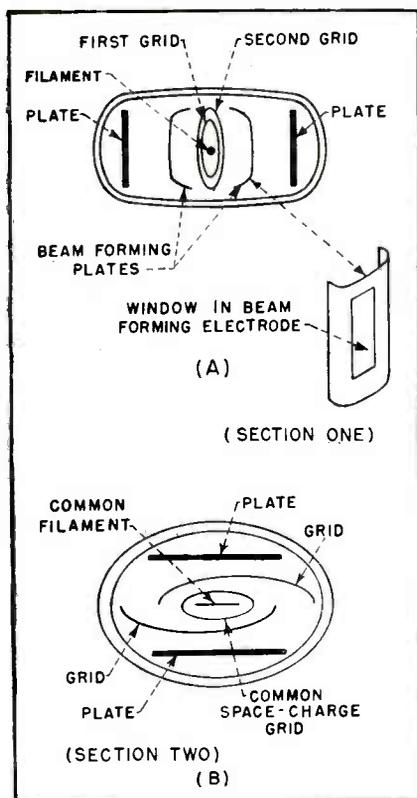


FIG. 1—(A) Cross section of beamed-power tube shows use of windows to form secondary emission suppressing beams. (B) Cross section of space-charge tetrode shows use of virtual cathode to reduce filament heating power

pentode detector-amplifier, and pentode power amplifiers with output powers as high as 25 milliwatts. There is a series of directly heated filamentary tubes for use in wearable equipment where the power drain must be held to a minimum, and a series of indirectly heated unipotential cathode tubes for use in equipment that must be extremely compact but can consume usual powers.

The filamentary series of tubes, weighing less than a tenth of an ounce, are housed in flat T-2 by T-3 (two-eighths by three-eighths inch) glass envelopes no longer than 1.57 in. The filaments operate at 1.25 volts or less and draw between 30 and 50 ma. Types and essential characteristics of some of these tubes are listed in Table 1.

Although these tubes are rated for a maximum plate potential of only 45 volts, the power pentodes deliver sufficient power to operate an air-conduction earphone. More power can be obtained where necessary from push-pull or parallel operation of several tubes. Power triodes are not desirable in wearable equipment because of their relatively low power sensitivity. Low internal resistance of the output amplifier, necessary to damp some of the magnetic earphones, can be more readily obtained by voltage negative feedback in the pentodes than by using triodes.

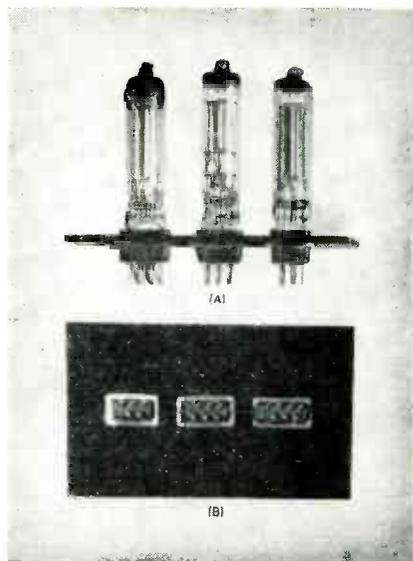


FIG. 2—Tube socket is held in chassis hole by retaining clip, thus eliminating space otherwise required for bolts

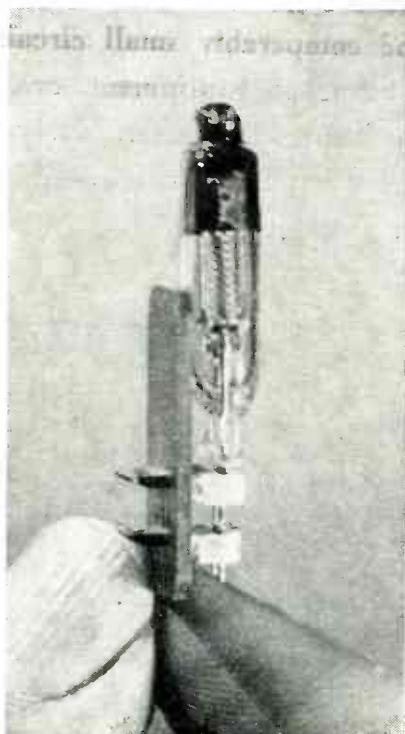


FIG. 3—Experimental subminiature tube socket consists of individual clips for each lead, mounted in nonconducting chassis. A small piece of plastic is used to illustrate the mounting method

In designing the output stage of electronic equipment, one begins with the required output and works backward. The output power required to operate an insert type earphone ranges from one to 100 mw, depending in part on the efficiency of the receiver itself and partly on the acuity of the individual ear. The medium value for hard-of-hearing persons can be taken as 20 mw. Allowing for a 20-percent power loss in the output transformer, an average value for miniature transformers, one obtains, as the required output power from the tube, 25 mw. With 4.5 volts peak on its grid, and no negative feedback, a CK506AX output pentode will deliver this power. In the case of equipment designed for persons with normal hearing, negative feedback could be used to decrease distortion, and still leave sufficient output.

The most recent development in subminiature tubes is the CK521AX beamed power tube. It approaches the beam tetrode in characteristics, yet can be made in smaller size. The first and second grids are not aligned; the sacrifice in performance being more than

made up in simplification of assembly. A thin metal window shown in Fig. 1A concentrates the electrons to the plate into a dense beam that suppresses secondary emission. To get optimum spacing between the second grid and the window and between the window and the anode, the plane of the electrodes is perpendicular to the long axis of the envelope rather than parallel to it as in other subminiature tubes. A grid bias of minus three volts is recommended with 22.5 volts on plate and screen.

Power to heat the filaments of these tubes is most critical. Although there are available several efficient A-batteries, they are exhausted before the B-batteries in most equipment. The CK510AX illustrates one of the techniques developed to fully utilize filament heating power. The tube consists of two space-charge tetrodes using a common filament. The first grid, extending through both sections of the tube as shown in Fig. 1B is used as a positive space-charge grid to produce a virtual cathode. The electron cloud formed at the first grid provides a reservoir of electrons for the two independent triode sections. Without the virtual space-charge cathode, the filament would have to be designed to provide the peak space current that might be required, despite the fact that this peak emission might be drawn only momentarily.

By using a virtual cathode, the filament can contribute electrons to the virtual cathode cloud of electrons at the average tube current and can be designed for a peak emission near this average value. The cloud of electrons in the virtual cathode serves as a reservoir that can become rapidly depleted during peaks of current but can be restored during the subsequent low current periods. Moreover, by using a virtual cathode, common cathode coupling is reduced.

Maximum instantaneous current that the tube can handle is more a function of the charge that can be stored at the virtual cathode than of the physical electron emission of the hot filament. By taking advantage of this storage in a virtual cathode, the filament can be designed for lower heating power,

thus lengthening the life of the A-battery. The independence of the two triode sections, provided no cathode impedance is added to the external circuit, is sufficient to enable them to be operated in cascade to give an overall gain of over 40 db.

Sockets

Filamentary tubes are available either with long leads for wiring directly to the circuit or with short leads for insertion into sockets. Designers of industrial equipment often prefer to solder tubes into the circuits to be sure of rigid, corrosion-resistant connections. They also prefer to make the equipment semipermanent. (One manufacturer is planning a series of premium subminiature tubes that will have long life for use in semipermanent equipment.) In cases where space is extremely limited, it may be desirable to omit the socket. For very high-frequency circuits it may also be desirable to omit the socket both to eliminate a possible source of r-f loss and to shorten the leads to reduce shunt capacitance and series inductance.

Designers of communication equipment, accustomed to using tube sockets, ordinarily prefer them. The fact that in flat-press tubes the leads are along a straight line means that they can be started into the socket at an angle by bending all the leads, pushed home, and then stood erect among the compactly placed parts of the equipment. Thus little headroom need be left over the tubes. Parts can be located immediately adjacent to the tube, the tube being removed as it was put in—by being tilted out from its normal position to where one can readily grasp it before it is pulled out. These tubes are coated with Aquadag, the coating being connected to a normally grounded lead, so that an electrostatic tube shield is unnecessary.

There are two types of sockets now available: a completely assembled socket, and a group of individual clips that, when mounted on an insulating chassis, form a socket. The first type has the advantage of pre-assembly, because it is only necessary to fasten it into the chassis. The latter, available experi-

Table 1—Characteristics of Typical Filamentary Subminiature Tubes

Tube Number	Structure & Application	Filament V	Filament MA	Plate Voltage	Transconductance in μ mhos	Circuit Amplification	Power Output in Milliwatts ^g
2E31	(Sharp-cutoff r-f pentode ampl'fier)	1.25	50	45	500 ^e	—	—
2E32 ^b							
2E35	(Output pentode)	1.25	30	45	500 ^e	—	6
2E36 ^b							
2E11	(Diode-pentode detector, amplifier)	1.25	30	45	375 ^e	20	—
2E12 ^b							
2G21	(Triode-heptode frequency converter)	1.25	50	45	60 ^d	—	—
2G22 ^b							
CK502AX	(Output pentode)	1.25	30	45	550 ^e	—	6
CK11503AX	(Output pentode)	1.25	30	45	550 ^e	—	9.5
CK505AX	(Pentode amplifier)	0.625	30	30	175 ^e	35	—
CK506AX	(Output pentode)	1.25	50	45	500 ^e	—	25
CK507AX	(Output pentode)	1.25	45	45	575 ^e	—	11
CK510AX	(Double space-charge tetrode amplifier)	0.625	50	45	65 ^e	150 ^f 16	—
CK515BX	(Triode amplifier)	0.625	30	45	160 ^e	—	—
CK521AX	(Beamed output)	1.25	50	22.5	400 ^e	—	6 ^g

^a Measured at ten percent total distortion
^b Lower number indicates leads are long enough to solder into circuit; upper number indicates leads are clipped for insertion into socket
^c Measured at zero plate and screen resistance
^d Conversion transconductance
^e Per section
^f Two sections in cascade
^g Internal plate resistance 220,000 ohms; into 20,000 ohms

mentally, has the advantage of compactness, because it comprises only the essentials of the socket, the metal clips; the plastic or impregnated fiber chassis forms the base.

One method of mounting the assembled socket is illustrated in Fig. 2. A hole is cut in the chassis to accommodate the socket. The flange around the top of the socket keeps it from passing through the hole; a retaining clip, slipped on from the bottom, holds the socket in the hole. Another method is to put the socket in a hole in a metal chassis and

punch the chassis on either side of the socket hard enough to cold flow metal into recesses in the sides of the socket. For mounting the tube in the most advantageous position, it may be necessary to locate the socket on an angle strap. During tests for socket leakage on this assembled type, resistance between pins after immersion for 48 hours in an atmosphere of 90 percent relative humidity and 50 C measured 2,000 meg. These particular plastic sockets are useful up to 60 mc; polystyrene sockets are available



(D) Pocket wire recorder

experimentally for higher frequencies.

The clip type of socket offers a method of mounting tubes on an insulated chassis, using minimum space. The socket shown in Fig. 3 is built of heat-tempered beryllium copper that has been formed into individual lead clips and relieved of stresses so as to eliminate spring-back and distortion. The clips are inserted into the insulating chassis, two banks of clips being used to obtain wide spacing. Tube leads pass through an aligning hole in the top of each clip and between the folded flaps below, where they are held by spring grip.

Good practice in mounting tubes.

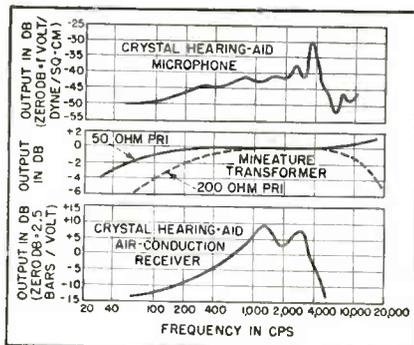


FIG. 4—Frequency response of limiting components in midget equipment

is to provide holding cushions of rubber at their tops. To connect wires to the sockets in the small space, welding is being used in some instances. Welding's advantage over soldering is ease in reaching the connection with reduced damage from hot irons and spilled solder or flux, however a welded connection is difficult to service.

Components and Construction

Frequency responses of typical components are shown in Fig. 4. Considering their small size, their performance is good. Small capacitors and resistors are also available. Wax-impregnated resin-protected tubular paper capacitors are available in capacitances from 0.002 to 0.1 μ f, the largest ones being 0.375 in. in diameter and 1.125 in. long; the smaller capacitors are only 0.625 in. long and correspondingly thinner.

Half-watt resistors from 10 ohms to 22 meg are 0.125 in. in diameter and 0.375 in. long; they

are rated at 70 C in anticipation of the higher ambient temperatures that may be reached in the compact closed assemblies of wearable equipment. Large powers are usually not available in midget equipment, so high wattage components need not be used.

Several techniques of metalizing insulated mounts to form the electrical connections of an electronic unit have been proposed as a means of both simplifying the assembly of small units and conserving space. Metal leads can be printed onto ceramics by a screen process or deposited either on the surface or in grooves by spraying through a mask; foil can be stamped onto plastic bases or baked on.

It has been found desirable because of variations in circuit parameters, particularly of thermionic tubes, common to all sizes of components, to construct calibrated pre-assemblies. Components are matched to give the required circuit characteristic and to balance one another's drifts in each unit. The pre-assemblies are then interchangeable. One such standardized multivibrator is shown in Fig. 5. In it subminiature tubes and selected resistors have been connected and mounted on a plug for connection into the complete equipment.

Tubes consisting of up to three separate tubes, either triodes, tetrodes, or pentodes in various combinations, mounted on one socket, have been manufactured in Europe. In some models the tubes are connected through resistance-capacitance networks built into the assembly.

Overall size of midget electronic equipment intended to be carried in one's pocket is the major factor determining its utility. Measurements on size of pockets in numerous men's suits, including vests, indicate that the most frequently encountered pocket size is from 2.5 to 3.0 inches wide. It was similarly found that the optimum depth of a wearable unit is between 5 and 6 in., long enough not to be out of reach at the bottom of a pocket, yet not so long as to project awkwardly from the pocket. The thinner the unit the better. Thinness is limited by the thickest component that must fit into the assembly, in this

case, the B-battery. The thinnest usable B-battery is 0.56 in. thick.

Batteries

Filament heating power requirements are most severe, as was pointed out in describing tubes designed for wearable equipment. The fact that filamentary cathode tubes can be quickly heated to operating temperature and so need not be kept hot during standby is a major factor in their favor for all portable equipment. In addition, high powers for which large, indirectly heated cathodes are necessary are not encountered in wearable equipment. Most stages of electronic circuits operate at low power levels, thus high plate power capacity is unnecessary. The problem is to supply the power to heat the filaments, small though that power is.

Recently a new dry cell having a high ampere-hour capacity was experimentally developed. An internal potential of about 1.34 volts is produced between mercuric oxide and zinc electrodes. Because of its negligible polarization, this cell delivers the same ampere-hours



FIG. 5—Calibrated pre-assemblies are used to obtain stable circuits, by balancing drifts in the components against each other, in this multivibrator

whether operated continuously or intermittently, has nearly constant output voltage and substantially constant internal resistance at audio frequencies throughout its life. A substantially flat voltage characteristic is maintained throughout life up to rated current drain (50 ma max), thus efficiency is maintained during life. The voltage drops quickly at the end of the cell's useful life. Of particular interest in wearable equipment is the fact that, volume for volume, the cell has three to four times the ampere-hour capacity of a conventional zinc-graphite dry battery. The corrosion-resistant steel case, acting as positive terminal, does not enter into electrolytic action of the cell.

Carbon-zinc cells are made in a variety of sizes for compact assembly, with the A- and B-batteries scaled to comparable dimensions, as shown in Fig. 6. The familiar layer-built B-batteries, which have duplex electrodes (zinc on one side, carbon on the other) to conserve space, are made in 15, 22.5, 30, 45, and other voltage sizes. The efficiency of energy conversion from chemical to electrical is higher in these flat cells than in comparable zinc-graphite cells of other shapes, and for the same external size they contain a larger volume of depolarizing mixture than cylindrical dry cells, and have higher zinc utilization. These batteries can readily be broken open between cells to obtain any intermediate voltage for use in experimental portable equipment. The stack must be restrapped to keep the cells pressing tightly on one another if the internal resistance of the battery is to be kept low. Because the inert plastic case does not enter into chemical action with the paste, there is no danger of corrosive chemicals eating through the container and damaging adjacent parts.

Research into the action of the carbon-zinc cells indicates that their efficiency of energy conversion can be increased. These cells are still undergoing development.

Battery equipment is usually designed to such tolerances that it will work until the battery terminal voltage has fallen to two-thirds its initial value. For example, an A-

battery is expected to remain in service until its initial 1.4 volts has fallen to about 0.9 volt. However, in the B-battery circuit, the increase in internal resistance of the battery may result in interstage coupling before the terminal voltage has fallen to this low value. This coupling through the battery impedance can be reduced by external decoupling filters, or usually by a large bypass capacitor across the B-battery. The bypass capacitor should have very little shunt leakage, or else be disconnected when the circuit is not in use. In one very small hearing aid model recently marketed, opposing feedback of the signal appearing across the battery is made to the last two stages to reduce the battery coupling and thereby obtain longer B-battery life.

Methods of Providing Grid Bias

Although many subminiature tubes are designed for zero grid bias, others require a small negative bias. Because of the inevitable decrease in plate supply potential, some provision must be made for the grid bias to decrease correspondingly, if the tube is to continue operating effectively during the entire battery life.

Self bias is the simple and obvious method of obtaining the necessary simultaneous decrease in grid bias with loss in B-voltage. The self bias resistor will, of course, cause considerable loss in tube amplification if unbypassed, but will improve the linearity of the effective transfer characteristic, thereby decreasing harmonic and intermodulation distortion.

In pentode output stages, the increase in the tube's internal impedance caused by this current feedback may be objectionable in certain applications. To prevent this cathode degeneration, a large bypass capacitor is required, with added space requirements. That the bypass capacitor will occupy considerable space will be recognized from its capacitance. In a typical circuit the CK507AX with a plate and screen supply of 45 volts requires a grid bias of minus two volts and conducts an average space current of 1.2 ma. (Although the required grid bias is small, the



FIG. 6—Batteries for wearable equipment are available in a variety of types and sizes. Shown here are two pairs of A- and B-Batteries with their paper covers removed; both pairs give the same voltage

low plate current necessitates a large cathode resistor.) The self biasing resistor must be 1,670 ohms. The bypass capacitor that, in shunt with this resistance, gives a time constant of 0.01 sec (period of a 100 cps signal) is 60 μ f. In addition, the A-battery will have to be insulated from ground, which is usually preferable to wasting heater power in the cathode resistor (even though the cathode resistor would then be smaller, but requiring a much larger bypass capacitor) which would be necessary if the A-battery were grounded.

One means of counteracting the degeneration introduced by an unbypassed cathode resistor is to provide positive feedback across the cathode resistor from the plate circuits.

If voltage amplification can be sacrificed, voltage feedback can be used in the output stage to decrease the effective internal impedance of the tube. The components of such a circuit usually require less total volume than the cathode bypass capacitor, although the A-battery drain may be higher because of an added tube. However, the combined effects of these feedbacks will be complex and can lead to instabilities. Whatever the solution, it is usually a compromise between minimum bulk and minimum battery drain.

Material for this article has been obtained from more sources than can reasonably be listed here. To those who generously supplied information, greatful appreciation is extended.—F. R.

SLOTTED - CYLINDER

Simple mechanical construction, easily obtained vertical directivity, and horizontal polarization make the slotted-cylinder antenna ideal for f-m and television transmission and reception. Directivity and impedance characteristics for designing arrays are presented

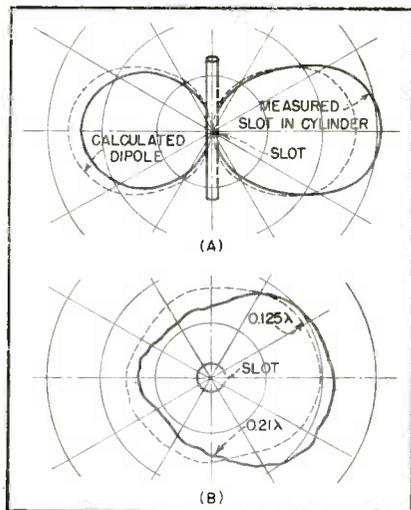


FIG. 1—(A) Vertical radiation pattern of a three-quarter wavelength slot antenna compared to that of a half wavelength dipole, and (B) horizontal radiation pattern of slot antenna in a vertical cylinder of 0.21 wavelength diameter

SLOT ANTENNAS have been successfully used on high speed aircraft to establish electric currents on outside surfaces of the metallic airplane structure and so make the aircraft itself the radiator. Examination of the characteristics of slot radiators shows that they possess properties that make them useful in many other applications as well.

In such applications a particularly useful form of the radiator is a slot cut lengthwise in a long, narrow, hollow cylinder. The first reference in the literature to this form of radiator appeared several years ago¹. It proposed the use of a slit cylinder to guide or radiate electromagnetic waves. Slot radiators of one form or another have already found commercial applica-

tion in frequency modulation² and television³.

It is the purpose of this article to discuss some general properties of slot-in-cylinder radiators and to present radiation patterns and impedance curves that should enable engineers to determine the suitability of these antennas for

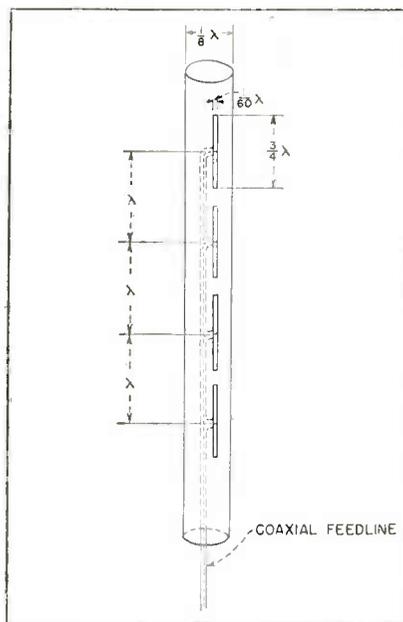


FIG. 2—Vertical directivity can be increased by stacking slots. Mechanical construction is simple. Slots are fed from a transmission line inside the slotted cylinder

applications in which they may be interested.

Radiation Patterns

Figure 1 shows the vertical and horizontal radiation patterns of a three-quarter wavelength slot cut in a vertical cylinder. For comparison, the vertical pattern of a half-wave dipole is also shown. For

equal lengths, the vertical slot and vertical dipole have practically the same vertical radiation patterns. Length of the cylinder itself has no noticeable effect on the pattern. It must be long enough to accommodate the slot, but can be any convenient length longer. The horizontal pattern of the vertical slot-in-cylinder is dependent upon the diameter of the cylinder. In general, radiated field intensity is greater on the side on which the slot is located than it is on the opposite side of the cylinder. However, for cylinder diameters of about one-tenth wavelength or less, radiation in the horizontal plane is essentially uniform.

The radiation pattern of a slot in a narrow cylinder is almost the same as that of the corresponding length dipole, but with one important difference: the electric field produced by a vertical dipole is vertically polarized whereas that produced by a vertical slot is horizontally polarized. Because horizontal polarization is used for both frequency modulation and

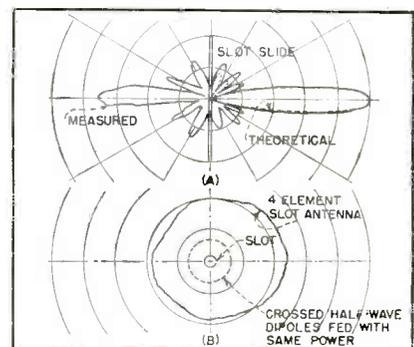


FIG. 3—(A) vertical, and (B) horizontal radiation patterns of slotted-cylinder array shown in Fig. 2

ANTENNA

By E. C. JORDAN and W. E. MILLER

*Department of Electrical Engineering
University of Illinois
Urbana, Illinois*

television, the slot-in-cylinder possesses considerable advantage over the ordinary dipole in these applications. A vertical slot has the desired vertical directivity with nearly uniform radiation in the horizontal plane and, in addition, has the correct polarization for f-m and television broadcasting.

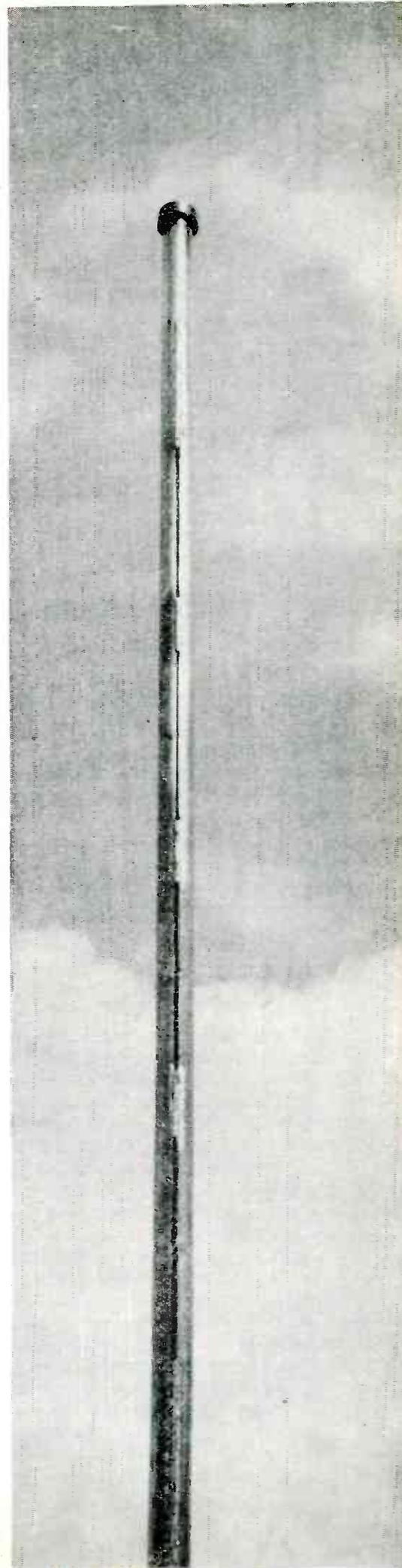
When greater vertical directivity is desired, it can be obtained by stacking slots vertically as illustrated in Fig. 2. Because each unit of the array (that is, each slot) has considerable vertical directivity by itself and therefore radiation from any one element does not interact to a considerable extent with that from other elements, it is possible to space the units a wavelength apart without producing unduly large secondary lobes. Directivity of any array is proportional to its overall length; so when large spacing between units is permissible it is possible to have a long, and hence a highly directive, array without requiring an excessive number of units, simplifying feeding problems. The array of Fig. 2 has four slots, each three-quarters of a wavelength long, and spaced one wavelength center-to-center. When longer slots are used, larger vertical separations are permissible.

In Fig. 3 there are shown the measured vertical and horizontal patterns of the four-element array. Vertical directivity is very sharp and it is seen that most of the power is radiated within a few degrees of the horizontal. The excellent agreement between measured and theoretical patterns indicates that predicted gains can be closely attained in practice. In

Fig. 3B there is also shown the relative field intensity in the horizontal direction produced by a pair of horizontal crossed half-wave dipoles fed with the same power as the four-slot array. Figure 4 shows the directed power gain of the slotted-cylinder array as a function of the number of three-quarter wavelength slots, spaced one wavelength apart. The gain shown is referred to that of a single half-wave dipole. The gain over a pair of crossed dipoles (as would be required to produce a uniform horizontal pattern with horizontal polarization) would be double that shown. The values given in Fig. 4 represent the average gain in the horizontal direction. For a one-eighth wavelength diameter cylinder, the horizontal pattern is not uniform and the actual gain is a little greater on the slot side of the cylinder and a little less on the side opposite the slots.

Impedance Characteristics

In order to feed the slotted-cylinder antenna properly, it is necessary to know something of its impedance characteristics and how these characteristics vary with slot length and width, and cylinder diameter. Figure 5 shows resistance and reactance of a slotted cylinder as measured at the center of the slot. Impedance is shown as a function of slot length for various ratios of antenna diameter to wavelength. As cylinder diameter in wavelengths is made progressively smaller, the length of the slot required for resonance becomes very large, and there is a certain critical diameter below which resonance cannot be obtained



at any slot length. For the particular slot width used in this case, this critical diameter appears to be about 0.11 wavelength. It will be noticed that the resonant length (that is, the length for zero reactance) is very long for narrow diameter cylinders, but becomes smaller as the cylinder diameter increases. For larger diameter cylinders, second resonance points appear at slot lengths roughly double that for the first resonance. Resistance at this second resonant point is comparatively low, being of the order of 40 ohms, while at

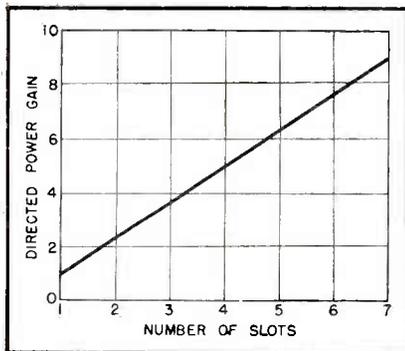


FIG. 4—Concentration of power in the vertical plane, relative to that from a dipole, for an array similar to that of Fig. 2

the first resonant point it ranges between 300 and 1,000 ohms. The effect of greater slot width is to increase the length of slot required for resonance for a given cylinder diameter.

Explanation of Operation

There are two rather simple physical pictures which can be used to explain the operation of the slot-in-cylinder antenna. The first considers the edges of the slot as constituting a parallel-wire transmission line which is shorted at both ends.

A voltage is applied across the transmission line (usually, but not necessarily, at the middle) and standing waves of voltage and current are set up along the line. Because of the close spacing between the edges of the slot, transmission line currents would not be expected to radiate appreciably. However, the slot transmission line has connected to it the remainder of the cylinder which has a twofold effect.

In the first place, the voltage

across the slot causes currents to flow around the outside of the cylinder and these currents flowing in the circular path radiate appreciable amounts of power, the diameter of the path being a significant fraction of a wavelength. In addition, the cylinder acts as an inductive reactance shunted across the slot transmission line, and so modifies the phase velocity and hence the wavelength along the line. From transmission line theory it is known that inductive shunt loading will increase both phase velocity and wavelength, and so increase the line length required for resonance. If the loading is too great (that is, if shunt inductive reactance is too low) wave motion along the line ceases and the loaded line acts as an attenuating network.

This simple picture serves to explain most of the characteristics of the impedance curves for narrow cylinders. For larger diameter cylinders it is necessary to resort to waveguide theory for the second physical picture. The inside of the

cylinder is a degenerate cylindrical waveguide.

Within a waveguide the phase velocity and wavelength are always greater than the corresponding free-space quantities and the ratio of wavelength in the guide to free-space wavelength becomes very large as the diameter of the cylinder decreases to the cutoff diameter. For completely closed cylindrical waveguides the cutoff diameter for the dominant mode is 0.586 times the wavelength, but when the cylinder has a slot in it, with the excitation applied across the slot, the cutoff diameter is very much less than this value. In this latter case the capacitance of the slot reduces the required diameter of guide in much the same way as the length of a transmission line section required for resonance is reduced by capacitive loading of the load to which it is connected. It is apparent that the greater the capacitive loading (that is, the narrower the slot) the smaller will be the cutoff diameter of the cylinder.

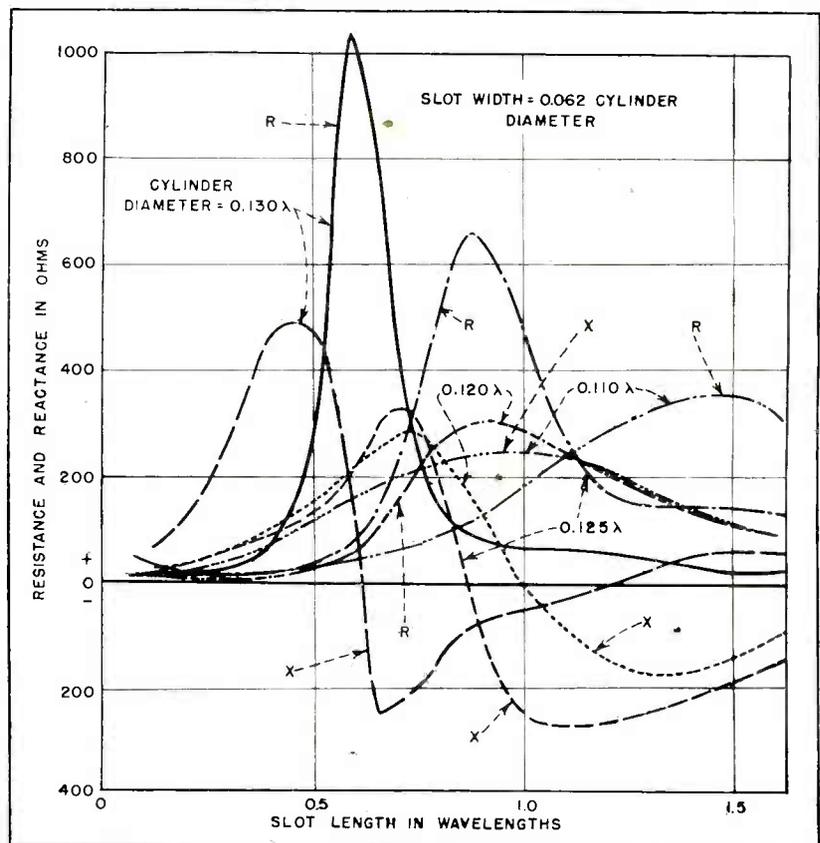


FIG. 5—For a slot representing a fixed fraction of the cylinder diameter, resonant impedance increases and resonant slot length approaches a half wavelength as cylinder diameter is increased

With slot widths used in making the measurements shown, cutoff diameter was of the order of one-tenth wavelength. With narrower slots, or slots the sides of which overlap, cutoff diameter can be reduced to one-thirtieth of a wavelength or less.

Figure 6 shows the electric field intensity across the slot, measured for several cylinder diameters. For large diameters the distribution of electric intensity along the slot is closely sinusoidal with the distance between nodal points only slightly greater than the free-space half wavelength. However, as the cutoff diameter is approached the distance between nodal points becomes relatively larger, attenuation within the guide increases and the distribution changes from sinusoidal to exponential. Figure 7 gives the ratio of wavelength in the guide to wavelength in free space for various cylinder diameters. From the curve or the field distributions on Fig. 6 one can determine the maximum slot length which can be used to give a single lobe in the radiation pattern. Figure 8 shows slot length required for first resonance as a function of cylinder diameter.

Methods of Feed

The slotted-cylinder antenna can be fed by either coaxial or parallel-

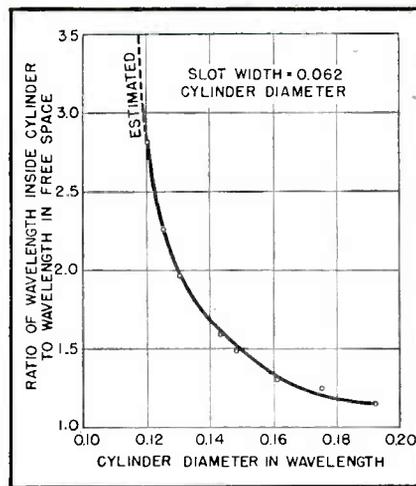


FIG. 7—Resonance phenomena presented in Fig. 5 and 6 can be summarized as a curve of ratio of inside to free-space wavelengths

wire transmission lines running up the inside of the cylinder. Both of these methods were used in obtaining the measurements shown. Choice between a single or double coaxial line or parallel-wire line feed depends upon convenience and impedance-matching possibilities.

The impedance around the second resonant point is low, indicating coaxial-line feed in this region of operation. At the first resonant point the impedance is high and parallel-wire feed inside the cylinder is preferable. However, lower impedances can be obtained by

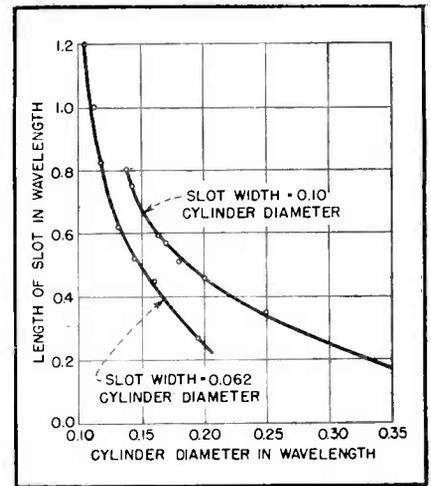


FIG. 8—Design of slotted-cylinder antenna involves choosing cylinder diameter and slot width that give reasonable slot length at the operating frequency

feeding the slot off-center. With an array of slots at one wavelength spacing, slot impedances are effectively in parallel and for a four-slot array operating at the first resonance, the input impedance of the transmission line is of the order of 100 ohms.

It is evident from the discussion on theory of operation that large variations in impedance can be obtained by adjusting the effective capacitance across the slot. The effective slot capacitance will depend primarily on slot width, but will also depend somewhat on the thickness of the cylinder wall. For impedance curves shown, a cylinder wall thickness of approximately 1.5 percent of the cylinder diameter was used.

Bandwidth measurements on the slotted-cylinder antenna indicate bandwidths at the first resonance of between four and eight percent (between frequencies at which the standing-wave ratio on the feed line was two to one). The bandwidths around the second resonance points were not measured, but a study of the impedance curves indicates that they should be considerably wider than at the first resonance points.

REFERENCES

- (1) Blumlein, A. D., High Frequency Electrical Conductor or Radiator, U. S. Patent No. 2,238,770, April 15, 1941.
- (2) Alford, A., Antenna for F-M Station WCHP, *Communications*, p 22, February 1946.
- (3) Color Television on Ultrahigh Frequencies, *ELECTRONICS*, p 109, April 1946.

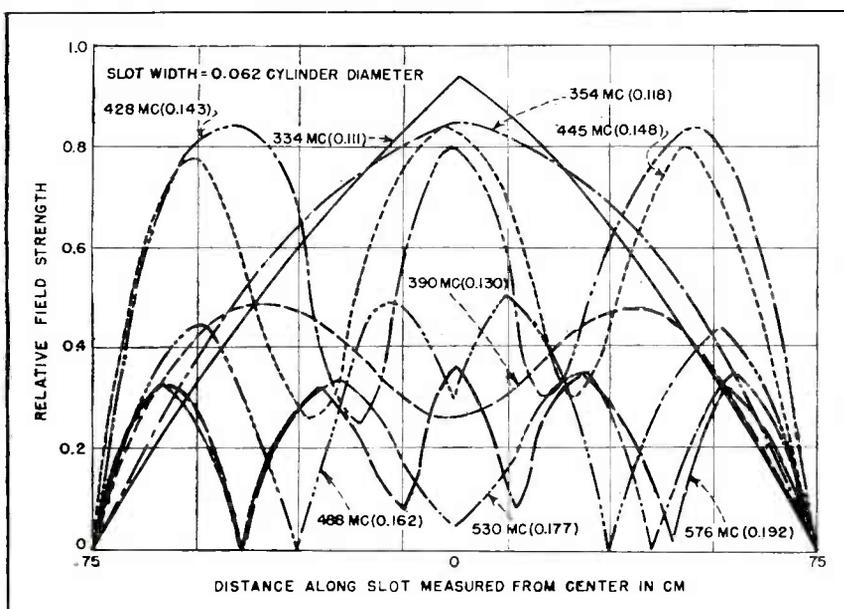


FIG. 6—Field strength distribution along a 150-cm slot varies with frequency because of the change in velocity of propagation along the radiator. Numbers in parentheses indicate cylinder diameter in wavelengths

Electronic TOY-TRAIN CONTROLS

The engineering problems in carrier-current control of model railroads rival those in telemetering and remote control. Successful design of system components capable of hard usage and mass production is described

By **JOSEPH L. BONANNO**

*Chief Engineer
Lionel Corp.
Irvington, N. J.*

THE problem of remote control has always taxed the ingenuity of miniature railroad enthusiasts. Literature and patent office files are replete with devices of various degrees of complexity, ranging from purely mechanical trip mechanisms to electronic circuits, all intended to lend verisimilitude to the operation of toy trains. A genuine remote operation of miniature railroads became possible only with the recent development of an electronic system of control.

While there is nothing novel in the application of electronics to remote control apparatus—such systems have been used for over two decades in drone aircraft and elsewhere—the adaptation of electronic control to miniature railroads presented a number of design problems.

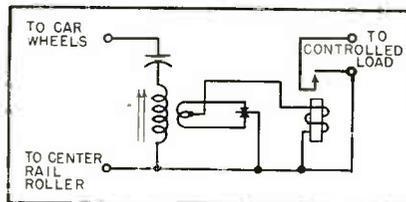


FIG. 1—Schematic wiring diagram of the receiver. Relay contacts are factory adjusted

Paramount is the problem of size. Each receiving unit must be self-contained and small enough so that it can be conveniently and inconspicuously mounted within the miniature rolling stock. Equipment must be rugged to withstand the vicissitudes of model railroading. It needs stability within a wide range of operating conditions, and interchangeability with a minimum of adjustment. And, of course, it

must be inexpensive and suitable to mass production technique.

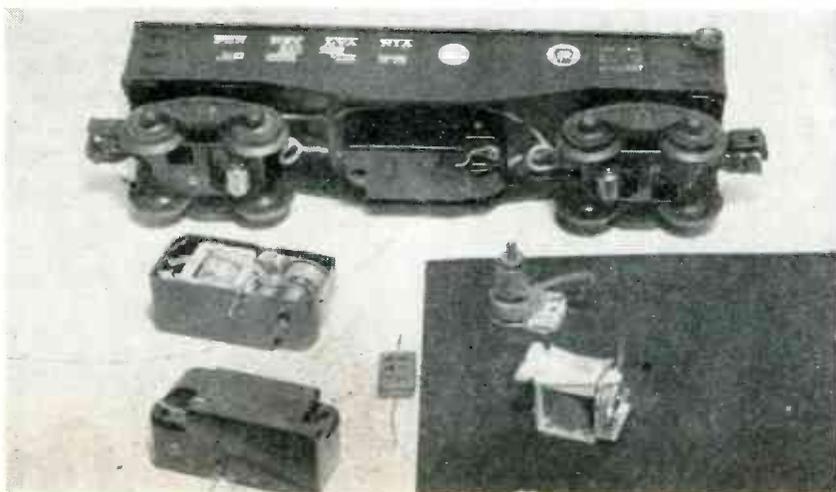
Receiver Design

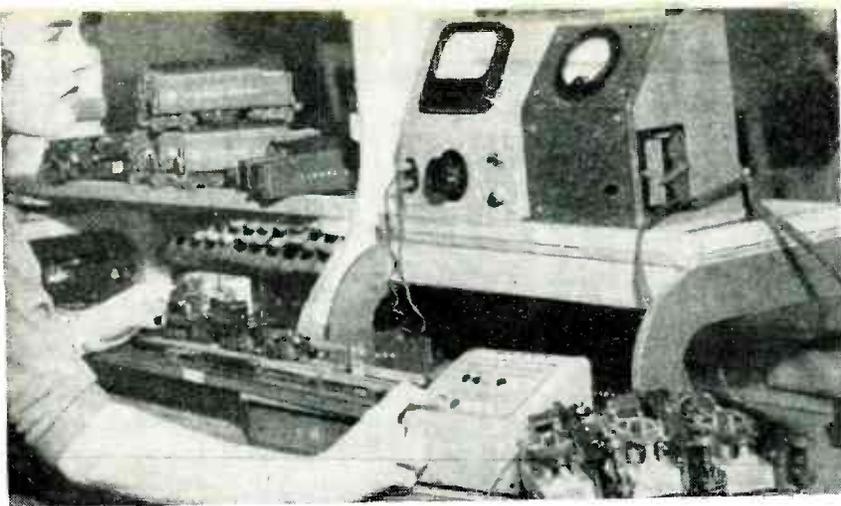
The use of miniature vacuum tubes was considered in the early stages of receiver development but rejected principally because of the problem of plate and filament supply. While a miniature step-up transformer and metallic rectifier pile could easily be built, the operating track voltage—which would serve as the power source—normally ranges between 6 and 18 volts. So wide a variation in the power supply, as well as the cost, rendered the use of vacuum tubes impractical in the receivers.

The circuit selected for the receiving stations is an r-f series circuit utilizing a small commercial type mica capacitor and a miniature permeability-tuned inductor. The high r-f voltage developed at resonance across the inductor coil is stepped down in a center-tapped secondary winding, and then rectified by means of two metallic rectifiers. Sufficient power is thus obtained from the r-f signal to operate a sensitive d-c relay in the power circuit, shown in Fig. 1.

Of the several types of metallic rectifiers investigated, copper oxide instrument type discs proved the most practicable, principally because their resistance was of an order of magnitude that can be matched to a convenient size 500-

Gondola car showing mounting of receiver. Complete receivers are shown in left foreground with tuning unit and relay at right





Test setup for adjustment of two receivers in locomotive tender, one for controlling locomotive and one to operate whistle. Spring assembly in foreground provides predetermined mechanical load for couplers

ohm relay. Selenium rectifiers, while satisfactory in most respects, were rejected because they were not at the time readily available in instrument sizes. Their relatively higher resistance would also have required a higher impedance relay, having a poorer winding space factor, and lower power sensitivity.

Frequency of Operation

The first experimental outfit was built to operate within the range of 50 to 80 kilocycles. Further tests proved, however, that the capacitance of the rectifier discs did not unduly load the output until frequencies of the order of 500 kc were reached. Consequently, the frequency channel was raised to between 240 and 360 kc, which while still low enough to avoid interference in the standard broadcast band, reduced further the size and cost of the components.

Two other considerations influenced the selection of the upper frequency limit. When higher frequencies were employed, stability of individual components became too critical for economical production. Further, the shorter wavelengths fall within the order of magnitude of practical track layouts with the consequent danger of creating standing waves at points along the track.

Possibly the key to a successful receiver circuit without vacuum tubes, amplifier, or volume control is the design of a compact and relatively inexpensive relay operating reliably on 6 milliwatts and handling currents up to 4 amperes at 18 volts for at least 10,000

operations. The design of this relay constituted a major part of the receiver development. To achieve the necessary sensitivity, the relay is maintained within close limits of mechanical tolerance.

To provide a simple and compact means of adjustment the lower contact was designed in the form of an eccentric disc which can be rotated to properly regulate the magnetic air gap. Because the armature spring restoring force at the contact points is only 1.5 grams, special nonwelding contact material had to be found. A solid palladium silver disc proved to be the solution.

The exigencies of space also resulted in the design of a novel jar-proof, self-locking permeability adjustment illustrated in Fig. 2. A molded tube serves as a channel for the movement of the pressed iron tuning plunger. The upper end of the tube is slotted and threaded. A split retaining ring forced over the slotted end of the tube maintains a continuous locking pressure upon the adjusting screw regardless of the thread wear. The outside of the tube serves as mounting for the coil and the same molding contains nests for the miniature rectifier discs which are kept in position by means of a metal contact plate crimped to the molding.

The receiver unit as finally developed operates with an overall system efficiency of 8 percent and is housed together with the relay within a molded plastic housing measuring $1 \times 2\frac{1}{4} \times \frac{7}{8}$ inches, or almost exactly the volume of a safety match box. A typical resonance curve is shown in Fig. 3.

The criteria of low cost and high order of frequency stability under a wide range of operating conditions also governed the design of the transmitter. Early determination of power requirements revealed that the r-f shunting effect of motors, solenoids and other operating equipment containing windings either with or without iron cores was negligible; the only serious problem was offered by lamps.

The average lamp used in miniature railway layouts operates on 12 volts and consumes $\frac{1}{4}$ ampere. Assuming a maximum of 20 lamps in parallel, the total hot lamp resistance approximates 2.5 ohms. To this resistance, however, is added track and contact resistances and lead impedances so that the maximum r-f impedance is seldom less than 10 ohms under the most adverse operating conditions. To maintain good voltage regulation the transmitter output is matched to 1.5 ohms. Since power requirements thus do not exceed 0.6 watt, it is possible to employ a type 117 diode-pentode which develops one watt of power and operates directly from the line.

The power leads normally connecting the track layout to the variable low-voltage transformer offer an easy solution to the transmission problem. A wired wireless system has been adopted, and the r-f transmitter output superimposed directly on the train power circuit,

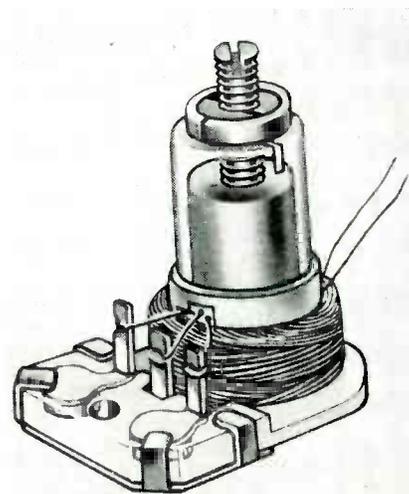


FIG. 2—Drawing of the receiver proper showing split lock ring at top, adjustable tuning core and tuning coil. The rectifier discs are under the contact plate tabs to left and center

Pulse-Type Tester for High-Power Tubes

Motor-driven 5-rpm commutator in simple trigger circuit causes ignitron to fire and apply high-voltage pulse to grid of tube being tested. Resulting grid and plate voltage and current pulses are measured on high-persistence c-r tube by means of calibrating spot

By **E. C. EASTON**

*Assistant Professor of Electrical Engineering
Graduate School of Engineering, Harvard University
(Formerly of Cruft Laboratory)*

and

E. L. CHAFFEE

*Professor of Applied Physics
Director of Cruft Laboratory
Harvard University, Cambridge, Mass.*

THE purpose of the pulse-type high-power tube tester herein described is to obtain simultaneous measurements of plate voltage, plate current, grid voltage, and grid current at the crest of the grid-current curve of a triode when the grid current is made to vary as a pulse of very short duration.

An electrically operated commutator alternately applies to a cathode-ray oscilloscope a signal from the tube tester or a signal from a calibrating circuit. When the tube tester is connected to the oscilloscope, a voltage proportional to the grid current is applied to the horizontal plates while the vertical deflection is produced by either the plate voltage, plate current, or grid voltage as desired. The operator obtains readings of the peak values by matching a calibrating spot with the end of the characteristic curve as seen on the long-persistence screen of the oscilloscope.

The apparatus was designed to test tubes of the type used for Ioran. The tube can be supplied with plate-current pulses of 200 amperes at plate voltages up to 20,000 volts. The grid voltage may be varied from -5,000 to +10,000 volts.

Measuring Circuit

The measuring circuit is shown in Fig. 1. The grid current is measured in terms of the voltage across a noninductive shunt R_{10} .

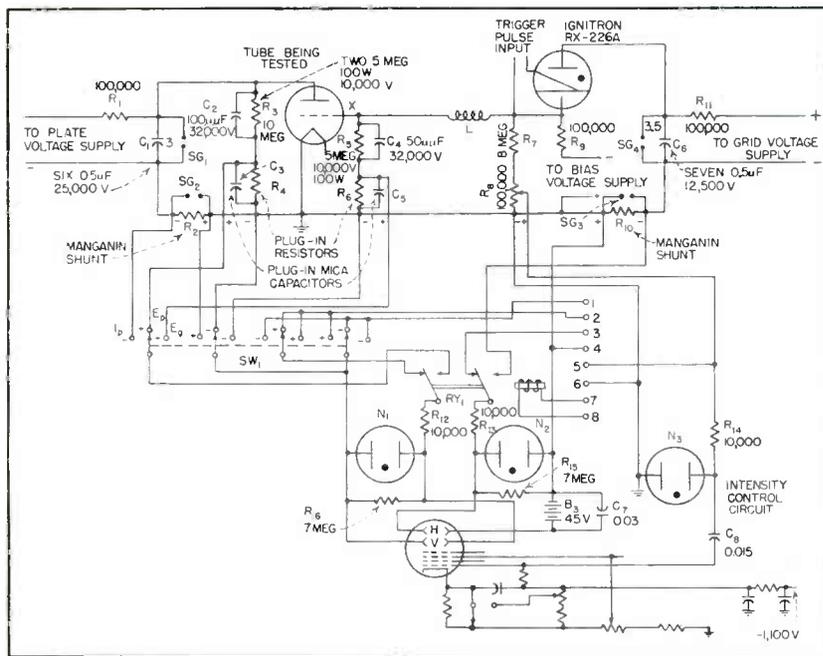


FIG. 1—Measuring circuit for pulse-type tube tester

This voltage is applied directly to the horizontal plates of a cathode-ray oscilloscope. The plate current is measured in similar fashion by applying directly to the vertical plates of the oscilloscope the voltage across the noninductive shunt R_2 . By means of switch SW_1 , the vertical plates may be connected either across R_2 for plate current measurement, across R_1 for plate voltage indications, or across R_6 for determining the grid voltage. Complete shielding of all portions of the measuring circuits is most

essential in this method because of the use of pulses having high rates of change of current.

The combination $C_2C_3R_3R_4$ forms a compensated voltage divider to supply a known fraction of the plate voltage to the oscilloscope. Similarly, $C_1C_5R_5R_6$ form another compensated voltage divider for the measurement of grid voltage. Each voltage divider is carefully adjusted with the aid of a square-wave generator so that when a square wave of voltage is applied across the divider, a good

reproduction of the square wave appears across the low-voltage section.

The high-voltage section of each divider is enclosed in an aluminum shield. The low-voltage section plugs into sockets mounted on the shield. The shield and the bottom of the low-voltage section are grounded to a common point which also serves as the ground connection for the tube to be tested, the cage which holds the apparatus, and the shunts R_2 and R_{10} . By the use of a common ground point, ground currents are kept out of the cage and shields, and thus magnetic disturbances from ground currents are minimized.

Connections from the voltage dividers and shunts to the oscilloscope are made through coaxial cable. The grounded side of each shunt and voltage divider is connected to the outer conductor of the corresponding cable. All these cables run to a junction box which contains switch SW_1 and relay RY_1 . The junction box is grounded to the common ground point, but all cable connections are insulated from the box. Thus, if, because of very heavy tube currents, the grounded side of a cable should be at a different potential from ground, no part of the tube current will flow through the outer conductor of the cable. With these precautions in grounding and shielding, no magnetic pickup or interaction between circuits is observed.

The impulse of grid current is controlled by the ignitron RX-226A. When the trigger circuit causes the ignitron to fire, the voltage on capacitor C_9 is applied between grid and cathode of tube X . The inductance L retards the rise and fall of grid current sufficiently to provide a grid-current pulse which rises rapidly and then holds a rounded peak for several microseconds before dropping.

Pulse-Forming Circuit

Before the ignitron is fired, the grid of the tube X is kept at a negative potential by a bias power supply acting through R_6 . This negative bias is adjustable to a maximum of 5,000 volts and is set at a value sufficient to hold the plate current to a negligible value over the normal range of plate voltage.

By means of voltage divider R_7 in Fig. 1, a portion of the grid voltage is fed to the intensity control of the oscilloscope. When the ignitron fires, the intensity of the electron beam is greatly increased, and the rapidly-formed trace is made visible on the long-persistence screen. (Battery B_3 serves to position the electron beam to the left of the center of the screen.)

The oscilloscope beam is deflected horizontally by the grid current, and vertically by either the plate voltage, plate current, or grid voltage, depending on the setting of SW_1 . When the grid current is

at its peak, the beam is deflected to a maximum horizontally. Hence, if observations are made on each vertical signal at the extreme of the horizontal deflection, all readings are obtained at the peak of the grid current.

Calibration Procedure

In order to calibrate the oscilloscope and thus obtain the true value of each measured quantity from the deflection on the screen, two variable d-c voltages are provided, as shown in Fig. 2. By means of battery B_1 , potentiometer R_{17} , and voltmeter V_1 , a known voltage of any desired value can be applied to the vertical plates; B_2 , R_{18} and V_2 supply a similar known adjustable voltage for the horizontal plates. When relay RY_1 is in the position shown in Fig. 1, these calibrating voltages are applied to the oscilloscope.

By adjusting R_{17} and R_{18} , the luminous spot may be moved to any point on the screen. Thus the spot may be moved to the end of the signal trace, and by reading V_1 and V_2 , the vertical and horizontal deflection voltages can be determined at the peak of the grid current. Knowing these deflection voltages and the resistance of shunts R_2 and R_{10} , the plate and grid currents may be found. Similarly, knowing the voltage divider ratios, the plate and grid voltages may be determined.

In order to keep the outer conductors of all coaxial cables at ground potential, it is necessary to have the plate and grid voltages cause a deflection in the opposite direction from that caused by the plate current. Switch SW_1 reverses the polarity of the calibrating voltage whenever the polarity of the signal voltage changes.

Relay RY_1 switches the oscilloscope from signal to calibration. When the relay is energized, the signal is fed to the oscilloscope. When the relay coil current is removed, the oscilloscope is connected to the calibrating voltages.

The operation of relay RY_1 is controlled by the trigger circuit shown in Fig. 2. This circuit includes a mechanical commutator having three contacts. The commutator rotates at 5 rpm. The

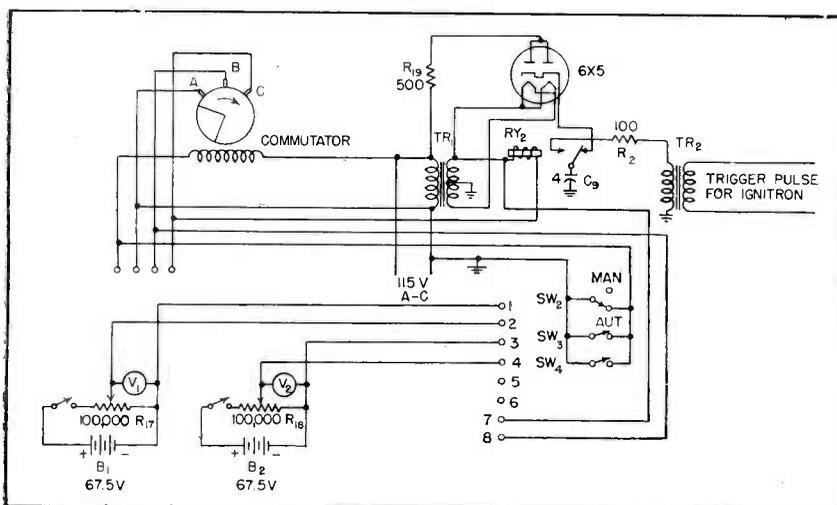


FIG. 2—Calibration and trigger circuit

rotating Bakelite disc contains a brass insert which connects the contacts with each other as the disc turns. When contacts *A* and *B* are connected by the brass insert, relay *RY*₁ is energized by transformer *TR*₁, and the measuring circuit is connected to the oscilloscope.

When all three contacts are connected together, relay *RY*₂ is energized. This relay causes *C*₀ to discharge through the primary of transformer *TR*₂. The pulse of voltage from the secondary of *TR*₂ fires the ignitron and thus applies the grid voltage to tube *X*. As the commutator continues to rotate, both *RY*₁ and *RY*₂ are deenergized, and the calibration voltages are applied to the oscilloscope. Thus, five times a minute, the following cycle of operations takes place: *RY*₁ closes, *RY*₂ closes, the ignitron fires, *RY*₁ and *RY*₂ open. With *RY*₁ closed, the operator sees the tube characteristic on the oscilloscope screen. With *RY*₁ open, he sees the spot as positioned by the calibrating voltage.

The operation of the mechanical commutator is made automatic by setting switch *SW*₂ in Fig. 2 on AUT. When this switch is open (position indicated as MAN) the commutator does not rotate. With *SW*₂ open, the operation of the commutator may be controlled manually by pushbutton *SW*₃ on the main panel, or by *SW*₄, which is a remote trigger mounted at the end of a long cord. The 6X5 tube shown in Fig. 2 is a rectifier which charges *C*₀.

Protective Devices

To insure the safety of both operator and equipment, various protective devices are provided. In Fig. 1, *N*₁, *N*₂ and *N*₃ are ¼-watt neon bulbs. Should a flashover occur in any of the high-voltage circuits these neon bulbs together with resistors *R*₁₂, *R*₁₃, and *R*₁₄ will prevent the voltages applied to the oscilloscope from exceeding a value of approximately 70 volts.

Spark gap *SG*₁ is set to break down at 20,000 volts in order to protect *C*₁, which is rated at 25,000 volts. Gap *SG*₂ breaks down at 10,000 volts to protect the 12,500-volt capacitors at *C*₀.

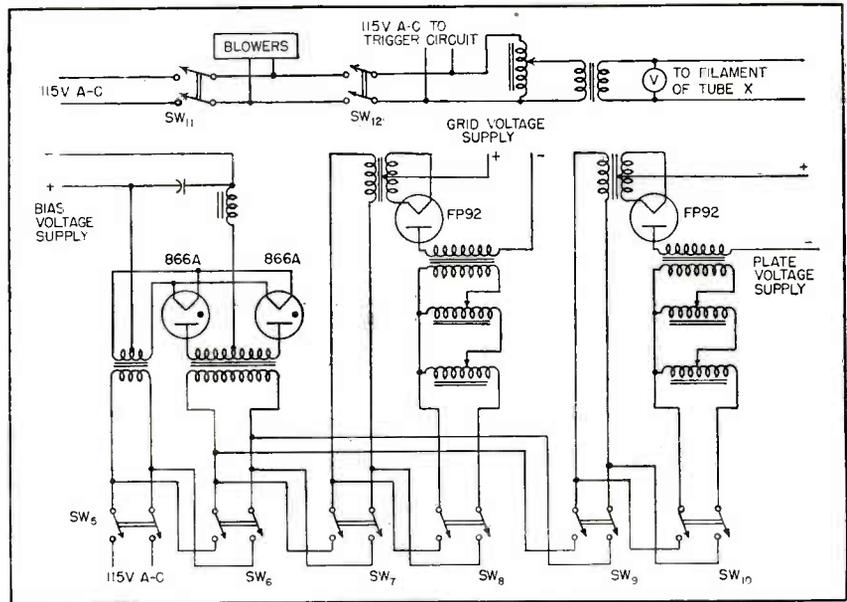


FIG. 3—Power system for pulse-type tube tester

Paper gaps *SG*₂ and *SG*₃ are designed to break down and form a mechanical short-circuit if excessive voltage should appear across either shunt *R*₂ or *R*₁₀. These gaps each consist of a spring whose pointed end presses against a brass plate. A piece of thin paper is placed between the point and the plate. If excessive current should be passed through the shunt, the paper is punctured, the spring makes contact with the plate, and the shunt is short-circuited.

In order to prevent the operator from applying plate voltage to tube *X* before the negative grid bias is connected, the power controls are interlocked as shown in Fig. 3. Closing switch *SW*₅ applies filament voltage to the 866A mercury-vapor tubes in the bias power supply. This switch also supplies voltage for *SW*₆. Closing *SW*₆ applies plate voltage to the bias rectifier and thus provides the negative bias for tube *X*. After *SW*₆ is closed, voltage is available for the grid and plate power supplies.

The use of two autotransformers in the high-voltage parts of the grid and plate power supplies is an added safety feature. In each system, one autotransformer is placed out of the operator's reach and is set so that when the second autotransformer is adjusted by the operator, no dangerously high voltages may be applied to the tube

X at any setting of the operator's control transformer.

Switch *SW*₁₁, mounted on the main panel, turns on the blowers which cool tube *X* and also provides voltage for *SW*₁₂. Closing *SW*₁₂ applies voltage to the filament of tube *X* and also provides voltage for the trigger circuit.

When the tube tester is used for making measurements, it is advisable to keep the oscilloscope signal voltages between 25 and 50 volts. Voltages below 25 give deflections whose short length increases errors in measurement. Voltages much in excess of 50 volts may cause the neon protective bulbs to ignite and give a false indication.

To keep the oscilloscope voltages within the required range when measuring grid or plate voltages, each voltage divider is provided with several different low-voltage sections. Thus, the plate-circuit voltage divider has four low-voltage sections providing voltage ratios of approximately 50, 100, 200, and 400. These ratios cover the voltage ranges 0-2,500, 2,500-5,000, 5,000-10,000, and 10,000-20,000 respectively.

Similarly, shunts of different value are provided for *R*₂ and *R*₁₀. For *R*₂ the available resistances are approximately 2, 1, 0.5, and 0.25 ohms covering the current ranges 0-25, 25-50, 50-100, and 100-200 amperes respectively.

WIDE-ANGLE

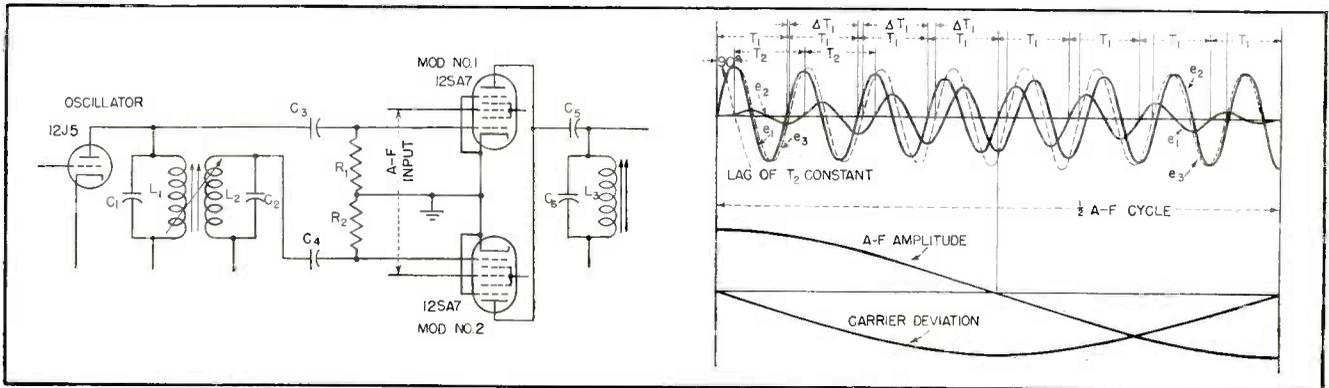


FIG. 1—Basic modulator consists of a phase-shifting network feeding two differential amplitude-modulating tubes. The vector output is phase modulated

FIG. 2—Addition of two components of varying amplitude and constant phase difference gives a signal of constant amplitude and varying phase position

By H. K. BRADFORD

Assistant Project Engineer
Communication and Navigation Dept.
Bendix Radio Division
Bendix Aviation Corp.,
Baltimore, Md.

A FREQUENCY-MODULATION system was developed concurrently with amplitude-modulation equipment for railroad communication so that its advantages could be made known to the railroads. The equipment was designed so that conversion from one type of modulation to the other would be as simple as possible. While the amplitude-modulation system is conventional, the frequency-modulation system offers some interesting aspects.

Phase-Shift Modulation

The phase-shift method of modulation was chosen for this mobile equipment so that direct crystal control could be used for the carrier. The use of a master oscillator with correction circuits necessary for the frequency stability required in the vhf band of 152 to 162 mc was regarded as impractical. With phase-shift modulation, the carrier is derived from a crystal oscillator, the frequency of which remains unchanged in the process of modulation.

With reactance-tube frequency modulation the base or oscillator

frequency can be changed as much as desired within the circuit capabilities, but with phase-shift modulation we do not change the base or oscillator frequency, we continuously shift the phase of a frequency component derived from the oscillator. The oscillator component is never completely detached from the multiplier-amplifier following it so its component is always part of the driving force. For this reason the phase shift is limited to an amount which will not seriously change the driving amplitude.

For example, if the phase shift becomes as much as 180 degrees, the derived phase component will cancel the normal oscillator component and there will be no output, providing that the amplitudes are equal. This fact restricts the angle of phase shift to an amount which, with the oscillator component, will not seriously affect the total amplitude used to drive the multiplier-amplifier. For a complete discussion of the theory of various forms of angle modulation refer to Frequency Modulation by W. L. Everitt, *A. I. E. E. Trans.*, Nov. 1940, p 613.

For the purpose of this discussion we will regard phase-shift modulation as adding or subtracting increments of time throughout each r-f cycle. If equal increments of time are added to each cycle, the resultant frequency will be lower than before and constant. However if we add increasingly larger increments of time to succeeding r-f cycles, the frequency reduces in accordance with the sizes of these increments. If the increments are proportional to sine functions, those at the beginning of the modulating cycle will be largest, displacing the frequency by the greatest degree, while those toward 90 degrees of the modulating cycle will tend toward zero, at which time the r-f will return to normal frequency. The carrier deviation is proportional to the rate at which these time increments increase or decrease and not to their magnitude.

If the phase between two carriers remains constant they will have the same frequency regardless of the amount by which their phase differs. Thus if time (and hence phase) increments follow a sine-

PHASE MODULATOR

Technique for phase modulating a crystal-controlled carrier, whereby two components of fixed phase difference are amplitude modulated and added to give the output, is described. Circuit can be used to give frequency modulation, or modified to give amplitude modulation

wave form, their rate of change will follow a cosine form. If these increments follow a transient form, their rate will follow as their first differential.

Modulation Relationships

If we define the instantaneous voltage of a sine wave as

$$e = E_0 \sin \omega t \quad (1)$$

we must realize that the angular velocity ωt is changing in frequency modulation according to one law for the reactance tube and according to another for the phase-shift method. Suppose that we are to phase-shift modulate with another sine wave defined as $E_1 \sin \omega_1 t$, then the angle ωt in Eq. 1 would have to be altered as $\omega t + E_1 \sin \omega_1 t$. However the amplitude here defined as E_1 has the meaning that a maximum number of degrees or radians of angle is to be added to or subtracted from the original angle ω . The circuit analysis to follow will show that the a-f amplitude E_1 produces a proportional phase shift. If it is more convenient to regard ωt as a rotation, then the addition of $E_1 \sin \omega_1 t$ simply means that this rotation is periodically accelerated and decelerated by an amplitude E_1 and a period $\omega_1 t$. If E_1 is actually a maximum angle set by the design of the equipment, it may be designated more properly as an angle ϕ in which case the entire equation for a phase-modulated wave becomes

$$e = E_0 \sin (\omega t + \phi \sin \omega_1 t) \quad (2)$$

Because we are not immediately

interested in the energy distribution in the radio spectrum it is possible to make a very simple analysis of Eq. 2.

The part of the total carrier angle $\omega t + \phi \sin \omega_1 t$ which accounts for modulation only is $\phi \sin \omega_1 t$. Moreover, we have just found that it is the rate of change of this expression which determines the frequency deviation of the carrier, hence

$$\begin{aligned} 2\pi\Delta f &= \frac{d(\phi \sin \omega_1 t)}{dt} = \omega_1 \phi \cos \omega_1 t \\ &= 2\pi f_m \phi \cos \omega_1 t \\ \Delta f &= f_m \phi \cos \omega_1 t \quad (t = 0 \text{ for } \Delta f_{\max}) \\ \Delta f &= f_m \phi \end{aligned} \quad (3)$$

where $\omega_1 = 2\pi f_m$
 f_m = modulating frequency
 ϕ = angle in radians

Circuit Operation

A simple circuit for performing this type of modulation fundamentally is shown in Fig. 1. Elements C_1 and L_1 are the crystal-oscillator plate-tank components adjusted for oscillation in the usual way. The circuit $L_2 C_2$, inductively coupled to the oscillator tank, is adjusted so that it acts capacitively. For example, if the phase shift produced by C_1 and L_1 while loaded with $C_2 R_1$ and the distributed input values of Mod No. 1 could be made plus 45 degrees, and that from $L_2 C_2$ in turn made minus 45 degrees by detuning for higher inductance, then the potential on Mod No. 1 would be 90 degrees out of phase with respect to that of Mod No. 2 (Fig. 1). Now if these tubes (12SA7's) are differentially (push-pull)

amplitude modulated at their No. 3 grids by an a-f input indicated so that the r-f in the No. 1 grids can be used in inverse degrees, $C_6 L_3$ will alternately be driven with the r-f component from the grid of one of the 12SA7 modulators and then the other. During one-half of an audio cycle, the utility of the r-f energy in the modulator grid circuits will be transferred from one 12SA7 to the other and 90 degrees of r-f phase will be gained or lost depending on the instantaneous polarity of the a-f. The modulation process will bring about a smooth transition of energy from one source to the other.

The mechanism of this type of modulation is shown in Fig. 2. The designation e_1 refers to the carrier component entering the grid of Mod No. 1 (12SA7) of Fig. 1 and e_2 is the wave entering the other

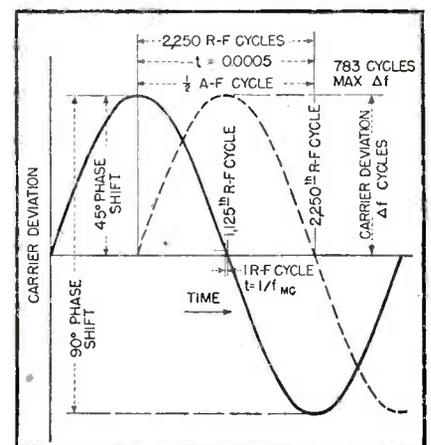


FIG. 3—Determination of frequency deviation produced by modulator

12SA7 modulator grid. Each cycle of e_1 is marked off and its period T_1 is constant. Likewise e_2 has a constant period T_2 and throughout the entire range of e_2 it is lagging e_1 by exactly 90 degrees.

Now e_1 is decreasing in amplitude due to amplitude modulation, while e_2 is increasing in amplitude. The sum of these two waves is designated e_3 . This sum-wave (dotted curve Fig. 2) appears in C_6L_3 of Fig. 1. Note in Fig. 2 that as the amplitudes of e_1 and e_2 change inversely the sum-wave e_3 is actually changing frequency. Its frequency is lowered by the ratio of $(\Delta T_1 + T_1)$ to T_1 . It appears to be changing phase with respect to e_1 . If this process can be made to take place fast enough, a considerable frequency change can be brought about. To understand how a phase shift amounting to a fraction of an r-f cycle can bring about many hundreds or even thousands of cycles deviation, it is important to note carefully that only one-half of one a-f cycle from positive to negative peak is shown in Fig. 2.

Frequency Deviation

We must produce all of the r-f frequency change or deviation from the carrier in the time consumed by one-half of an a-f cycle just as we must achieve all of the amplitude change from peak to peak of the a-f cycle in this time. An example of the conditions actually used may serve even better to explain the phase modulation.

With a carrier of 4.5 mc and an a-f of 1,000 cycles, in 1/2000th second we must obtain 90 degrees of phase shift between the two carrier components derived from the oscillator. In this time there will occur 4,500,000/2,000 or 2,250 r-f cycles. At the middle or 1,125th r-f cycle the maximum deviation will occur.

There will be 45 degrees r-f phase shift at the middle cycle covering 90 degrees of the a-f cycle. Thus the maximum phase shift per r-f cycle to quite a high degree of accuracy will be

$$\begin{aligned} \Delta f &= 45 \sin(90/1125)^\circ \\ &= 45 \sin 0.08^\circ \\ &= 0.06264^\circ \end{aligned}$$

Figure 3 shows the conditions involved here. Because these values are given in degrees, it is obvious

that if the time of one cycle is measured by 360 degrees that the time of this cycle in question is longer by 0.06264 degrees and the ratio of 360 to 360.06264 is 1.0 to 1.000174. Multiplying 4.5 mc by this figure we obtain 4.500783 mc showing that the carrier has deviated 783 cycles from 4.5 mc. From Eq. 3 it is clear that the deviation is proportional to the a-f times the total angle of phase modulation. For example with 1,000 cycles a-f and a total phase shift of 90 degrees or $\pi/2$ radians, from Eq. 3 we have $1,000\pi/2$ or 1,566 cycles total deviation of which 783 cycles or one-half of this is the deviation in one direction from the carrier. Thus by this process of rapidly shifting phase, it is possible to change the frequency considerably.

The method of modulation of the 12SA7 modulators from the amplitude viewpoint in Fig. 1, is not important except that it must be as linear as possible and as near 100 percent as possible if the advantages of total phase shift are to be realized. Grid modulation using converter tubes such as the 12SA7's shown in Fig. 1 provides a good means although 100-percent modulation may not always be realized. Plate modulation would seem effective although more apparatus is required and the circuit is thereby made more complex.

Because the r-f phase-shift rate

and hence the deviation of the carrier is dependent upon the a-f, the degree of modulation must be made inversely proportional to the a-f if a constant bandwidth is desired. A network for accomplishing this was found unnecessary however and was not used. Because the transient noise components are largest in the upper part of the a-f band the modulation factor (ratio of carrier deviation to a-f) being constant, the noise will be attenuated more than it otherwise would be. Audio correction can be made easily in the a-f system of the receiver.

Practical Circuit

Although the circuit of Fig. 1 is useful for explanation it is not a practical circuit. Adjustment of the phase-splitting circuit L_2C_2 would affect the operation of the oscillator. Every time the oscillator is adjusted, the phase between the grids of the 12SA7 modulators is altered. Out of several circuits tried, a final design was chosen. It is shown in Fig. 4. In this circuit, the oscillator may have any phase suitable for oscillator tank components C_1 and L_1 .

Using the output voltage at C_2 as a reference, components are fed through resistors R_1 and R_2 to two individual tank circuits L_2C_3 and L_3C_4 . The shunt impedances of these tank circuits unloaded are approximately 80,000 ohms at resonance

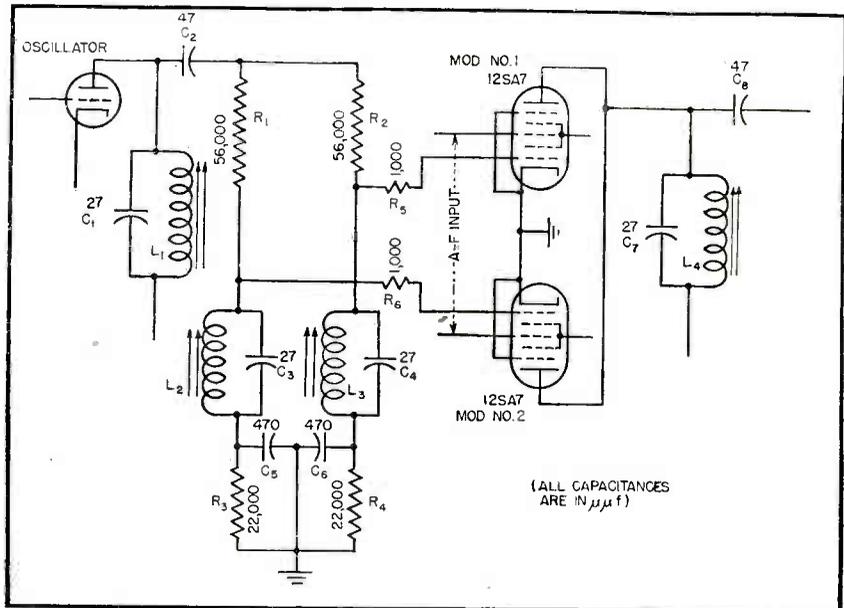


FIG. 4—Actual phase modulator circuit as used in railroad communication equipment

and they lose about 30 percent of this value when displaced 45 degrees in phase by tuning. Values of R_1 and R_2 up to 560,000 ohms were found quite successful, but lower values made adjustment of L_2 and L_3 less critical and suitable for a fair degree of oscillator frequency range without readjustment. In addition, the grid driving voltages into the phase modulators were increased to a more practical degree through a more favorable voltage division between the series resistors R_1 and R_2 and the tuned circuits.

The grid drive must be just adequate to produce a vector sum in the plate circuit C_1L_1 , sufficient to drive the following tube. More than this amount of drive makes grid modulation less effective in the limited grid range for a-f. Values of 56,000 ohms for R_1 and R_2 were found satisfactory. Capacitors C_3 and C_1 are large enough (27 μmf) so that the modulator tubes can be replaced without readjustment of L_2 and L_3 and to provide ready compensation for distributed capacitances. Bias and bypass components are conventional.

Because the driving power was more than enough for the purpose, it was found more practical to use grid or plate suppression of self-oscillation than any form of neutralization. Grid suppressors R_5 and R_6 are shown in Fig. 4 and are adequate for the purpose. Inductors L_2 and L_3 can be adjusted with an oscilloscope and set for the life of the equipment. They are set at the r-f grids of the phase modulators for the most perfect circle obtainable (showing 90 degrees phase difference between the r-f components fed to the grids). Phase modulation can be observed and the actual angle of modulation measured by attaching the vertical and horizontal free oscilloscope plates to C_2 and C_3 , and adjusting L_1 for a straight diagonal line in the absence of modulation. Modulation will open the line into a family of ellipses the limits of which will be an index of the angle of phase modulation. Ninety degrees phase modulation will be indicated when the major axes of these ellipses are four times the lengths of their minor axes and their major axes

are 45 degrees from each other in their limiting positions.

Linearity Calculations

The oscillator frequency was arranged to be multiplied 36 times to the vhf output of 152 to 162 mc to take advantage of the phase modulator and have a deviation of approximately 30-kc total at the carrier output. For overall modulation angles in the neighborhood of a radian, the overall distortion was

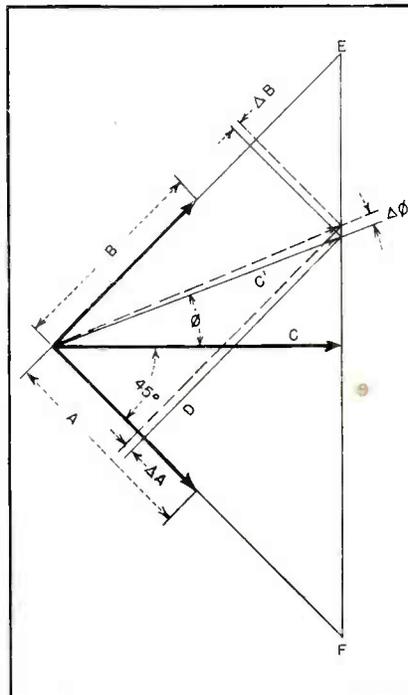


FIG. 5—Vector analysis of modulator linearity

found to be about 9.5 percent so the following calculations were made to determine the distortion inherent in the phase modulator for 90 degrees total phase shift (approximately 1.5 radians).

Figure 5 shows vector grid components A and B 90 degrees displaced, and a sum vector C . Linear amplitude modulation of A and B will subtract an increment ΔA from the A vector and add an equal increment ΔB to the B vector at any arbitrary point in the a-f cycle simply by definition of linear modulation. These increments will produce a phase shift $\Delta\phi$ of the sum vector. Line EF is the locus of all positions of the sum vector C limit, and by geometry, any increment such as ΔA will intersect propor-

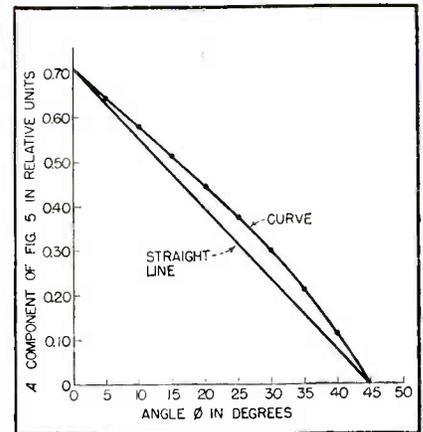


FIG. 6—Curve shows degree of nonlinearity in modulator circuit

tional increments along EF . The angle $\Delta\phi$ however, will vary throughout the distance EF . From Figure 5, it may be seen that

$$\frac{C}{C'} = \cos \phi \quad (5)$$

$$\text{and } \frac{A}{C'} = \cos(\phi + 45^\circ)$$

$$\text{or } A = C' \cos(\phi + 45^\circ) \quad (6)$$

Substituting Eq. 5 in Eq. 6

$$A = \frac{C \cos(\phi + 45^\circ)}{\cos \phi} \quad (7)$$

Equation 7 gives us a true expression of A in terms of ϕ and constants. Plotting A in relative units against ϕ ($C=1$) between zero and 45 degrees for ϕ , we obtain the curve shown in Fig. 6. This curve shows that within 90 degrees total phase shift the proportionality between A and ϕ is fairly good. The distortion resulting from this much curvature is directly related to the area between the curve and the straight line as compared to the total area under the curve. This was roughly estimated at 9 percent which checks well with actual measurement. At the low-level point where phase modulation is accomplished other sources of distortion are very low, less than one percent by measurement.

It is interesting to note that if modulation makes A or B of Fig. 5 more than double, the phase change abruptly stops. An analysis was made on this same basis of the distortion conditions for a total phase shift of 120 degrees and the distortion was estimated at about 43 percent which is, of course, prohibitive for intelligibility using ordinary communication techniques.

Electronics in the CATERPILLAR TRACTOR PLANT

Personnel safety, reduced maintenance costs, improved quality and increased production tempo are a few of the advantages for a manufacturer using electronic methods intelligently

ELECTRONIC DEVICES

Coil-Winding Speed and Direction Control
Crankshaft Finish Grinder Control
Induction Heater (brazing)
Magnetic Chuck (rotary table grinder)
Annealing Oven Feed and Discharge Control
Flame-Failure Protection Devices
Multiple Temperature Recorders
Fuel Proportioning Control
Intercommunicators
Diathermy (infirmary)
Automatic Welder Controls (track rollers)
Seam Welder Controls (fuel tanks)
Nonoxidizing Welder Controls (seams)
Crankshaft Balancer
Mass Spectrograph
Spectrum Analyzer
Microphotographic Controls
Power-Factor Corrector
Air-Cleaner
Safety Device for Spectrometer
Cathode-Ray Oscilloscopes
Oscilloscope Preamplifiers
Cathode-Ray Tachometer
Oscilloscope-Trace Time Marker
D-C Amplifier
Continuous-Graph Ink Recorder
Torsion Tester for Crankshafts
Synchronous Sweep Generator
Photoelectric Timing Mark Generator
High-speed Cameras
Stroboscopes
Strain Indicators
String Oscillograph
Oscillator
Frequency Meter
Sound Analyzer
Vibration Analyzer
Sound Level Meter
Safety Device for Hydraulic Press
Sequence Timer for Machine Operation
Moisture Meter (lumber)
Surface-Roughness Tester
Comparator Gage
Insulation Tester
Tube Tester
Voltage Regulator

THE Caterpillar Tractor Company manufactures Diesel tractors, motor graders, bulldozers, scrapers and other earth-moving equipment as well as Diesel engines for industrial, marine and electric power use.

The main plant, in East Peoria, Illinois, employs 20,000 men and women who are engaged in every phase of a manufacturing process that turns raw metals into thundering prime movers. About 550 people work in the research department, 475 of them on the grounds occupied by the manufacturing plant but apart from it physically and in purpose. While a certain amount of life testing is carried on, the principal emphasis is placed on the purely research aspects of developing better Diesel engines and associated equipment,—gears, crankshafts, and bearings that are necessary to improve the product.

Electronic Methods

In common with other progressive but practical industries, this company has little interest in electronic devices as such, but uses electronics whenever the technique does a job better or cheaper than other methods.

In the factory, many packaged units of conventional manufacture are permanently installed as a regular part of the production line machinery. In addition, a number of other devices, manufactured by the maintenance department from parts at hand are in regular daily use.

The research department, although using a large number of packaged electronic units, is, by the

nature of its work, likely to rig up temporary combinations of equipment, some purchased, some fabricated in the laboratory, in such a manner as will serve a given short-term experiment to best advantage. To this end, a regular cataloged stock is maintained consisting of resistors, capacitors and meters, and over 75 different tube types.

Although many of the research engineers and physicists encounter no difficulty in developing and using electronic testing techniques, it has been thought advisable to add to the staff a full-time electronics engineer who is available for consultation with other members and designs new testing equipment for more exacting research.

Temperature Controls

For temperature recording and control of heat-treating processes there is no substitute for electronic means that will maintain temper-



FIG. 1—Portion of temperature graph from a heat-control unit. For this particular application, a variation of 4 degrees each side of 1060 is tolerated when the oven has come up to temperature



Airplane view of the East Peoria plant of the Caterpillar Tractor Company. The business section of Peoria is seen across the Illinois River

ature within the required narrow limits.

A large number of drawing furnaces in the plant require different types and degree of control together with a continuous graph of temperature. Packaged units manufactured by two different companies are used, although some of these have been modified in the plant. All these equipments operate on varia-

tions of the bridge principle wherein unbalance is indicated by a pen or stylus making a lateral movement of its trace on a vertically moving continuous strip of graph paper such as that shown in Fig. 1. This same deviation from a balance point, corresponding to a desired temperature, can be translated into counteraction of a fuel valve to maintain the temperature within either a few degrees or even within a fraction of a degree. Earlier models of commercial equipment have been modified so that a single recording and control mechanism can be switched from one oven to another. Each trace is then made up of a series of dots and dashes with a means of identifying the different traces. Later commercial equipment for multiple control prints the trace number in small but legible characters beside each point. Motorized positioning

controls connected to the recorder through a selector switch adjust the flow of gas.

Flame Failure Protection

Another important consideration in heating equipment using gas is the danger of flame failure. If it were extinguished even momentarily and the flow of heating gas continued, an explosion might occur that would injure personnel and damage equipment.

Such an untoward event is effectively guarded against by a combination of controls. A pilot flame in the oven is kept burning at all times so that no appreciable amount of unburned gas can accumulate. In addition, conductivity through the pilot flame maintains a negative bias on the grid of an electronic control tube, connected to an emergency gas shutoff valve. If the pilot flame fails for an instant, the bias is removed from the tube, current flows through a relay in the plate circuit, and gas flow stops. It can not be restored until the heating

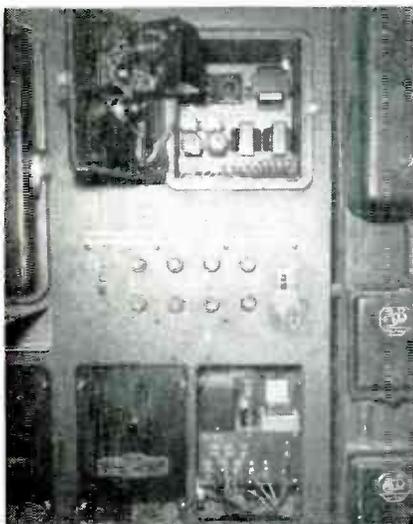


FIG. 2—Continuous temperature control associated with graphical recorder is shown at top. Lower section of draw-furnace panel carries electronic flame control safety equipment

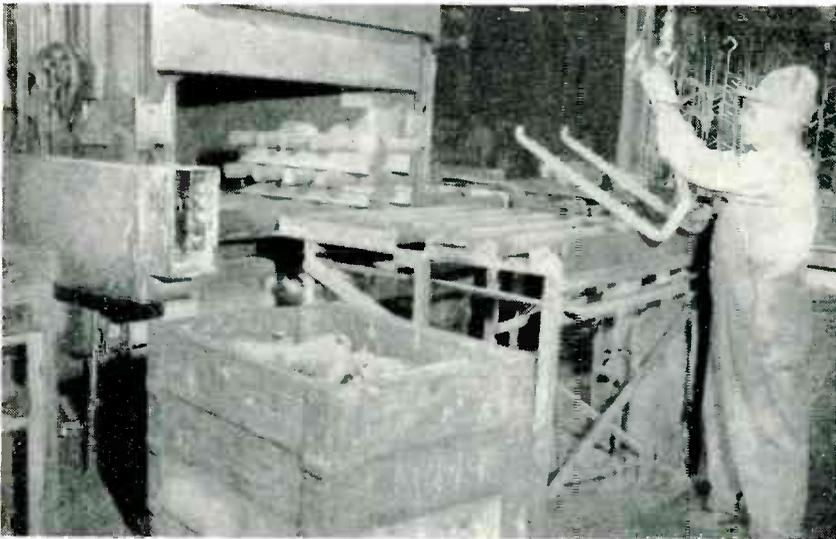


FIG. 3—Discharge end of heat-treating oven with material emerging. Photoelectric devices open oven doors and speed rollers as charge nears end of journey. At the same time, doors at the other end open to receive a new charge

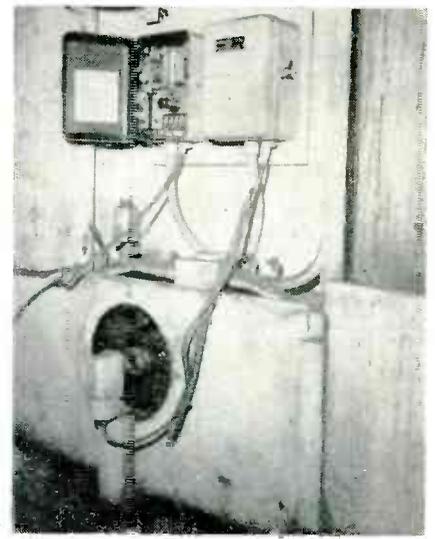


FIG. 4—Phototube electronic control equipment used in opening and closing doors of heat-treating oven

apparatus is recycled by relighting the pilot and biasing the flame control tube. Packaged units are shown in Fig. 2.

Continuous Drawing Oven

By extension of the electronic techniques for control and safety, it has been found practicable to build a drawing oven for heat treating that requires only the racking up of material at one end as it comes from one manufacturing process and lifting it off at the other with a compressed air hoist, as shown in Fig. 3, as it emerges. All intermediate steps are cared for by electronic controls.

The oven is 100 feet long and is kept at a temperature such that the material moving through at a specified rate receives the proper treatment. Transit is accomplished by mounting the material on rails or bars that move easily across revolving rollers. As the rails reach the far end of the oven they interrupt a beam of light that is sent from a lamp at one side of the oven through a window to a phototube at the opposite side as illustrated in Fig. 4. Relays and contactors then set into motion the machinery for raising the guillotine doors at both the charge and discharge ends of the oven. At the same time, the apertures are screened by a gas reducing flame that prevents an undue amount of oxygen from entering, and the last few rollers at both ends are speeded up so that the material

is discharged quickly onto an un-driven-roller platform. As the new charge passes the opening at the incoming end, a light beam at that end is broken, the gas flame is reduced to a minimum and the guillotine door closes. Since the action is automatic, the process requires only relatively skilled operators at each end to charge and discharge the oven.

Welding Controls

A number of production welding operations in the plant require specialized equipment. Among these

are a commercial seam welder for fabricating fuel tanks. Two tanks at a time are handled by this machine in which the previously formed sides are butted together and clamped in proper position on the welder. The operator throws a switch and fluxed welding rod is unreeled at a proper speed, arc current is maintained at the proper value and the welding rod carriage moves along at a speed that is also determined electronically.

Another type of straight-line welder, shown in Fig. 5, is less formidable in size and works in

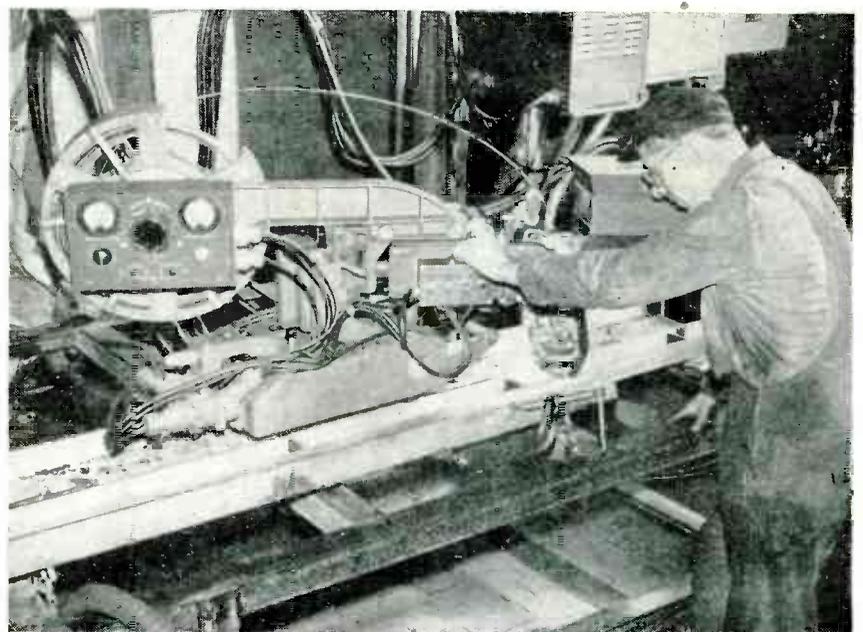


FIG. 5—Seam welder controls are mounted on carriage and connected by cable with electronic equipment in box over operator's head

such a way that it minimizes oxidation. A small unit moves along a track with the power and electronic controls connected to it by cable. Meters and control switches are mounted on the carriage. A hopper filled with flux and a blanketing material resembling sand maintains a flow to cover the arc at all times. The proper proportioning of current, speed of movement and welding-rod feed is electronically maintained.

Still another type of welder is used for joining the hubs of two flanges together to form the rollers used in carrying the tracks of diesel tractors. A three-position revolving jig is arranged so that while one roller is being welded another is in position for heating by a gas flame and the third position of the jig is available for a new pair of flanges to be affixed. Each position rotates continuously. In the welding position, electronic controls apportion the proper current while fluxed rod is fed down from a large reel overhead that contains an 8-hour supply.

Safety Devices

Electronic controls are used as safety devices to prevent the operation of equipment during periods when material is being introduced or when preliminary adjustments are made. Two examples of this technique are given below.

A hydraulic press illustrated in Fig. 6 is controlled by two switches so that the operator must theoretically operate a switch with each hand in order to start the machine. However, since it is not impossible to operate the switches by means of a hand and an elbow, a photoelectric device has been added to give a maximum of protection. It consists of a light beam that must be unbroken before power can be turned on. In the photograph, the light beam entering the invisible maze from the left is reflected four times, making a total of five paths that must remain unbroken before the punch can be operated and which will instantly stop the punch if broken. The four mirrors shown have since been replaced by two mirror strips, one on each side of the operating position, so that an extremely intricate maze is developed by multiple reflections between the mirrors.

Another unique instance of personnel protection is a metal-mesh screen placed above the sparking section of a mass spectrograph used in the analysis of metals. Because of the high potentials involved in producing the spark it is extremely desirable to afford the operator a measure of protection. A black box contains electron-tube circuits such that a change of capacitance in the grid circuit of the first tube initiates an impulse that

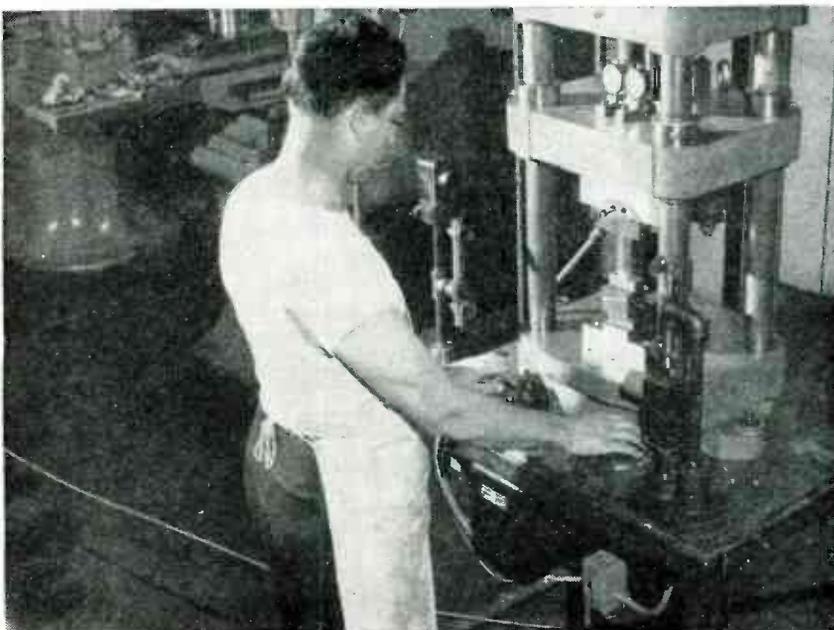


FIG. 6—Hydraulic press protective device. The equipment stops if the light beam reflected back and forth by four mirrors between source and phototube is broken



FIG. 7—Complete control equipment for crankshaft grinder. Vacuum-tube section occupies left-hand bay

is amplified in following tubes to cut off high voltage from the semi-exposed terminals. The mesh screen serves as one plate of a capacitor, the spectrograph serves as the other, and the operator's body acts as a change in the dielectric, throwing the capacitance to another value. So long as he is near the equipment the operator can not turn it on.

Crankshaft Finishing

An otherwise difficult operation of finishing crankshafts and balancing them has been eased by electronic circuits. The finish grinding is done on a commercial machine in which the grinding wheel is driven by an a-c motor but the crankshaft itself is revolved at the required speed by an electronically controlled d-c motor. The control equipment pictured in Fig. 7 uses 14 tubes about equally divided between the so-called industrial and communications types.

After the grinding process, each crankshaft is balanced in a machine designed to indicate by means of simple dial readings the crankshaft angle at which unbalance occurs and the amount of unbalance at this point. The equipment is operated from a-c but the shaft is rotated by means of a d-c motor. Four industrial type tubes are used to operate the motor directly, but eight communications types handle the off-balance indication. By means of this versatile and accurate ma-

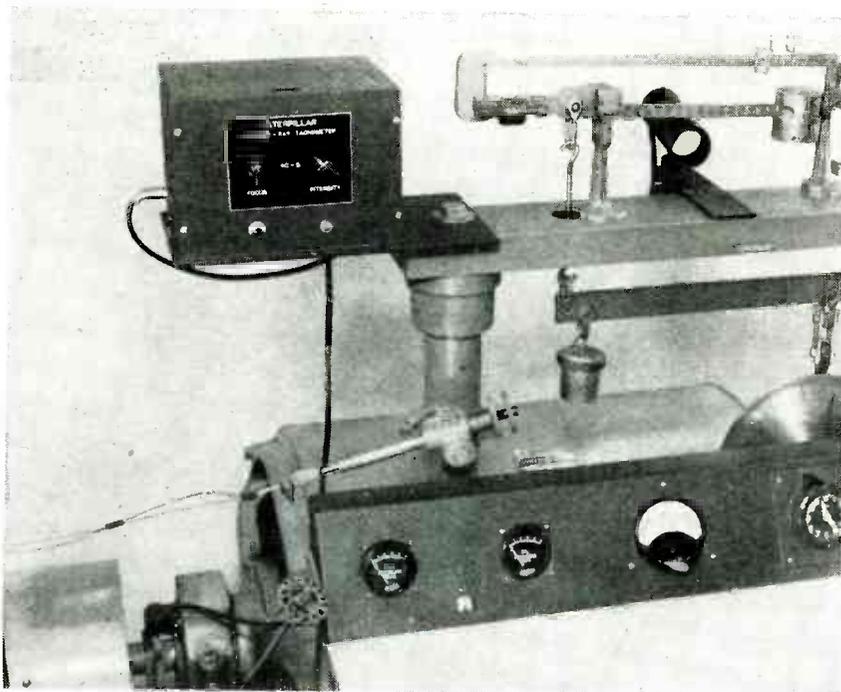


FIG. 8—Cathode-ray tachometer. Pickup and cam mounted on shaft of dynamometer at lower left. The viewing tube at the upper right can be swiveled into almost any position

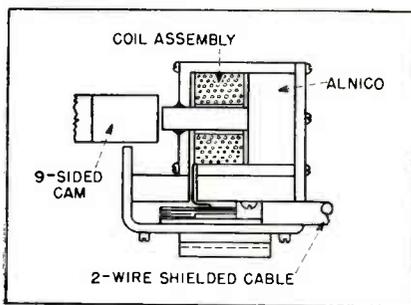


FIG. 9—Detail of the cathode-ray tachometer pickup and its relation to the cam. The coil is wound with several thousand turns of fine wire

chine, a skilled machinist is able quickly to check a crankshaft, remove it to a drill press nearby, drill out a small amount of metal from the appropriate point to obtain balance, return the crankshaft to the balancing machine and recheck it under the changed conditions.

Cathode-Ray Tachometer

A typical laboratory device is the cathode-ray tachometer used in maintaining constant engine speed under test conditions. It is frequently desirable to obtain data on the performance of new engine parts or techniques which, if continued many minutes would result in the destruction of equipment. Ordinary mechanical tachometric devices often lack the necessary long-term accuracy and in any case require an appreciable time of ob-

servation in order to integrate slight speed variations.

The cathode-ray tachometer to be described is limited in the number of definite speeds it can accurately indicate, but gains in simplicity and suffices for all practical purposes. A small metal cabinet shown in Fig. 8 and containing only intensity and focus controls is bolted to the standard dynamometer test bench, out of the way but access-

ible. The 2-inch cathode-ray indicator tube is mounted in a ball-and-socket joint so that it can be swiveled into any position convenient for observation by either the operator at the test bench or an assistant working on the other side of the engine. The pickup illustrated in Fig. 9 is mounted near the dynamometer bearing housing close to a 9-sided cam attached to the shaft. Two pole pieces at right angles to each other, one near the periphery of the cam and the other near the side form a closed magnetic circuit, the flux density of which is affected by rotation of the cam. Output from the pickup is fed through a 2-wire shielded microphone cable to the amplifier.

Placement of the pickup is not critical. The overall gain of the system is adequate to permit speed measurements on tiny motors using the slight nonuniformity of the

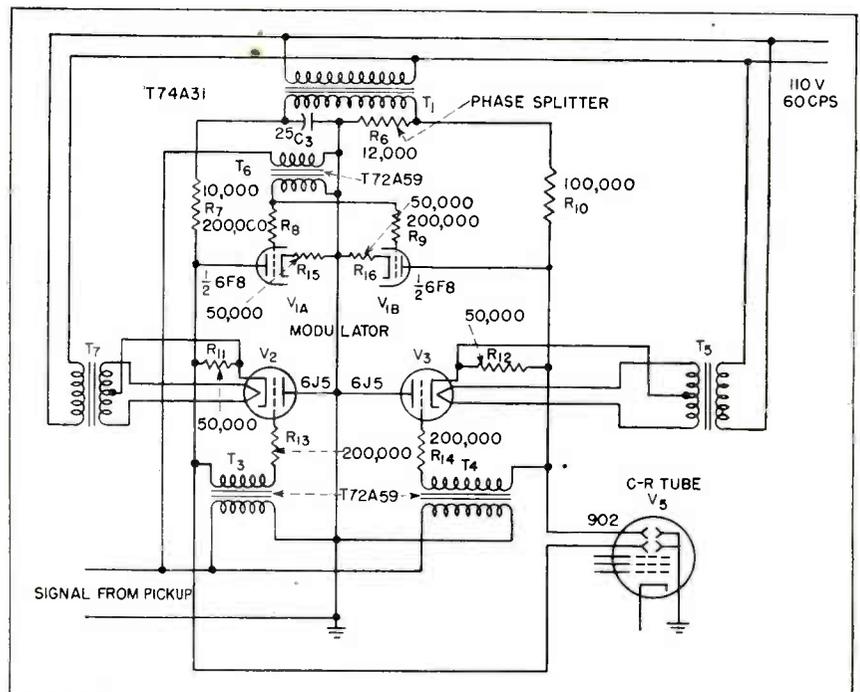


FIG. 10—Schematic circuit diagram of the cathode-ray tachometer

shaft, owing to flattening or a key-way, as the variable element in the magnetic circuit.

Making use of the fact that the 60-cps power line frequency is controlled to very close limits, the electronic circuits of Fig. 10 provide a circular pattern on the oscilloscope resulting from the phase-splitting circuit C_s, R_s across the secondary of step-up transformer T_1 . The approximate sine wave generated in the pickup is simultaneously coupled through transformers T_0, T_2 and T_3 into V_1, V_2 and V_3 in such a way that at the same instant V_{1A} and V_3 are conducting, whereas on the next half cycle, V_{1B} and V_2 conduct.

Since conduction through the tubes results in a decrease in voltage fed to the deflection plates of the cathode-ray tube and since the action occurs in a way to reduce the voltage on opposite plates at the same instant, the static circular pattern is modulated into a form containing one or more petals, or bumps. The shape of the bump is not critical and depends to a great extent upon the form of the cam inducing the pickup voltage. Since the line voltage corresponds to 3,600 rpm and the cam has 9 faces, each bump on the circular trace indicates a speed of 400 rpm, or with a 2-line pattern each bump represents 200 rpm.

Highest speed that can be easily read on the present equipment is 2,400 rpm (12 bumps), adequate for relatively slow-speed Diesel engines. Speeds intermediate between the 200-rpm increments are indicated qualitatively by a revolution

of the notched trace. While it is seldom necessary to run at intermediate speeds, the ordinary tachometric equipment can then be used with 200-rpm points calibrated against the electronic tachometer.

In one test, the position of a fuel-pump plunger is accurately measured by a micrometer. The test operator checks the position by screwing the micrometer in until fuel begins to be reduced. This slowing down because of reducing fuel is immediately apparent using the cathode-ray tachometer and the operator can quickly back off the micrometer without sensibly affecting the test.

Dual-Gun Oscilloscope

Electronic techniques are mandatory for economical and accurate recording of data involving simultaneous observation of several phenomena. The dual gun oscilloscope and associated amplifiers illustrated are used in a fuel testing setup in which photographic recordings are made of pressure, fuel injection needle motion, flame intensity, and the pressure of nitrogen fed into the precombustion chamber of a Diesel engine. The interconnections are shown in Fig. 11.

A visual indication is given showing the position of the flywheel at the same instant that a mark is placed on the photographic record. The significant portion of the record is initiated by means of a crankshaft commutator that flashes a light to indicate the position of the engine shaft. This flash is

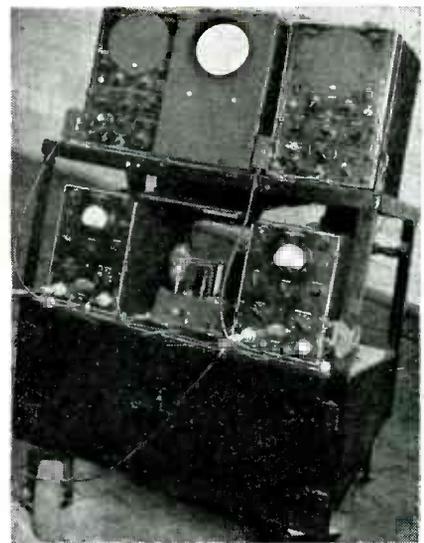


FIG. 12—Dual-gun cathode-ray oscilloscope, with two amplifiers and marker mixer on lower shelf.

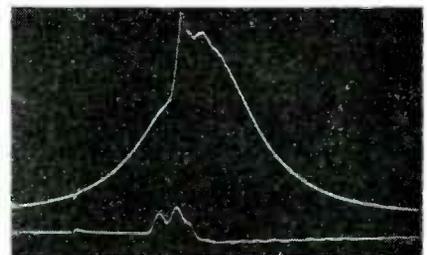


FIG. 13—Pressure curve from diesel engine precombustion chamber is shown on upper trace, with fuel injection needle motion shown below. A single shaft-angle mark appears on both traces

picked up by a phototube and fed into an input of a four-channel mixer. The mixer and its power supply are shown between the amplifiers on the lower deck of the equipment dolly in Fig. 12. Pressures and fuel valve needle position are continuously photographed. Other varying functions like flame intensity are observed by a second phototube. Signals are fed through appropriate amplifiers into the modified oscilloscopes and then into the double-gun tube. A representative record showing only two elements and a single shaft-angle mark is illustrated in Fig. 13.

Acknowledgment

The assistance of E. W. Landen, Gordon Monfort, Jerry Reichart, C. R. Schad, S. J. Schmidt and George Walters in the collection and review of the material from which this article has been written is gratefully acknowledged.

—A.A.MCK.

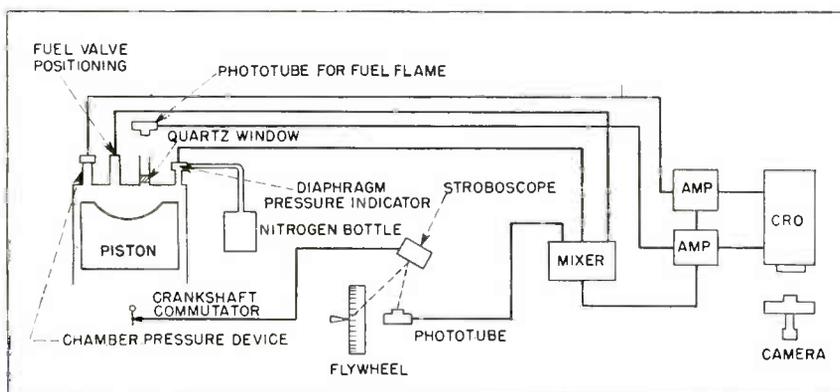


FIG. 11—Block diagram showing electronic equipment setup for engine test. Fuel-valve position is converted to a variable voltage as is diaphragm pressure. Fuel flame is viewed by a phototube. A high-speed camera photographs the traces on the dual-gun oscilloscope

Power MICROWAVE

By **OLIVER HOAG**

*Project Engineer
Research Laboratories
Sperry Gyroscope Co., Inc.
Garden City, N. Y.*

ient and simple, with a minimum number of controls.

(4) The supply should be fully protected for the safety of the operator and of the tube under test.

(5) To be useful for medium and high-power tubes, voltage and current range should be wide.

Present Circuits

The common inverse-feedback regulator circuit can be designed to give the required regulation at low voltages. However, at higher voltages more glow-discharge, voltage-regulator tubes for the reference voltage are necessary. For an output of 5,000 volts, approximately 31 type OD3/VR150 tubes would be needed. Furthermore, most voltage-regulator tubes have small spasmodic variations in the order of 0.1 to 0.5 volt.¹ Because even the finest voltage-regulator tubes have some spasmodic variations, the chance of a voltage shift is multiplied by the number of voltage-regulator tubes in the string, and any changes that do occur will appear in the output. Such disturbances can be observed in the output of all high-voltage regulators, and can usually be traced to the VR tubes.

Conventional low-voltage regulator circuits usually include some kind of compensation for input voltage variations but satisfactory compensation is not possible when the number of VR tubes in the circuit is changed frequently.

Another objection to a power supply using many VR tubes is the number of controls necessary for its operation. Three adjustments must be made for each voltage setting; a coarse tap-switch control, a transformer primary voltage adjustment to put the correct voltage across the

regulator tube, and a fine control setting.

Automatic System

This paper describes a voltage regulator system of four main parts, meeting all five requirements of a high-voltage supply for laboratory use. The output is smoothly and continuously variable from 300 to 5,000 volts or higher, using one knob.

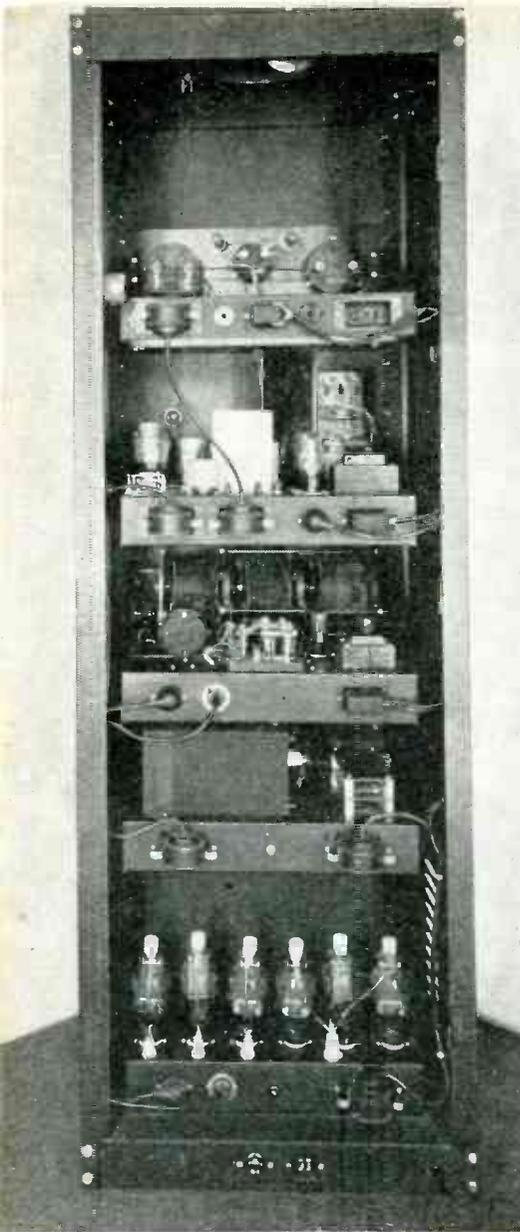
While designed for laboratory use on microwave oscillators and amplifiers, the characteristics of this regulated supply are such that it should prove useful for many other applications requiring high voltages with good flexibility and regulation, provided the positive output can be grounded.

Control Circuit

The block diagram in Fig. 1 shows the four essential units. The servo-transformer unit consists of a three-phase autotransformer to vary the primary voltage of the high-voltage transformer (and thus the d-c input of the electronic regulator), a reversible servo motor geared to the autotransformer, and a control circuit.

The operation of the control circuit can be seen by reference to Fig. 2. The regulator-tube voltage appears across the divider R_1 , R_2 , R_3 . The voltage appearing across R_1 is compared with the independent plate supply and the difference is the bias for V_1 , the left-hand section of the double triode. Similarly, the difference between the voltage appearing across $R_1 + R_2$ and the plate supply is the bias for V_2 , at the right. The value of this voltage is greater than that applied to V_1 .

With normal regulator-tube voltage, V_1 conducts and V_2 does not.



Chassis of the high-voltage power supply. From the top down: meter panel, regulator and control panel, servo transformer, filter, and rectifier

DUE to recent trends toward high frequencies, power supply requirements have become more stringent. In microwave equipment, operating voltages must be extremely stable to maintain necessary frequency stability. This is particularly true in the case of laboratory equipment.

The requirements for an adequate voltage supply in the laboratory operation of the majority of microwave tubes are:

(1) It should have excellent regulation for line voltage fluctuation, less than five millivolts of ripple, and efficient control for load current fluctuation.

(2) The output voltage should be smoothly variable without steps through the entire voltage range.

(3) Operation should be conven-

Supply for EQUIPMENT

Continuously variable from 300 to 5,000 volts, the voltage-regulated power supply described utilizes an electronically controlled servo motor to automatically adjust an auto-transformer. The d-c output of the device has less than three millivolts ripple at all voltages

Then the contacts of both relays are open and the motor is not operating. As the regulator-tube voltage becomes lower, the V_2 bias becomes less negative, and this tube conducts, energizing the RAISE relay. The bias of V_1 is also decreased, but since V_1 was already conducting, the change has no effect on the LOWER relay. Thus, the motor operates to restore the regulator-tube voltage, until the restored voltage cuts off V_2 .

When the regulator-tube voltage becomes too high, the increased V_1 bias cuts off tube V_1 . This de-energizes the LOWER relay, thereby closing its contacts to operate the motor to lower the voltage to normal.

The normal voltage bandwidth can be adjusted by R_2 . Its centerpoint is set by R_3 . This servo control is necessarily a discontinuous type⁹ because a primary voltage correction should be made only when the regulator tube is getting too near the limit of its ability. Narrower bandwidth is not desirable.

Before power is applied to the transformer, or before the 6SN7GT is warm, the relays are in a position to lower the autotransformer. The failure of either the 6SN7GT or the 5Y3GT tube would result in a lowering of the transformer primary to zero. Thus this control circuit is inherently safe. This servo-transformer arrangement can be made to work with existing regulator circuits as well as with the one described.

Rectifier and Filter

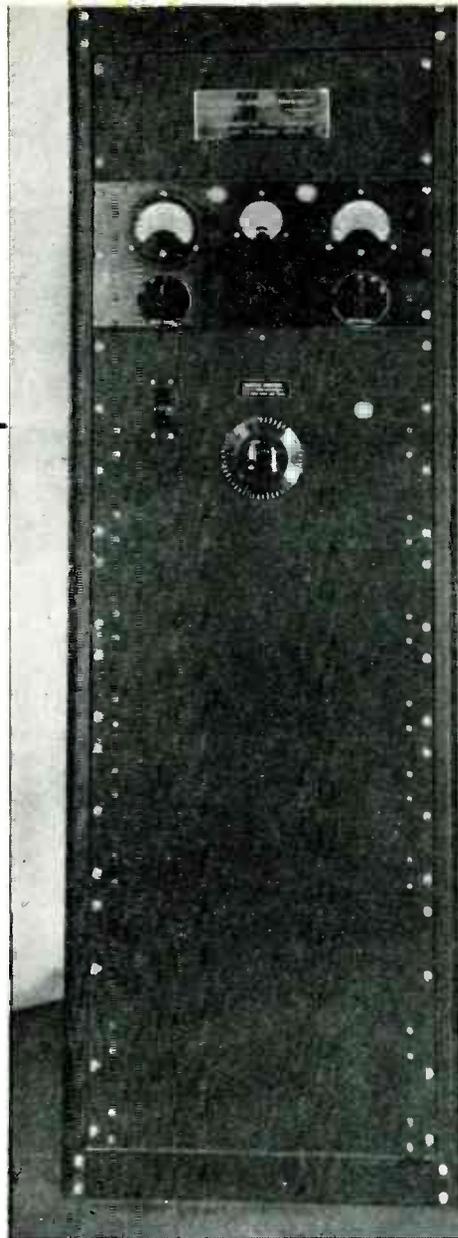
The rectifier of Fig. 1 is a conventional six-phase single-Y circuit

with delta primary. The primary is rated at 208 volts, 60 cycles. The filter requires some special consideration because neither the positive nor the negative lead is grounded. Instead, the positive output after the regulator must be grounded in most microwave work. Since the positive output is not common with any lead in the filter, the latter must float with respect to the ground. This would interfere with the filtering action and produce spikes too large to be corrected by ordinary regulator tubes. Figure 3 shows how the filter is bypassed in a way to eliminate the spikes caused by the distributed capacitances in the transformer. High alternating voltages are bypassed to ground through each 0.1 μ f capacitor.

Regulator Circuit

The circuit of Fig. 4 shows an inverse-feedback regulator with some fundamental changes. To eliminate the long string of voltage-regulator tubes employed in older regulators, an independent regulated auxiliary voltage source is used. This serves two purposes; first, it supplies the reference voltage and it is extremely stable and constant; second, it is a constant plate supply for the regulator's direct-coupled amplifier.

The reference voltage is compared in the right-hand section of the 6SL7GT to that appearing across R_1 . The difference is the signal which, when greatly amplified, drives the 6B4G regulator tubes. The auxiliary voltage source is constant for all output voltages.



The power supply in its cabinet. The master control provides both coarse and fine adjustment by taking advantage of the slack in the gear train

When the regulator is operating at high voltages, $R_2 = 12 \times R_1$ and the magnitude of the d-c signal is reduced by the factor $R_1/R_1 + R_2$ or 1/13. At lower output voltages, this factor approaches unity. Actually, however, the gain of the amplifier (estimated to be greater than 15,000) is so large that this voltage division becomes negligible. Furthermore, the capacitor C_1 increases the factor to nearly unity for rapid changes in the divider by effectively shunting R_2 .

Because of the high gain, the regulator has a strong tendency to oscillate, but the addition of capacitor C_2 across the output prevents the over-compensation caused by the high gain. The stabilization ratio is defined as dE_o/dE_i , where E_i is the voltage applied to the regulator and E_o

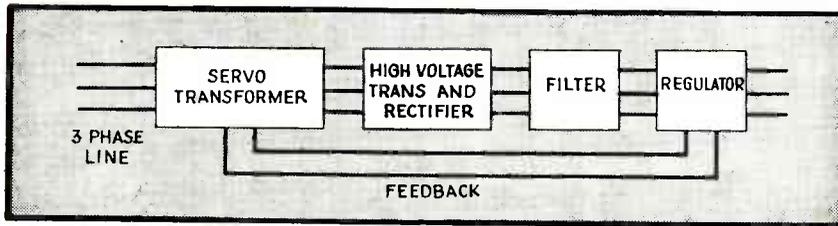


FIG. 1—Essential elements of the voltage regulator

is the regulated output. Although difficult to measure accurately, this ratio of the changes in voltages is estimated to be over 10,000.

Assuming the reference voltage to be constant, the most likely cause of voltage drift is the divider R_1 , R_2 . Resistor R_1 is a commercial one-watt, $\frac{1}{2}$ -percent, wire-wound precision resistor. The other, R_2 , is a special variable resistor. The divider carries only 0.5 ma of current and the resistors dissipate only about 13 percent of their rated values. Thus the temperature rise, and hence the resistance change, is held to a minimum.

Various attempts were made to measure the drift, and because of the necessity of maintaining a bucking or reference voltage more constant than the voltage being measured, the system shown in Fig. 5 was used.

The regulated reference supplies are extremely stable and were thoroughly warmed up before the measurements were made. The voltage to be measured is adjusted to a value close enough to the total reference voltage to make the difference within the range of the recording voltmeter. This method shows a drift of less than 0.1 percent during the first five minutes of warm-up of the regulator, and not more than 0.01 percent at any time thereafter.

Resistor R_2 in Fig. 4 is made up of ten two-watt composition volume

controls connected as rheostats. There are 475 volts maximum across each one and 4,750 volts across the ten. They are rated at 500 volts each.

The ten volume controls are mounted on vacuum-impregnated linen Bakelite and driven by gears made of impregnated Bakelite. The normal backlash in these gears provides the basis for a combination coarse and fine control of the regulated voltage.

When the control knob, which has a 12 to 1 ratio to the volume control gears, is turned in one direction, the first volume control alone changes its resistance. Then the second takes, and later the third, until finally, when all the slack is taken up, all ten are turning. At first, the control is ten times as fine as when all the volume controls are moving. When the control knob is reversed, it is again a fine control. On the panel, the knob is labeled, MASTER CONTROL: (Coarse; turn continuously. Fine; rock back and forth).

Auxiliary Voltage Source

The regulated auxiliary voltage source is indicated by a block in Fig. 4, and is shown in schematic form in Fig. 6. It is an independent constant voltage source, although it may be operated from the same a-c line. In this case, it is supplied by one of the 208-volt lines and neutral. Therefore, the primary on the transformer

is wound for 120 volts, single phase.

The output of the auxiliary unit is first electronically regulated and then again regulated by the glow-discharge tubes. This inverse-feedback regulator does depend upon a glow discharge tube for its reference, but only one type VR75 is used and it is supplied from the regulated side of the 6Y6G tube. The VR75 was selected because of its freedom from spasmodic variation found in other glow-discharge tubes. The slope of the top VR75 provides excellent compensation for the slope of the bottom VR75³.

Safety Features

For the safety of inexperienced or careless operators, and for safety in servicing, a closed cabinet is used with an interlock switch, which opens the main three-phase relay when the rear door is opened. The regulated auxiliary voltage source and all filaments, except those in the servo-transformer control circuit, operate with the interlock open. The opening of the interlock prevents the application of any voltage to the autotransformer and prevents the operation of its control circuit. The high-voltage output jacks are located inside the cabinet, and leads to them are brought in through separate grommets. When there is any output voltage, no work can be done on the supply, and high-voltage connections cannot be made.

If failure in the control circuit of the servo transformer allowed it to run to its highest position, many times the proper plate voltage would be applied to the regulator tubes. Since this would be beyond the ability of the electronic regulator to correct, the output voltage would also

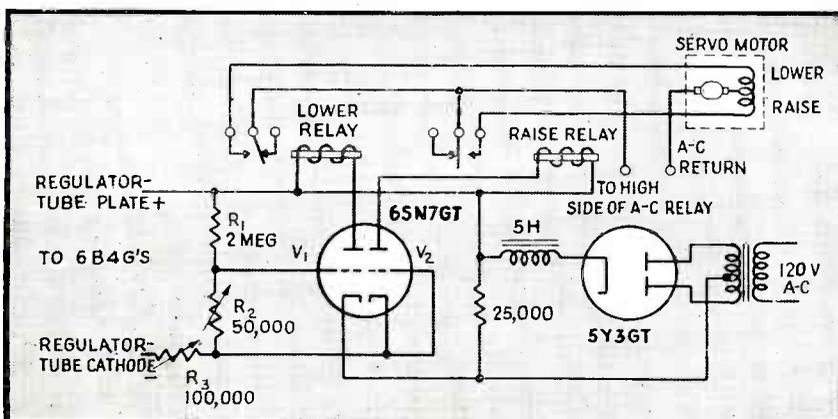
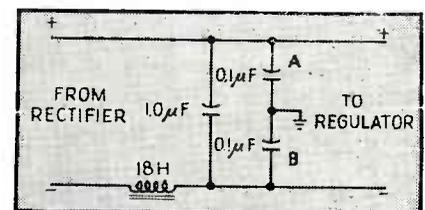


FIG. 2—Electronic circuit for control of the servo motor which is geared to the autotransformer

FIG. 3—Although the output of this filter cannot be grounded, capacitors A and B bypass to ground the high peaks caused by distributed capacitance of the transformer



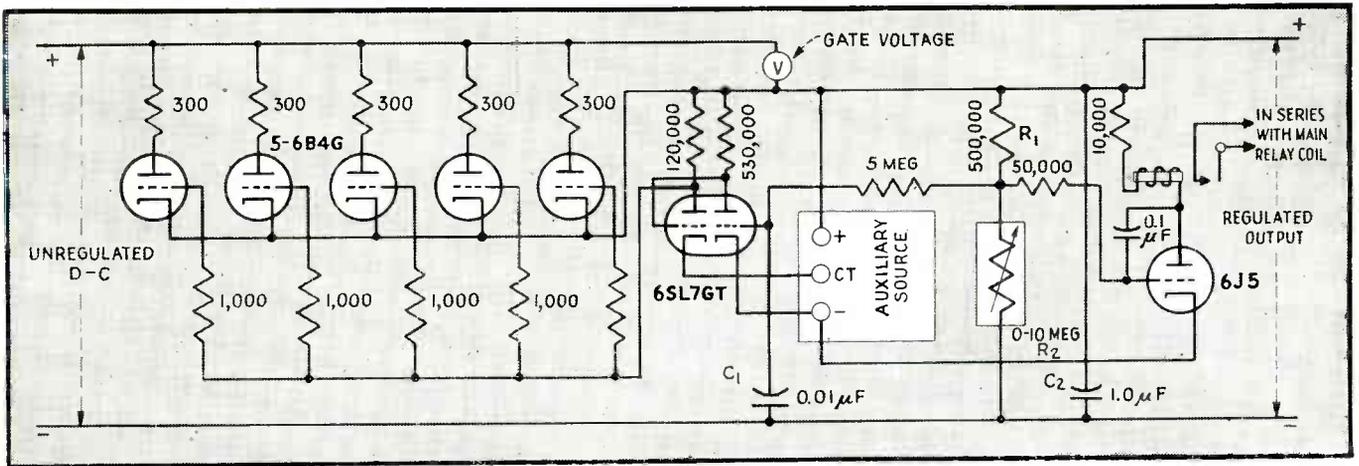


FIG. 4—Inverse-feedback type of regulator with auxiliary voltage source to supply the reference voltage

increase to an excessive value. Regulator tubes, and perhaps other valuable equipment, would be damaged. Two things were done to prevent such an occurrence.

First, the circuit shown in Fig. 2 is made inherently safe, in that failure of either tube to conduct will result in lowering the servo transformer to minimum, where it will remain. And second, included in the regulator circuit of Fig. 4 is a triode-operated relay which must be closed for the operation of the main high-voltage relay.

The grid of the 6J5 triode receives its bias from the difference between the voltage across R_1 and the auxiliary voltage source which is its plate supply. If this bias gets too high, (and it will if the servo transformer goes too high) the triode cuts off, opening its relay. The relay contacts are in series with the main high-voltage relay coil and thus all high voltage is removed. The main high-voltage relay (not shown) is so connected that it will not close except when the servo transformer is at

minimum. When this main relay is open, the motor can lower the servo transformer, but cannot raise it. Thus, should the voltage across R_1 become excessive, the high voltage is shut off and cannot be applied except under safe conditions.

Ion bursts in some klystrons cause a sudden and severe surge in the beam current which may damage the power supply and its current meter. An over-current relay with contacts in series with the high-voltage relay coil, and a choke in series with the current meter, provide excellent protection from such overloading. The choke will delay meter deflection until the relay opens the main high-voltage relay. Tests indicate that with these safeguards, the power supply can be shorted or subjected to a sudden open-circuit without damage, that failure of any tube will not cause damage to any other part, and that interruption of the power line will safely shut the supply off. Magnetic breakers in the a-c lines provide additional protection against internal breakdowns

and will operate within one-half cycle.

Tests show that the high-voltage regulator has a d-c output with less than three millivolts of ripple which is approximately the same at all output voltages. At 5,000 volts, this is 6×10^{-6} percent and at 300 volts it is 1×10^{-3} percent. When viewed on a high-gain oscilloscope, the output is practically free from transient jumps. It can handle a 3-ma or a 500-ma load with equal facility. The maximum output current of the regulator is limited only by the number of regulator tubes used.

REFERENCES

- (1) Hogg, F. Livingston, Electronic Voltage Regulator, *Wireless World*, p 330, Nov. 1943.
- (2) Middel, H. D., Electronics in Instrumentation, *Proc. of National Electronics Conference*, 1944, 1.
- (3) Hogg, F. Livingston, Electronic Voltage Regulator, *Wireless World*, p 329, Nov. 1943.

BIBLIOGRAPHY

- (1) A Voltage Regulator for DC Power Supplies, *RCA Application Note No. 96*, Aug. 24, 1938.
- (2) Hunt, F. W., and Hickman, R. W., On Electronic Voltage Stabilizers, *Rev. Sci. Inst.*, 10, Jan. 1939.
- (3) Bereskin, A. B., Voltage-Regulated Power Supplies, *Proc. IRE*, 31, Feb. 1943.
- (4) Hill, Jr., W. R., Analysis of Voltage-Regulator Operation, *Proc. IRE*, 33, Jan. 1945.

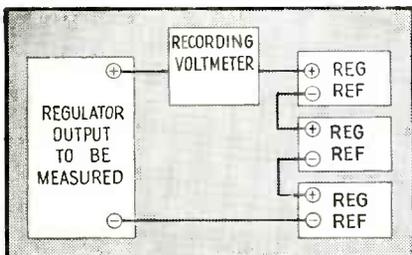
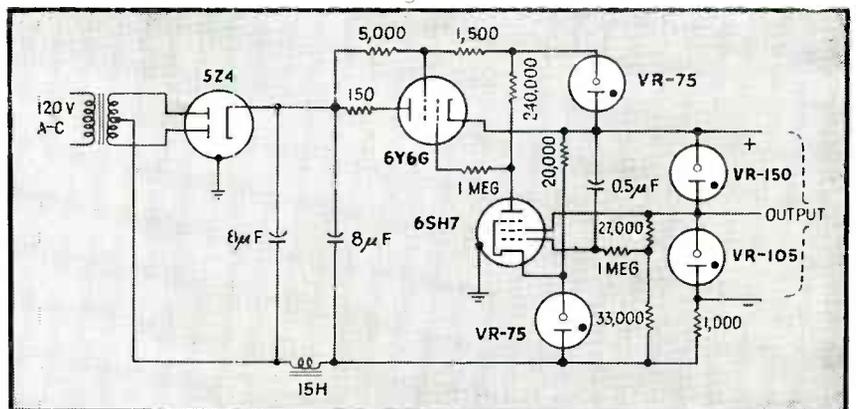
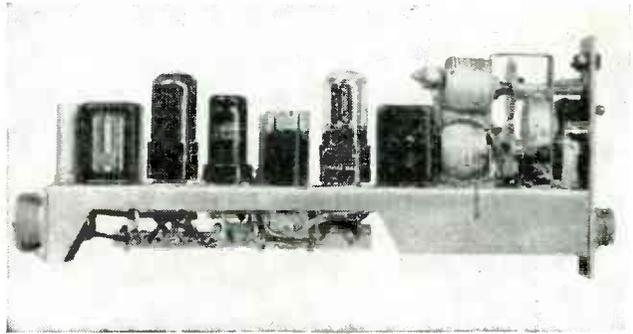
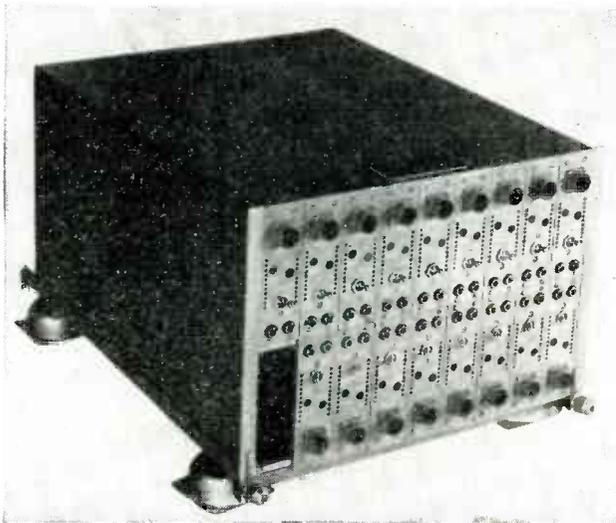


FIG. 5—Block diagram illustrating method of measuring drift

FIG. 6—Circuit of the auxiliary voltage source used for reference. This unit supplies plate voltage for the d-c amplifier of Fig. 4



Electronic For



Electronic commutator unit of airborne transmitter, with one of the 18 commutator channels removed and shown at right. Connectors go to bridge units of instrumentation being telemetered

By **LAWRENCE LEE RAUCH**

*Princeton University
Princeton, N. J.*

IN the flight testing of modern high-performance military aircraft, often pilotless and radio-controlled, the aircraft may crash due to some failure. One method of obtaining and keeping records from various instruments in the aircraft is to transmit the readings by radio, as they occur, to a ground station where they are recorded. Thus, all records until the instant of the crash are available without risk of loss.

A separate radio link could be used to transmit the signal from each instrument, but this becomes impractical when the number of instruments to be telemetered is large. The telemetering problem then becomes one of multiplexing, where a number of signals are synthesized into a single signal which is transmitted by a single radio link and then analyzed into the original signals after reception.

Commutation Multiplexing

The telemetering system developed at Princeton University and described in this paper uses an electronic commutation method of time division multiplexing wherein short samples of the various instru-

ment or gage readings are converted into signals and transmitted in cyclic serial order. Twenty-one channels are used, and each one is sampled 952 times per second to give a repetition rate of 952 cps. The switching rate is then 952×21 , or 20,000 cps (values are approximate).

The overall system is designed for an essentially uniform frequency response from 0 to 200 cps in each of the eighteen active channels (three are inactive). The short

samples in each channel of the synchronized receiving commutator are integrated to provide a smooth signal for a recording galvanometer so that an exact record of the original instrument signal may be obtained.

Operation of Transmitter

The block diagram in Fig. 1 illustrates the operation of the transmitter portion of the telemetering system. In effect, the heart of the

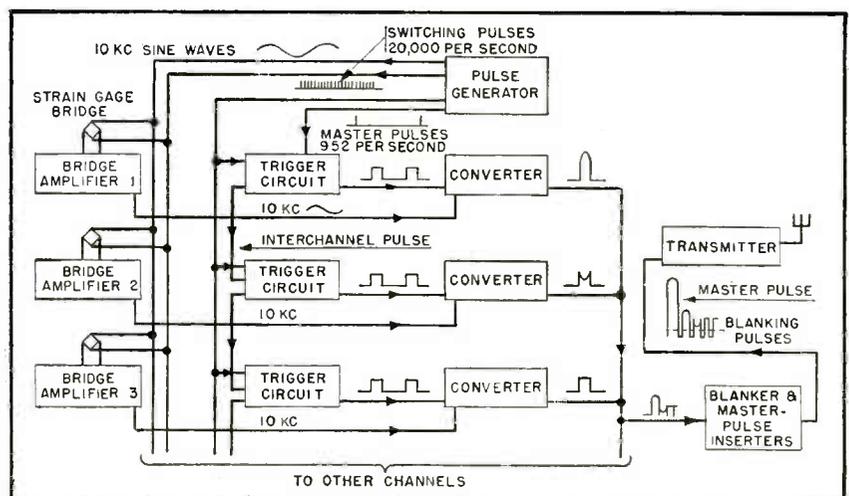


FIG. 1—Block diagram of telemetering transmitter. A total of 18 active and 3 inactive channels are used in the system

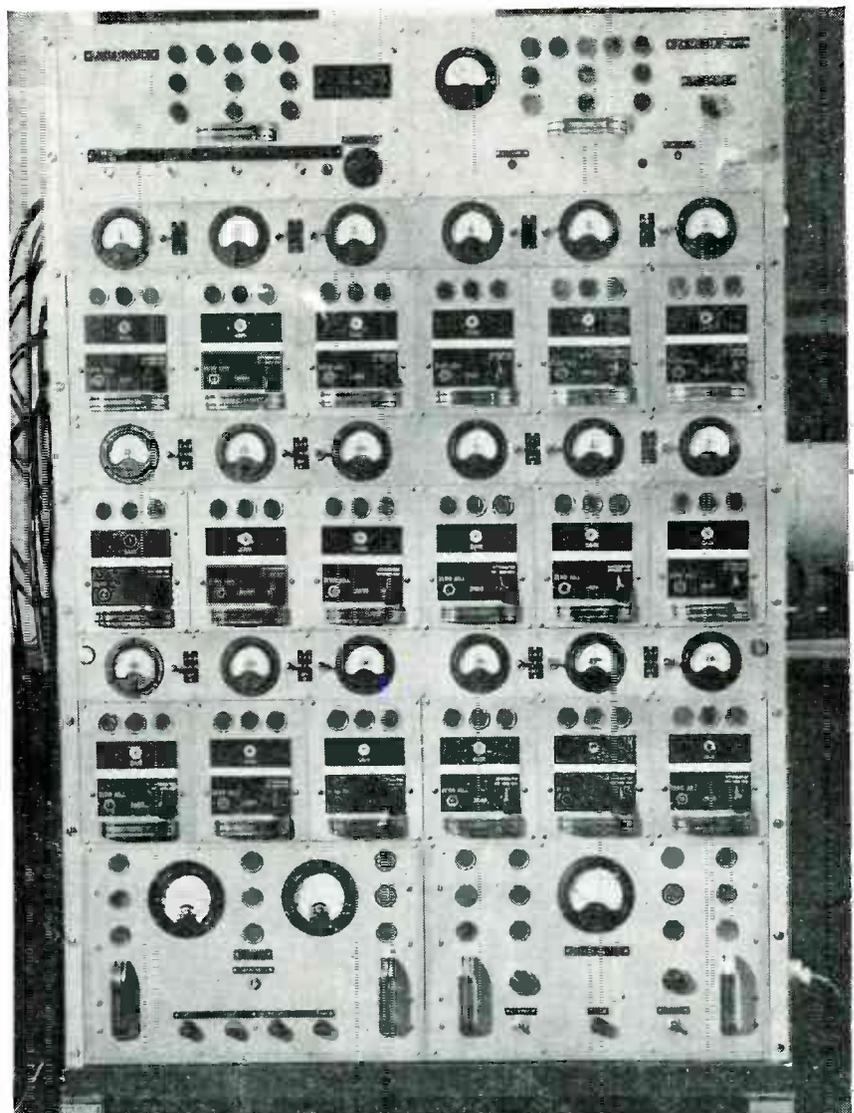
Commutation TELEMETERING

Readings of 18 bridge-type instruments are sampled in sequence 952 times per second by broken-ring trigger stages controlled by a master pulse generator, for transmission over an f-m radio link during flight tests of new aircraft or on pilotless runs

system is the pulse generator located in the airborne transmitting equipment. This supplies 10,000-cycle sinusoidal voltage to drive bridge-type instrumentation, 20,000 switching pulses per second phased to occur each time the sinusoidal voltage crosses the zero axis, and 952 master pulses per second occurring simultaneously with each 21st switching pulse. Both the switching and master pulses are also sent over the radio link for receiver synchronizing purposes.

Certain instrumentation used in flight testing is well adapted to operation in bridge circuits, as for example strain gages and inductance accelerometers. The readings of other instruments can usually be converted to bridge unbalance voltages by potentiometers or other means, so this telemetering system has been developed to operate only with bridge-type instrumentation.

Alternating-current excitation is used to permit easy and reliable amplification of the small unbalance voltages from the bridges to the order of magnitude necessary for electronic switching. Rectification and its attendant difficulties are avoided by synchronizing the excitation waveform with the commutator sampling. A half-sine-wave sample of each bridge output from zero axis to zero axis is initiated by some switching pulse and is



Ground receiver commutator unit of telemetering system

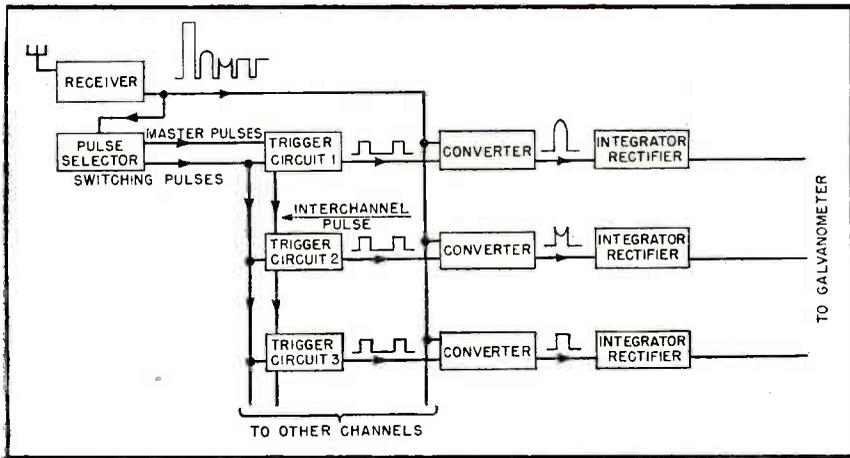


FIG. 2—Block diagram of receiving equipment. The 18 trigger circuits are connected as a broken ring to provide accurate electronic switching to each channel in turn, with the process repeated 952 times per second

wave sample passes through to the common output of the converters and on to the radio transmitter.

The entire commutation sampling sequence is thus controlled by the trigger stages. These operate on what is called the broken ring principle. The 20,000-cycle switching pulses are fed simultaneously to all trigger stages and have the effect of turning off any stage that happens to be on. Each master pulse fed to the first stage overcomes the action of the simultaneous switching pulse and turns the first stage on. The next switching pulse turns the first stage off, since there is no master pulse.

By the action of the first stage going off, an interchannel master pulse is fed to the second stage, turning it on in the same manner as the master pulse turned on the first stage. This process continues until the last channel is turned on by the preceding one and then off by a switching pulse. However, there is no interchannel master pulse connection from the last trigger stage to the first trigger stage,

terminated 50 microseconds later by the next switching pulse. The area under this half-sine-wave sample is proportional to the signal.

For sampling, each of the identical transmitting channels consists principally of a tuned 10,000-cycle bridge amplifier feeding into a converter (electronic gate circuit) controlled by a trigger stage. (The term converter rather than gate is

used since the action of a gate operated at a fixed frequency is in general to modulate the gated signal onto the harmonics of the fixed frequency). The amplified, amplitude-modulated 10,000-cycle signal from the instrument bridge is present at the input of the converter at all times. At the proper time the converter is turned on by its trigger stage and the half-sine-

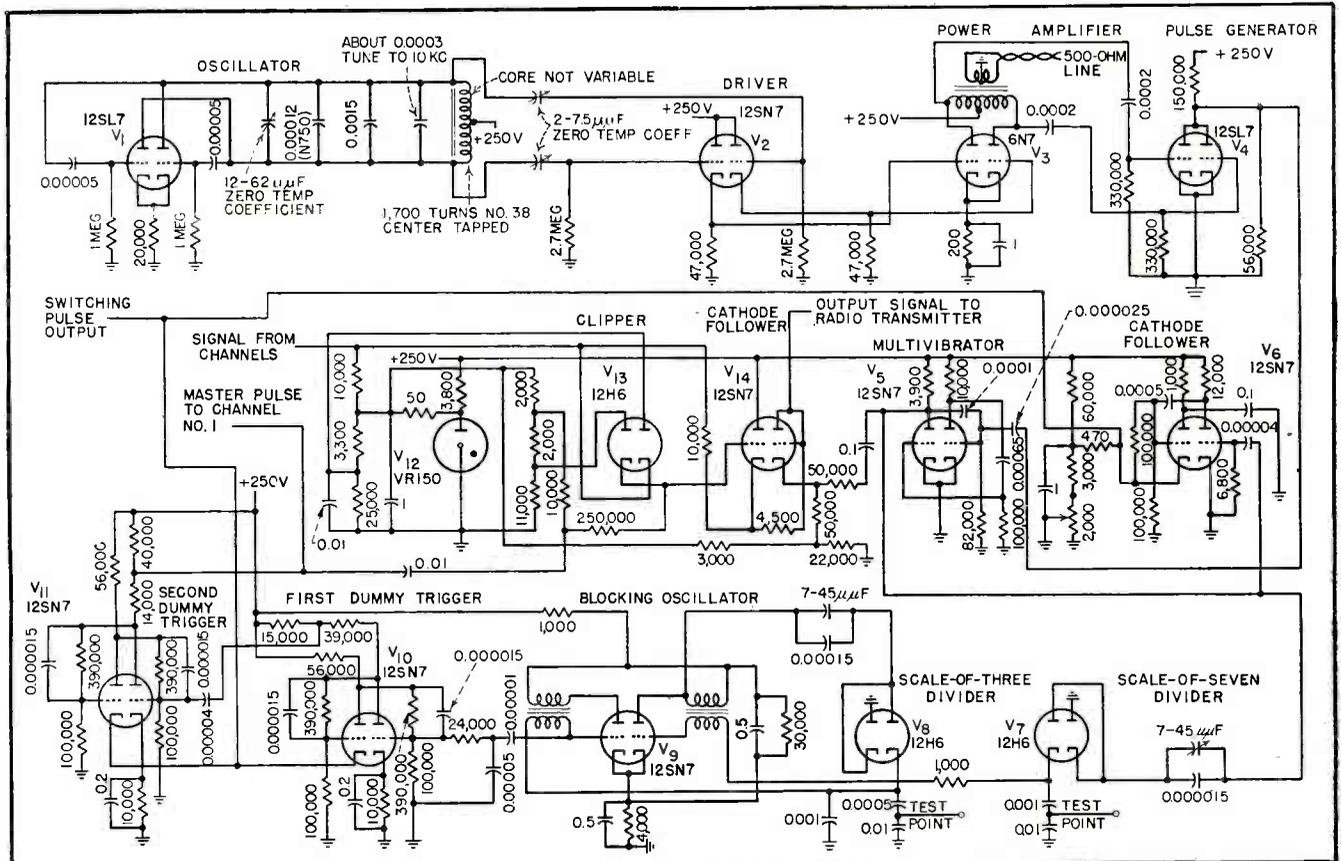


FIG. 3—Pulse generator circuit of transmitter, used to generate 952 master pulses and 20,000 switching pulses per second as well as 10-kc power for bridge excitation

so the switching sequence is ended until a new one is initiated by a master pulse from the pulse generator.

If the trigger stages are connected as a complete ring by starting the first channel with the interstage master pulse from the last channel, instead of by the master pulse from the pulse generator, the resulting switching action is entirely unsatisfactory. If an error in the switching once occurs, it remains. Two or more sequences may progress around the ring simultaneously, or a phase slip may occur, or the sequence may stop. These possibilities are particularly important at the receiving commutator which must be operated by radio link synchronizing pulses which are not infallible. If a switching error of any kind occurs in the present system using the broken ring principle, it will be corrected in not more than 1/952th second so that an error will not be carried for more than one sampling sequence.

Before the sequence of half-sine samples from the common output of the converters reaches the radio transmitter, it goes through blander and master pulse inserters. Here it is limited in positive and negative directions, after which are added positive synchronizing master pulses above the positive limit level and negative synchronizing switching pulses below the negative limit level. The synchronizing master pulses occur during one of the three sampling intervals not used by the eighteen active channels. The synchronizing switching pulses occur between all sampling intervals and also serve as interchannel blanking pulses so that the required radio link modulation bandwidth for tolerable crosstalk levels is reduced.

Operation of Receiver

At the ground receiving station, the output of the radio receiver is fed to the common inputs of all of the converters, as indicated in Fig. 2. The synchronized switching operation of the converters is accomplished in much the same manner as in the airborne commutator. The output of the radio receiver is also fed to a pulse selector, where master and switching pulses are

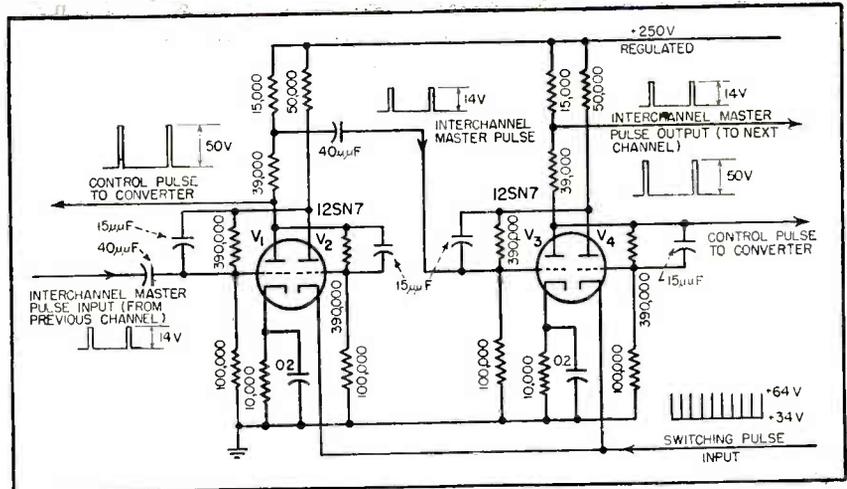


FIG. 4—Trigger stages of two adjacent channels, showing interconnections to give broken-ring action

generated in accordance with the respective synchronizing pulses on the radio signal. In this way the 50-microsecond samples from any given transmitting channel are connected to the proper receiving channel integrator and galvanometer.

The received samples consist of half-sine waves, proportional to the bridge unbalance voltage in the respective transmitting channel, added to pulses of constant height. Due to the number of channels being odd, the successive half-sine wave samples alternate in phase, which results in total samples whose areas are alternately larger and smaller. The amplitude of alternation is proportional to the desired channel telemetering signal. The frequency spectrum of the samples of the given channel then consists of constant components at even multiples of 476 cycles (half the repetition rate) and amplitude-modulated components proportional to the channel telemetering signal at odd multiples of 476 cycles.

The 476-cycle amplitude-modulated component arriving at the integrator-rectifier of a channel is selected by a low-pass filter which has little attenuation below 700 cycles and at least 60 decibels of attenuation at 952 cycles and above. The amplitude-modulated 476-cycle sinusoidal signal at the output of the filter is amplified and then demodulated by a balanced full-wave rectifier, followed by a low-pass filter attenuating above 200 cycles to eliminate the 952-cycle and higher components. The demodulated output of each channel is usu-



One channel of commutator unit at ground station. Low-pass pulse filter is at right rear on chassis

ally connected to a recording galvanometer having a uniform response from 0 to 200 cycles.

The pulse generator circuit of the transmitter, shown in Fig. 3, employs a 10,000-cycle pushpull tuned-plate oscillator using a 12SL7 double-triode tube V_1 . The tuned circuit is temperature compensated and a frequency-adjusting trimmer capacitor is provided. The relatively strong signal from this oscillator excites a 6N7 untuned class B power amplifier V_2 through a 12SN7 cathode-follower driver V_3 . Capacitance attenuators are provided at the input of the driver to adjust the output and balance of the power amplifier. A power output of 5 watts at 10,000 cycles is furnished to a 500-ohm line for excitation of instrumentation.

A 12SL7 push-push pulse generator V_4 is fed from the plates of V_3 . A positive pulse occurs each time the 10,000-cycle sinusoidal signal

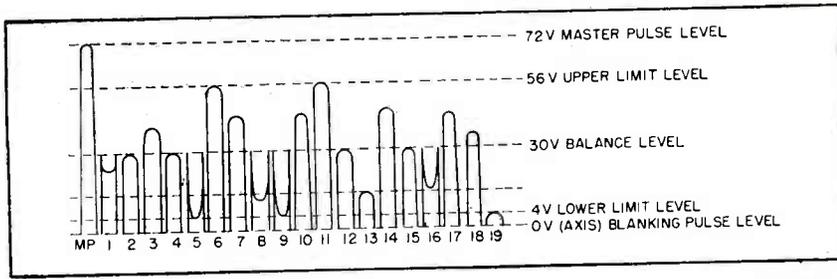


FIG. 6—Signal pattern at transmitter commutator output, showing one entire commutation cycle including master pulse MP

the output of the radio receiver. Referring to the circuit of the pulse selector in Fig. 7, the large negative blanking pulses from the radio receiver (absolute value of peaks is zero) applied to the grid of the 12SH7 tube V_1 , cause corresponding positive pulses at the plate, while the more positive portions of the signal of Fig. 6 are lost due to the biasing action of the circuit.

Pulse Selector in Receiver

The 12SH7 tube V_2 drives a 20,000-cycle tuned circuit of moderate Q to provide a stabilized sinusoidal signal synchronized with the blanking pulses. The output of the tuned circuit is then shifted in phase and passed through a two-stage square-wave generator consisting of the left section of the 12SN7 V_3 and the 12SH7 V_4 . The 20,000-cycle square wave is differentiated and the positive pulses are selected and delivered at low impedance by the cascade cathode followers of the 12SN7 V_5 for use as switching pulses for

the receiving commutator channels.

Having thus traced through the switching pulse section of the pulse selector, we return to the signal of Fig. 6 and the problem of selecting the positive synchronizing master pulse. This positive pulse on the grid of the 12SH7 V_1 causes a corresponding negative pulse at the plate, while the more negative portions of the signal are lost due to the positive bias on the cathode.

The negative pulse is applied to the right grid of the 12SN7 V_6 , thereby permitting the capacitor in the cathode circuit to discharge slowly through the resistor across it. If the pulse is long enough, the potential of the paralleled cathodes of the right section of V_6 and the left section of the 12SN7 V_7 will decrease to such a value that the multivibrator circuit of V_7 will trigger and deliver a negative pulse at the left plate. This negative pulse acts as a master pulse for the dummy trigger circuit of the 12SN7 V_8 (for it controls no converter),

which in turn supplies an inter-channel master pulse to operate the first channel of the commutator trigger chain.

The dummy trigger circuit is incorporated in the pulse selector because the master pulse from V_8 comes relatively late during a sampling period due to the delay action of the selection circuit, which insures that short noise pulses will not be mistaken for the longer 50-microsecond synchronizing master pulses.

Receiver Commutator Channel

The receiver commutator trigger chain is identical with that of the transmitter except that it is operated by the pulse selector instead of the pulse generator. The circuit of one receiver commutator channel is given in Fig. 8. The 12SN7 V_1 is used in the familiar trigger circuit. However, the 12SN7 double cathode follower converter V_2 is operated by negative control pulses from the trigger stage. The cathode of the left section normally holds the cathode of the right section at such a high potential that the latter is cut off. During the on period of the channel the negative pulse from V_1 cuts off the left section of V_2 and allows the right section to gain control and conduct the channel sample as a cathode follower. Thus the channel sample pulses at the cathode of V_2 are in the negative direction. These channel samples

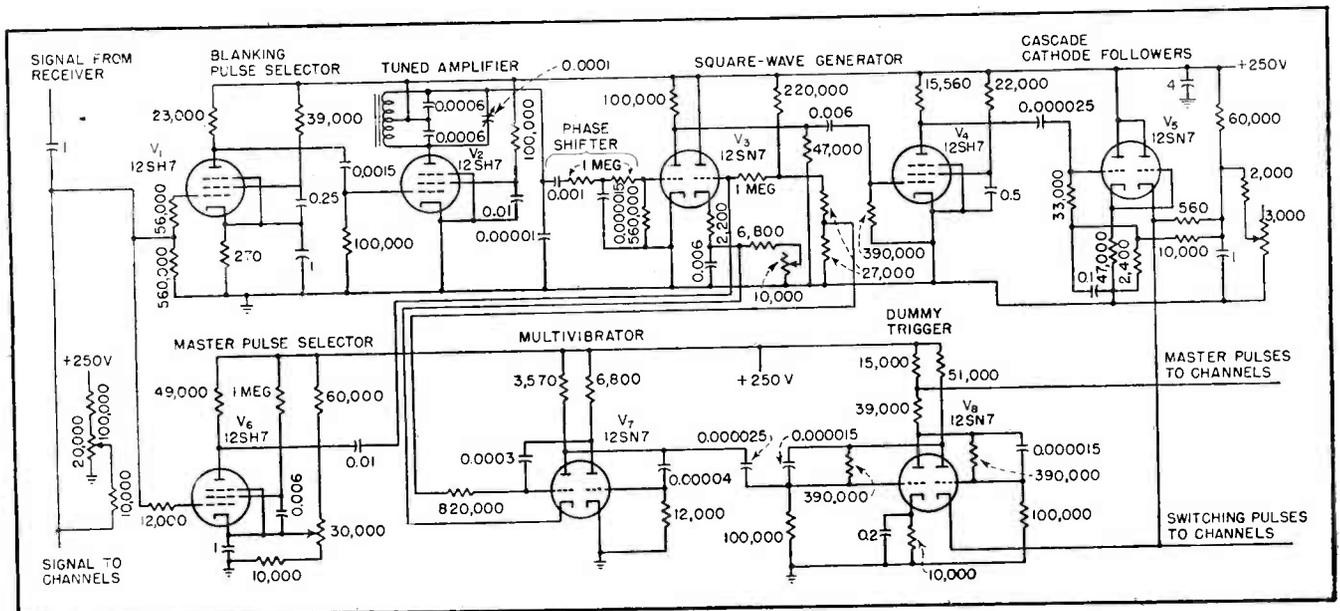


FIG. 7—Circuit of pulse selector in receiver

By EDWARD KASNER

Assistant Engineer
Kollsman Instrument Division
Square D Company
Elmhurst, N. Y.



Tachometric Audio-Frequency Meter

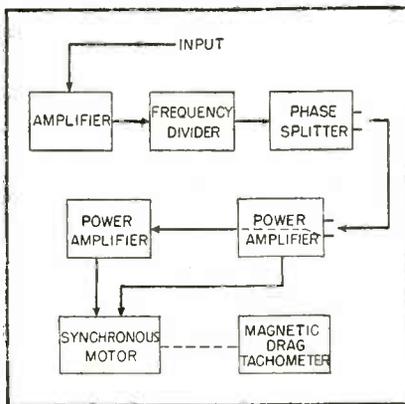


FIG. 1—Block diagram of tachometric audio-frequency meter

Eccles-Jordan scale-of-two trigger circuits divide the audio input frequency and produce two-phase output for driving a synchronous motor and magnetic drag tachometer. Frequencies from 30 to 450 cycles are indicated directly by pointer with 0.5-percent accuracy

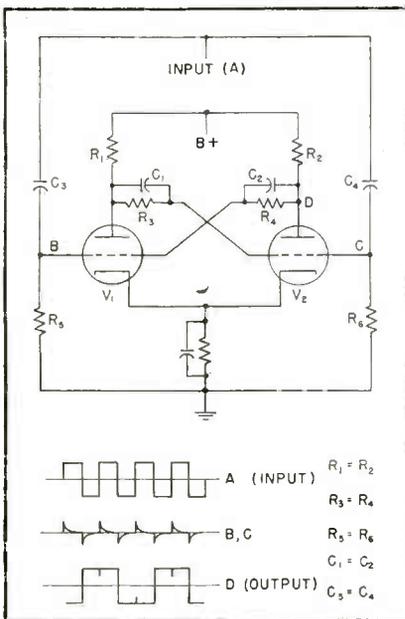


FIG. 2—Basic Eccles-Jordan circuit used to lower input frequency sufficiently to drive a synchronous motor, with input, output, and grid-voltage waveforms

DIRECT-READING, wide-range electronic audio-frequency meters are seldom capable of maintaining an accuracy of better than two percent. Limiting factors such as supply-voltage regulation, temperature variations, and the aging of tubes and circuit components can be compensated for only to a limited degree.

During the development of a more accurate frequency meter, investigation was made of all conventional methods of frequency measurement. The device which within reasonable limits proved to be the most dependably independent of variables other than frequency was the combination of a synchronous motor and magnetic drag tachometer shown in block form in Fig. 1. Its adaptation for the purpose of frequency measurement in conjunction with suitable electronic circuits is herein described.

The characteristics of a synchronous motor are such that although it will maintain constant speed at any rated load, its torque when out of synchronism is very low. Also, in order to realize a fair degree of efficiency and good starting characteristics, the motor must be of polyphase construction.

The use of a polyphase (two-phase) motor necessitates the inclusion of a phase-splitting circuit in order that the frequency-meter input be single-phase. Since the range of frequencies through which a synchronous motor will remain synchronous is limited (from about 10 to 150 cycles for a good 60-cycle motor), frequency dividers are required for range extension.

Frequency-Divider Circuit

The Eccles-Jordan scale-of-two circuit shown in Fig. 2 provides a reliable frequency divider. Resistors $R_1 - R_3 - R_5$ and $R_2 - R_4 - R_6$

impress bias voltages on the grids of V_1 and V_2 . Due to slight circuit inequalities, one tube (say V_1) conducts more current than the other. The larger voltage drop across its load resistor R_1 causes a decrease in current through V_2 . This in turn causes a smaller drop across R_2 , and V_1 conducts even more current. The tendency is to drive one tube toward cutoff and the other toward saturation. Actually, one grid is kept at about zero (because of grid current) and the other is driven well beyond cutoff.

When a square-wave input is applied at A. $C_3 - R_5$ and $C_4 - R_6$ differentiate the square waves, and sharp full-wave pulses appear at B and C. When a positive pulse appears, the conducting tube undergoes no change. The nonconducting

tube attempts to conduct but is prevented from doing so by the high negative bias impressed upon it by the other tube.

When a negative pulse appears, both tubes are momentarily driven to cutoff. The charges existing across C_1 and C_2 can now exert control over the circuit. The higher charge across C_1 causes V_2 to conduct more current and, through the process previously described, V_1 is driven to cutoff. One input cycle causes one transfer of conduction, and two input cycles cause one cycle of conduction transference.

Two-Phase Output Circuit

The use of the Eccles-Jordan circuit to extend frequency range and simultaneously produce a two-phase output from a single-phase

input is believed to be new. The method whereby this is done is shown in Fig. 3. Two dividers, each driven from a plate of the first divider, receive signals having 180 degrees difference in phase. Due to the frequency-dividing action, their outputs are 90 degrees out of phase. The principle underlying this arrangement is that the second subharmonics of two signals of the same frequency and of 180 degrees phase displacement are 90 degrees out of phase.

If V_2 and V_3 drive power amplifiers whose loads are the fields of the synchronous motor, the motor will run at a speed proportional to one-fourth the input frequency. Conditions which would be limiting factors in the accuracy of a conventional electronic frequency meter can in no way interfere with the synchronous operation of the motor in this circuit.

Construction of Tachometer

The magnetic drag tachometer is used to operate a direct-reading indicator corresponding to the speed of the motor. It consists of a spring-loaded shaft, on which is mounted a pointer and a copper

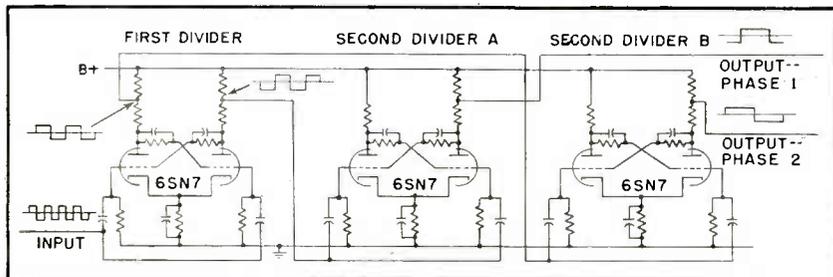


FIG. 3—Use of Eccles-Jordan circuits to produce two square-wave outputs differing in phase by 90 degrees

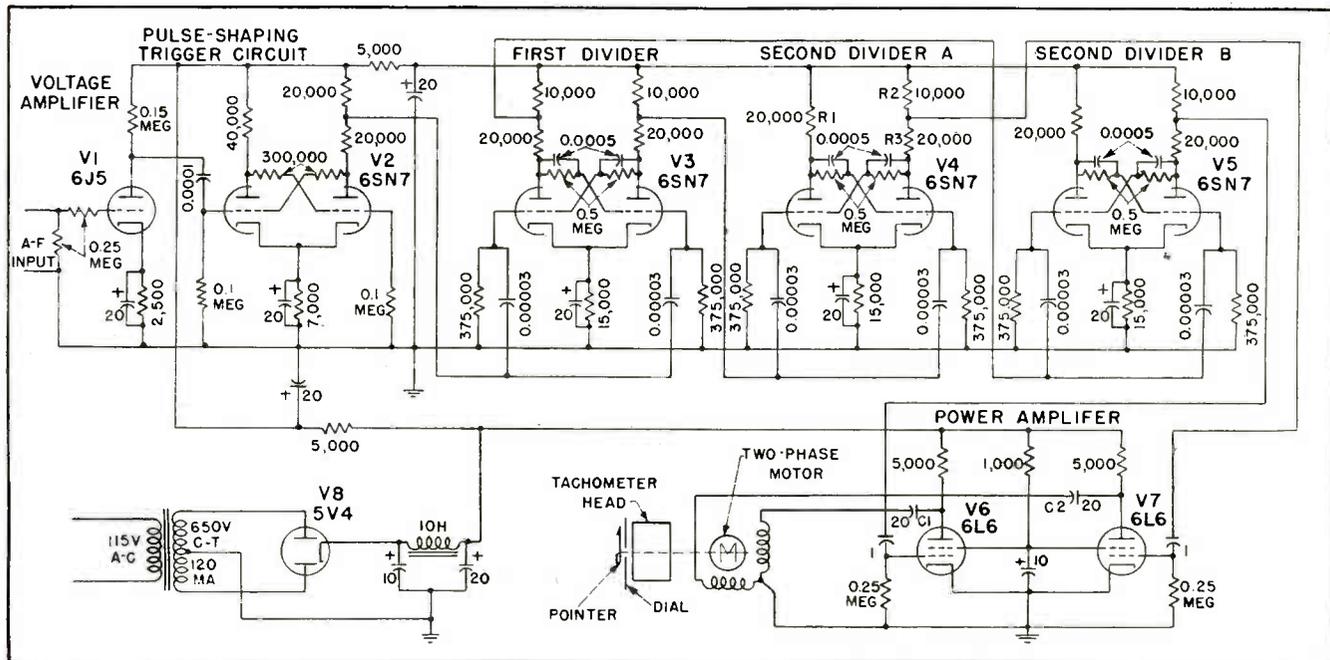


FIG. 4—Complete electronic circuit used to drive synchronous motor and magnetic drag tachometer. Values used for three 15,000-ohm cathode resistors in the dividers are critical

cup. A rotating permanent magnet within the cup, driven by the synchronous motor, sets up eddy currents in the cup, producing a shaft torque proportional to the speed of magnet rotation. The torque, acting against the spring, causes a shaft displacement proportional to the torque. The pointer indicates the speed on a dial calibrated in cycles per second.

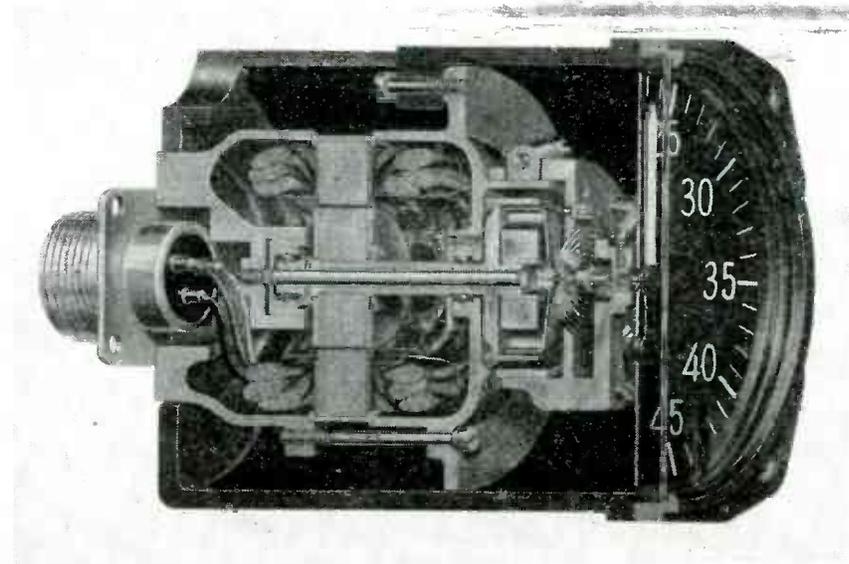
The drag cup is made of a special alloy with a very low temperature-resistance coefficient. The magnet is seasoned and is compensated for temperature errors. The effect of age upon accuracy is negligible. Overall accuracies better than half of one percent can be maintained in normal use.

Complete Circuit

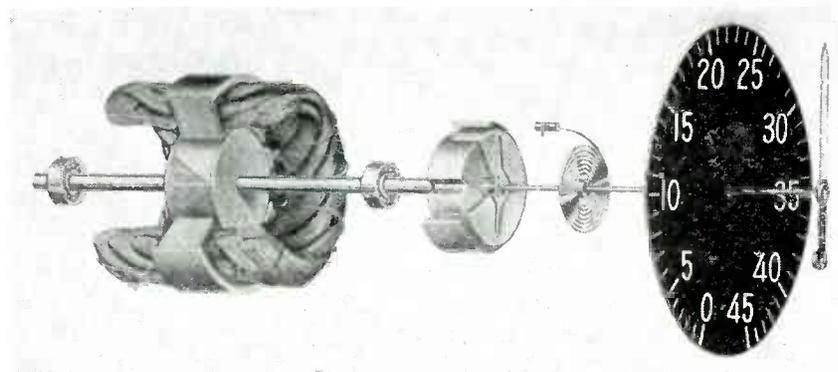
The complete circuit of an experimental unit designed to operate from 30 to 450 cycles is given in Fig. 4. Here the outputs from the frequency dividers are not taken directly from the plates but from taps in the load resistors, to prevent instability due to loading.

If one phase of a two-phase motor is reversed, the direction of rotation will be reversed. In order to prevent the instrument from reading backwards, the load resistors of the second dividers are made unequal ($R_2 + R_3 = 1.5R_1$). This unbalance assures consistency in the firing order of the second dividers. The simultaneous reversal of both phases will not affect the direction of rotation. Therefore, the first divider requires no unbalance.

The problem of varying input waveform is taken care of by trigger circuit V_2 preceding the first divider. Except that the input is applied to one grid and the static voltage distribution is changed, this circuit operates in a manner similar to the frequency divider. Its output is either a square or rectangular wave, regardless of input waveform. The only input limitation is that the unknown frequency be periodic. If it should be necessary to determine the average frequency of an aperiodic input, the trigger circuit would have to be replaced by some sort of



Cutaway view of synchronous motor, magnetic drag tachometer, and indicating scale



Exploded view of rotating parts of motor and tachometer, showing permanent magnet at right end of synchronous motor shaft and copper cup at left end of tachometer shaft. Eddy currents induced in cup by magnet cause tachometer shaft to be displaced against spring torque in proportion to speed of magnet rotation

integrating or averaging circuit.

Since the impedance of the motor varies with the frequency applied, the method of coupling the motor to the power amplifiers must be free of matching errors. This is easily done by using large electrolytic capacitors ($20\mu\text{f}$ for C_1 and C_2) directly between the plates and the motor.

Voltage amplifier V_1 precedes the trigger circuit. The sensitivity of the frequency meter is determined by the gain of the amplifier and can be extended as desired by the use of a pentode or another stage. Range extension can be accomplished through the use of additional frequency dividers preceding the first divider.

The power amplifier design is determined chiefly by the requirements of the motor used. For a motor rated at about 50 ma at 100 volts (per phase), the circuits of V_6 and V_7 suffice. Variations, such as inverse feedback and class-B output, would probably be required if the motor were larger or a range of frequencies greater than ten to one were to be used.

The foregoing combination of frequency divider, synchronous motor, and magnetic tachometer provides an excellent device for the measurement of audio frequencies. In comparison with available commercial frequency meters, it offers an increase in accuracy of better than 400 percent.

ACOUSTIC

UNDERWATER locating equipment has been developed by the Harvard Underwater Sound Laboratory for finding torpedoes lost during test runs.

An oscillator-amplifier and a magnetostriction projector are mounted in the torpedo. The oscillator unit, powered by the main battery in the electric torpedo or by special batteries in the air or steam torpedo, delivers a supersonic signal to the projector, which transmits an almost nondirectional sound beam of moderate intensity into the surrounding water.

Mounted on the searching ship is the second part of the equipment, a directional receiving hydrophone and a heterodyne receiving amplifier. The directional hydrophone is trained to receive a maximum signal. This signal is heterodyned in the receiving amplifier to an audible tone which is heard in the loudspeaker. The vessel is then steered in the direction indicated by the receiver.

Transmitter

The two-stage oscillator-amplifier employs two 3Q5-GT tubes, one of which operates as a frequency-stabilized oscillator driving the output stage. The schematic diagram of Fig. 1 shows the circuit of this unit.

Both filament and plate current are supplied from the storage batteries of an electric torpedo, and with a supply voltage of 150 volts an acoustic signal in excess of one-half watt is transmitted to the water. Figure

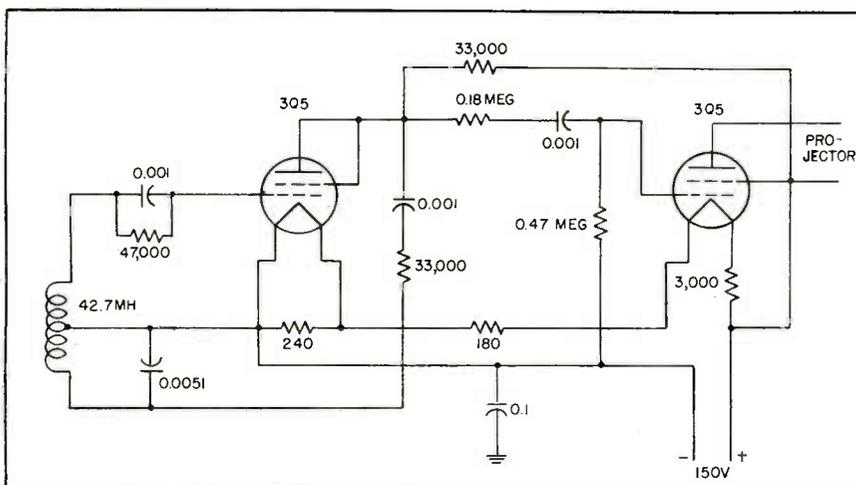


FIG. 1—Circuit of oscillator and amplifier that drives the magnetostriction transducer in the torpedo

By **ERIC A. WALKER** and **PAUL M. KENDIG**

*Ordnance Research Laboratory
The Pennsylvania State College
School of Engineering
State College, Pa.*

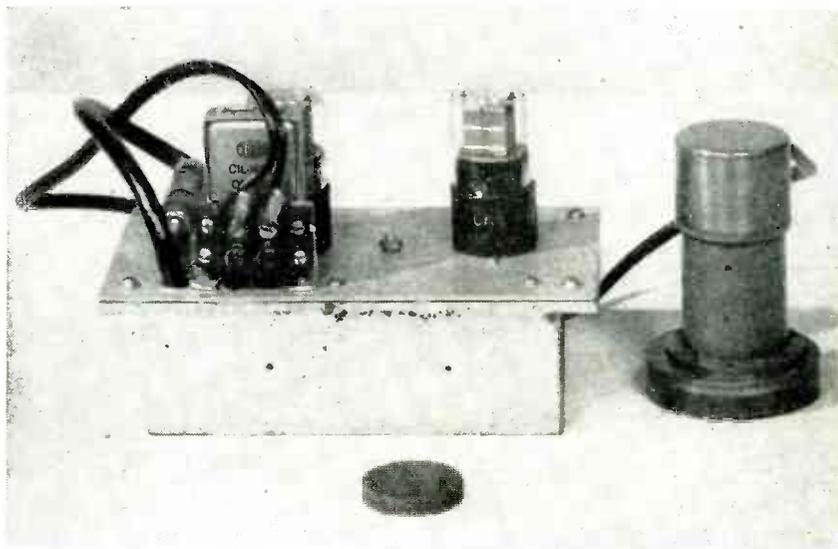


FIG. 2—Electronic portion of the transmitter, the transducer, and the rubber pad that clamps between the transducer diaphragm and the shell of the torpedo

2 shows the oscillator-amplifier assembly and projector.

The supersonic sound projector is mounted inside the torpedo by means of a mounting ring which is cylindrically curved on the bottom and is brazed, silver soldered, or welded to the inside surface of the torpedo shell. The projector is clamped into the mounting ring until the projector diaphragm makes proper contact with a rubber pad between the diaphragm and the shell surface. The active element of the transducer is a magnetostrictive nickel tube mounted on a small metal button, the diaphragm, which is joined to the case of the projector by a thin section of metal.

Transducer Construction

A coil of several hundred turns surrounds the nickel tube and a small permanent magnet rod is placed inside and along the axis of the tube, in order to provide mag-

LOCATING SYSTEM

A supersonic beeper, installed in a torpedo, produces a 24.5-kilocycle sound wave that is picked up by a directional magnetostriction hydrophone in a search vessel. Final location of a lost torpedo is done by a diver carrying a portable hydrophone

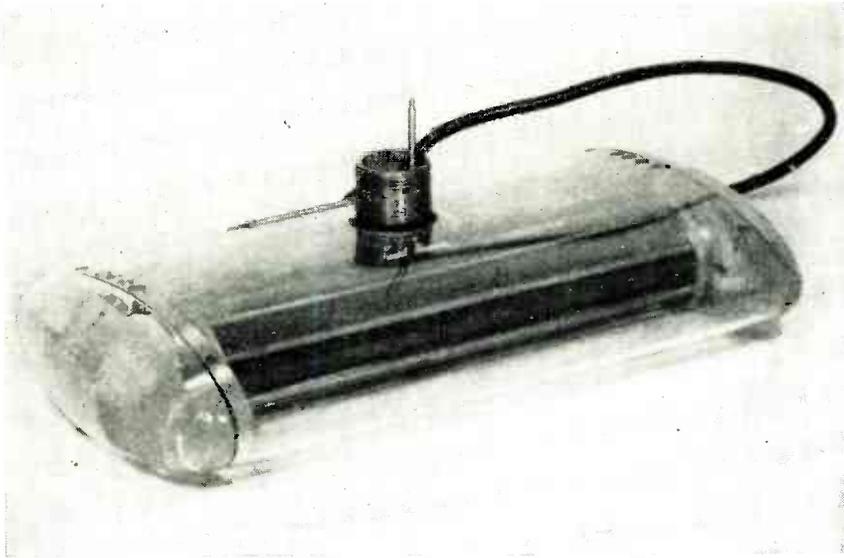


FIG. 3—Magnetostriction listening hydrophone in its streamlined plastic housing. Magnet and coil assemblies inside a nickel tube form the transducer

netic polarization. Alternating current from the oscillator-amplifier flows through the coil and produces the driving force to set the magnetostrictive tube into oscillation. The tube and its diaphragm comprise a mechanically resonant system so that the conversion of electrical to acoustical energy is achieved with high efficiency at the resonant frequency. This frequency depends primarily on the length of the nickel tube, which is approximately one-quarter wavelength.

The chosen frequency is a compromise between two conflicting factors: The range is increased as the frequency is lowered; and for given physical dimensions of the receiving hydrophone, the principal sound beam becomes sharper as the frequency is increased.

A frequency of 24.5 kilocycles was chosen because satisfactory range could be obtained, and the dimensions of the receiving hydro-

phone were not too large at this frequency.

Range

With a ten-volt signal at the resonant frequency impressed upon the coil of the transducer, the acoustic field at a distance of one meter in the direction of maximum intensity is from 30 to 35 db above one dyne/cm². Ideally, the projector would be nondirectional, but when mounted on one side of the 20 to 22-inch diameter torpedo shell, the shell causes the acoustic signal to differ by 10 to 15 db in different directions. Thus, the intensity of the sound field one meter away in the direction of minimum output is about 20 db above one dyne/cm².

Assuming an inverse square law of diminution of the field with distance and taking -20 db versus one dyne/cm² as a threshold signal strength, a maximum operating range is set at about 1,100 yards.

In operation, using the directional receiving hydrophone and the receiving amplifier to be described, an average unit receiving from 80 to 90 volts at 23 to 25 kilocycles from the oscillator-amplifier produces an excellent signal at 550 yards, and a detectable signal at 880 yards to 1320 yards, depending upon water conditions.

Listening Equipment

The hydrophone for the listening equipment must be directional enough to locate the missing torpedo, but not too sharp so that training the projector would be difficult. To fit this requirement, a magnetostriction hydrophone was developed.

The active element of the magnetostriction unit is a nickel tube about 12 inches long with 1½-inch outside diameter and 0.035-inch wall thickness. Three magnet and coil assemblies are placed inside the tube, the middle magnet and coil assembly being 5 inches long, while each of the two end coils is half the physical size of the center one and has half the number of turns. This produces a shading effect which reduces the minor lobes of the pattern, giving the desired sharpness.

Three bar magnets are used to produce a magnetic field in the nickel tube. The poles of the magnets appear along their edges, which are flush with the inside surface of the tube. Two half-cylindrical wooden forms are placed on either side of the magnets to form a cylindrical assembly which fits within the nickel tube. This assembly is small enough to permit wire to be wound on the cylinder to form a coil. The first turn of the coil is wrapped around one of

the poles of the magnet, and each successive turn is wrapped adjacent to the preceding one. Thus, the last turn appears around the pole of the magnet on the side of the coil opposite the one from which it started.

The three coils are connected in series aiding, and all three magnets are placed with like poles pointing in the same direction. The coil assembly is slipped inside the nickel tube to which a cap and rubber gaskets are fitted at each end to provide water tight joints. The caps are held together by six struts. The electrical cable is brought out through a gland providing a water-seal.

Figure 3 is a photograph of the listening hydrophone in its streamlined Lucite housing. The streamlining is required so that search may be conducted while the vessel is in motion. Several holes are drilled in the housing to make it free flooding.

Reflector Details

To limit the sensitivity of the hydrophone to one direction for use as a direction indicator, it is equipped with a pressure-release reflector. This consists of a semi-cylindrical sheet of $\frac{1}{8}$ -inch Celltite Neoprene, which covers one-half the cylindrical tube at one time. The characteristics of the hydrophone are such that at a frequency of 24.5 kilocycles (the frequency of the projector), signals striking the concave surface of this reflector

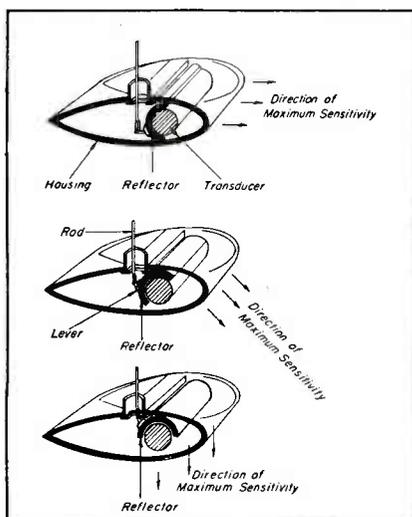


FIG. 4—The rod and lever mechanism rotates a reflector for training the listening hydrophone in depth

are focused along the axis of the hydrophone. Use of the reflector accordingly results in reducing the back response far below that of the front side; and increasing the level of the front response by virtue of the focusing effect.

Figure 4 illustrates a rod and lever system that is used to change the direction of maximum sensitivity by rotating the reflector through 90 degrees about a longitudinal axis. This permits of horizontal search when the reflector is as shown at the top of Fig. 4, and vertical search when it is as shown at the bottom. The rod which controls the reflector extends up through the center of a supporting pipe to the deck of the search vessel.

Performance Characteristics

The magnetostriction listening hydrophone has a peak sensitivity of about -80 db volts per dyne/cm², which is nearly constant (about five-db variation) from 15 to 35 kilocycles when used in conjunction with a matching transformer.

The azimuthal pattern for this unit is shown in Fig. 5. The minor lobes are nearly 20 db below the principal beam, while the front-to-back discrimination is about 30 db. The pattern is much broader in a plane perpendicular to the long axis of the hydrophone. In fact, it is practically nondirectional when used without a reflector. When used with the reflector, as previously noted, the back lobe is reduced about 30 db.

Receiver Circuit

To realize the maximum capabilities of the transmitting system located in a lost torpedo, satisfactory receiving equipment had to be devised. Water background noise on a moving boat limits the maximum usable sensitivity.

The diagram of the listening receiver is shown in Fig. 6. The first stage is an untuned very low-frequency amplifier which is followed by a tuned vlf amplifier, and converter. The local oscillator injects a signal to the converter which, when mixed with the incoming vlf signal, produces an audible beat-frequency output. Tuning of the

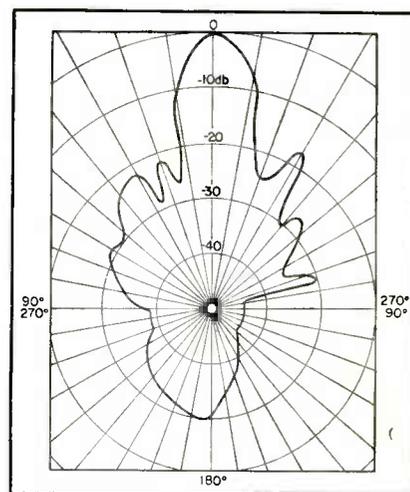


FIG. 5—Azimuthal pattern of magnetostriction listening hydrophone when mounted in its housing

local oscillator and vlf tuned circuits is ganged to produce proper tracking between the two frequencies over the tuning range of 21 to 51 kilocycles. The difference in frequency between the local oscillator and input signal is 1,500 cycles, and the audio resonant filter is adjusted to that frequency. If necessary, the audio filter consisting of C_1 and L_1 may be switched into the circuit to improve signal-to-noise ratio. The 6V6 output stage provides appreciable audio power which may be applied to the loudspeaker or may be picked up on headphones.

A level indicator is bridged across the output system, and use of this meter enhances the accuracy of bearing determinations. In addition, the rapid drop of level after the searching vessel has passed directly over a torpedo is immediately obvious, both visually and aurally.

A master gain control varies the gain of the first r-f stage, while auxiliary gain control in the a-f system permits the user of headphones to select his own desired operating level independent of the level of loudspeaker operation.

Search Procedure

The listening hydrophone is attached to a long pipe which is installed in a steel well, approximately 18 inches square and standing about 2 feet above the cabin deck, located amidships on the starboard side of the keel. The hydrophone is drawn up in the well when not in use, and

Measuring Complex Components

Real and imaginary components of unknown voltage are directly indicated in sign and magnitude relative to reference voltage by audio-frequency vacuum-tube voltmeter. Instrument simplifies measurements on amplifiers and filters. Operation is described

By **GEORGE E. PIHL**

Assistant Professor of Electrical Engineering
Northeastern University
Boston, Massachusetts

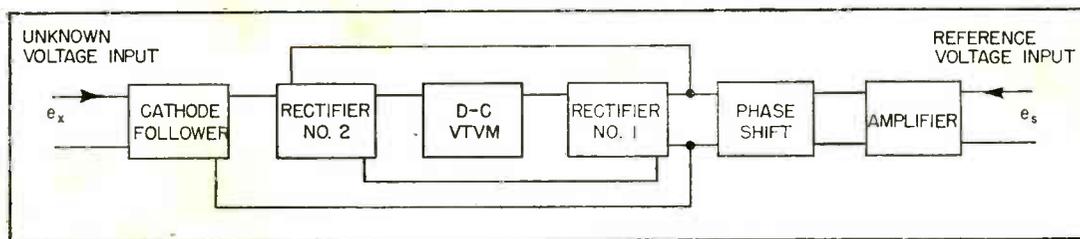


FIG. 1—Block diagram of meter for indicating real and imaginary components of a complex voltage

THE INSTRUMENT discussed in this paper is a vacuum-tube voltmeter that indicates directly the real and imaginary components of an unknown voltage, in terms of a reference voltage. The voltmeter has full-scale ranges of 1, 5, 10, and 50 volts and the frequency range extends throughout the audio spectrum, 20 to 20,000 cycles per second.

There has long been a need, particularly in the field of communications, for an instrument that would measure unknown alternating voltage in terms of its real and imaginary components, with respect to a second voltage used as reference. This need is especially true in measurements on filters, attenuators, and amplifiers where a knowledge of phase shift may be important. The instrument will perform such measurement at any frequency within the audio range. Its operation is based upon the well known

fact that the magnitude of the vector sum of a large voltage and a small voltage is very nearly equal to the sum of the large voltage and the in-phase component of the small voltage.

Basic Method

Let e_s be a voltage of large magnitude used as reference. Let e_r and e_i be the magnitudes of the real and imaginary components of the unknown voltage e_x . If we put e_s on the real axis, then the vector sum e_t of the two voltages will be

$$\begin{aligned} e_t &= e_s + e_x \\ e_t &= e_s + e_r + je_i \end{aligned}$$

The magnitude of e_t is

$$|e_t| = [(e_s + e_r)^2 + (e_i)^2]^{1/2}$$

If e_s is sufficiently large in comparison to e_r , then $(e_r)^2$ becomes negligible with respect to $(e_s + e_r)^2$ and the magnitude of e_t is approximately

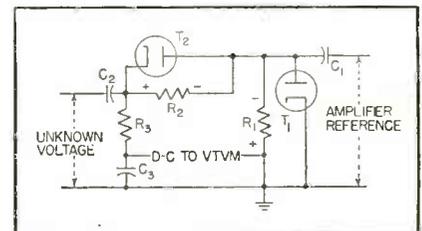


FIG. 2—Reference and unknown voltages are rectified and combined. Combination is effectively the algebraic sum of reference and the in-phase component of the unknown voltage

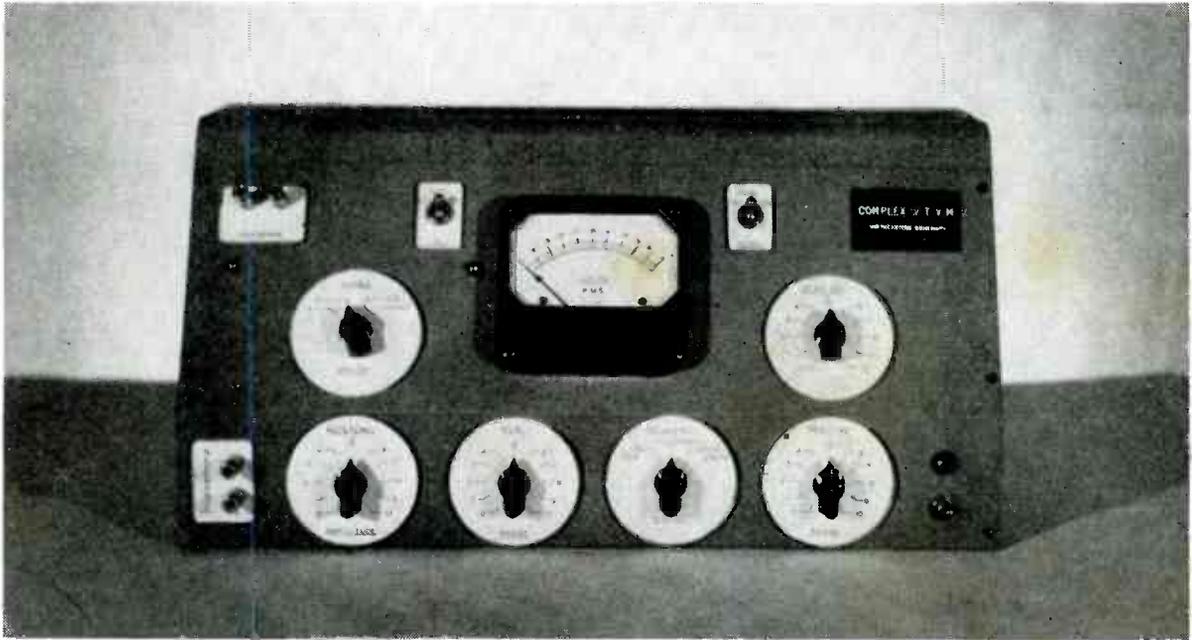
$$|e_t| = [(e_s + e_r)^2]^{1/2} = e_s + e_r$$

Therefore, e_r is approximately

$$e_r = |e_t| - e_s$$

It is therefore possible to measure the real component of the unknown with respect to a large voltage used as reference by providing an instrument that reads the difference between the magnitude of the vector sum of the unknown and reference and the magnitude of the reference alone.

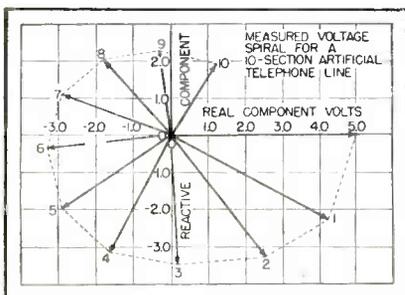
of Voltage



Complex vacuum-tube voltmeter simplifies study of phase and angle of voltages in audio-frequency circuits

In a similar manner, if the reference voltage is advanced in phase by exactly 90 degrees, then the indication of the instrument will be the imaginary component of the unknown with respect to the original reference axis.

The block diagram of a system which will perform as indicated by the preceding is shown in Fig. 1. The reference voltage e_r is fed into



Angle and amplitude of voltages across sections of an artificial transmission line can be quickly determined using the complex voltmeter

an amplifier to make the resultant amplitude large in comparison to e_r . The amplified reference is applied to a phase-shift circuit which allows the output voltage to be either in phase, or in leading quadrature with respect to e_r , thus providing for measurement of both e_r and e_j . Output of the phase-shift network is applied to rectifier No. 1, producing at its output terminals a d-c voltage proportional to the magnitude of the amplified reference.

The unknown voltage is applied (through a cathode follower) in series with the output of the phase-shift network to the input of rectifier No. 2. At the output of this rectifier there appears, therefore, a d-c voltage proportional to the vector sum of the unknown and the amplified reference. The outputs of the two rectifiers are connected in series opposition to a d-c vacuum-tube voltmeter which therefore

measures the voltage component desired. Multiple range can be obtained through a voltage divider in the e_r input circuit.

Inherent Error

If the reference voltage has an amplitude of 50 volts and the amplitude of the unknown is limited to a maximum of one volt, then the inherent error of this method for various assumed phase angles can be determined as follows

$$e_s = 50 + j0$$

$$e_x = e_r + je_j \text{ where } (e_r^2 + e_j^2)^{1/2} = 1.0$$

If we let e_r have the values given in the Table I, the true value of e_j can be computed from

$$e_j = [(1.0)^2 - e_r^2]^{1/2}$$

The magnitude of the vector sum will be

$$|e_t| = [(e_r + 50)^2 + e_j^2]^{1/2}$$

Therefore the measured values of e_r and e_j will be

Table I—Comparison of true and measured values of voltage

Value of either the real or the imaginary components			
True	Measured	True	Measured
0.00	0.01	0.60	0.61
0.10	0.11	0.70	0.70
0.20	0.21	0.80	0.80
0.30	0.31	0.90	0.90
0.40	0.41	1.00	1.00
0.50	0.51		

Measured values are tabulated to two decimal places to correspond with the precision of indicating instrument used in actual circuit.

$$e_r = [(e_r + 50)^2 + e_i^2]^{1/2} - 50$$

$$e_i = [e_r^2 + (50 + e_i)^2]^{1/2} - 50$$

Obviously the error in the measurement of either component will be the same for the same component value. As Table I shows, inherent error due to the method of measurement is not serious because the maximum error of 0.01 volts is only one percent of full scale. Furthermore, it is possible to reduce this error in the actual operation of the instrument as will be explained later.

Rectifier Circuits

Because the method of operation of this instrument is based upon the measurement of a small voltage difference between two large voltages, it is apparent that the two rectifier circuits must have characteristics as nearly identical as possible. This condition is not difficult to satisfy as each rectifier is operating linearly because the applied a-c voltages are large. In addition, although the voltage applied to rectifier No. 2 is a variable, depending upon e_x , the variation is never greater than two percent under all conditions. Because both rectifiers operate linearly, a simple zero set control can be provided in the d-c vacuum-tube voltmeter circuit to take care of slight unbalance of the rectifier circuits which may develop as the frequency is varied.

It is evident from the foregoing that the heart of the instrument is the rectifier system. The circuit diagram of Fig. 2 satisfies all of the requirements. In this circuit the amplified reference is rectified by T_1 acting as a linear peak diode, the

resulting d-c voltage appearing across R_1 with the polarity indicated. The vector sum of the unknown and amplified reference is applied to T_2 also acting as a linear peak diode, the resulting d-c voltage appearing across R_2 . The difference of these two d-c voltages then appears across C_3 as is evident from the above connections. Diodes T_1 and T_2 may conveniently be a dual diode, both diodes included in the same envelope. This circuit has the advantage over other possible solutions in that both signal sources and the vtvm have a common low potential or ground side.

Phase Shift Networks

From the description of the method given, it is apparent that if the reference is a source of low voltage, it must be amplified before being applied to the rectifier system. Furthermore, for the measurement of e_r , the amplified reference must be exactly in phase with e_s and for the measurement of e_i , the amplified reference must be exactly 90 degrees leading with respect to e_s . Because some phase shift within the amplifier is inevitable over an extended frequency range, two phase-shift controls are necessary. One is provided to secure the in-phase reference, the other for the 90-degree reference.

The reference is first shifted approximately 45 degrees in a leading direction by a resistance-capacitance circuit. The phase control

for the measurement of e_r consists of a resistance-capacitance network to shift the phase in a lagging direction so that the net phase shift is zero. The phase control for the measurement of e_i consists of another resistance-capacitance network to shift the phase an additional amount over the original 45 degrees so that the net phase shift is 90 degrees.

Complete Circuit

The diagram of the instrument is shown in Fig. 3. Tube T_1 is a double triode, each section being used as a cathode follower. The first section provides a means of changing the voltage range by the voltage divider in the cathode circuit. Range is selected by S_1 . The second section provides a divided output voltage at constant impedance for introduction into the rectifier system.

Tube T_2 is the double rectifier which works into the d-c vacuum tube voltmeter, T_3 . The latter has a range of plus or minus one volt, center zero. The switch S_2 provides a means of opening one rectifier circuit in order to set the magnitude of the amplified reference voltage at 50 volts, allowing it to be read by the same vtvm because S_2 also changes vtvm range from one volt to 100 volts. The magnitude of the reference is controlled by R_1 .

The reference is applied to the first section of T_3 , another double

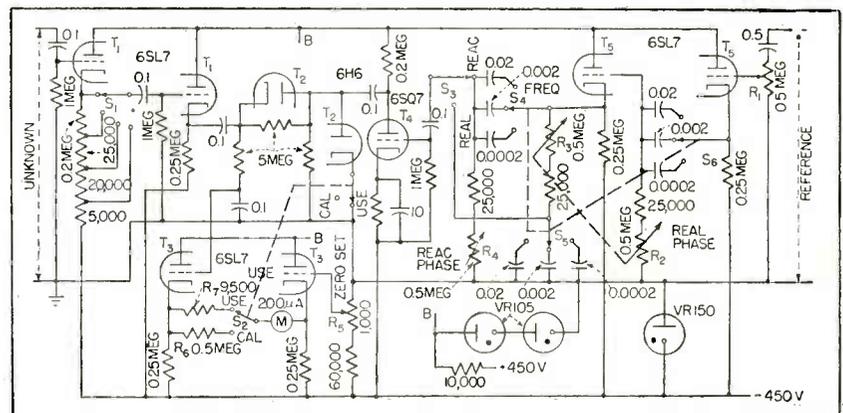


FIG. 3—Complete circuit diagram of the complex voltmeter indicates use of cathode followers to feed vacuum tube voltmeter

triode. The first section provides low output impedance for working into the phase-shift network controlled by S_3 and R_2 . This network, when properly set, provides a leading phase shift of approximately 45 degrees.

The second section of T_3 works into two phase-shift networks, one controlled by R_3 and S_4 , providing a lagging phase shift of approximately 45 degrees and its output providing the reference for measuring e_r . The other network out of T_3 controlled by S_4 and R_4 provides an additional shift of approximately 45 degrees leading for the measurement of e_j . The proper reference for the component to be measured is selected by S_5 and applied to T_4 , the voltage amplifier which then works into the rectifier system.

In all three of the phase-shift networks, the proper capacitance depends upon the frequency only. Therefore S_1 , S_2 , and S_3 are ganged together and labelled as a frequency control, to be set for the frequency range desired. Potentiometers R_2 and R_3 are ganged together and used as the phase control for the real component. The setting which gives in-phase reference results in the lead and lag 45-degree shifts mentioned above. After this control is set, the control for measuring the imaginary component, R_4 , is set for an additional 45 degrees.

Potentiometer R_5 is simply the zero set for the d-c vacuum-tube

voltmeter. Voltage regulator tubes insure stable operation.

Controls and Method of Setting

The following is a summary of all controls:

RANGE: Ranges of 1, 5, 10, and 50 volts full scale plus or minus are provided.

ZERO SET: With USE-CAL switch on USE, reference voltage applied, and unknown terminals shorted, this control is set for zero voltmeter indication. With the switch in the USE position, R_7 having a resistance of 9,500 ohms is used as the voltmeter multiplier. This multiplier gives the input to T_3 , a sensitivity of two volts. However, the microammeter scale has been altered to give a center zero, and the needle is adjusted to this point by R_8 , the ZERO SET control. The ZERO SET applies about one volt to the grid of the second section of T_3 by this adjustment. Thus the actual range of the input to T_3 is ± 1 volt.

REFERENCE AMPLITUDE: With USE-CAL switch on CAL, this control is adjusted for a voltmeter reading of 50 volts. Resistor R_6 of 0.5 meg gives the meter a full scale range of 100 volts, therefore the adjustment is made for center scale. Because R_7 has been previously set to give about one volt deflection, this voltage produces negligible deflection with the new multiplier in the circuit. The microammeter is therefore at its extreme left or zero-current position with no input voltage. The 50-volt point is therefore center scale which is marked zero on the microammeter face.

FREQUENCY: This control must be set to the appropriate range. The ranges provided are 20 to 200, 200 to 2,000, and 2,000 to 20,000 cps.

REAL PHASE: With S_5 on REAL, and an external lead used to connect the reference voltage to both the reference and the unknown terminals, this control is set for a maximum value as indicated by the vtvm.

REACTIVE PHASE: With S_5 on REAC, and an external connection as above, this control is set for zero value as indicated by the vtvm. This adjustment assures a reading of zero for the imaginary component of a pure real unknown and minimizes the inherent error of the method discussed previously.

Table II—Calculated and measured phase shift of an R-C circuit

Calculated Values		Measured Values		Operating Frequency In cps
e_r	e_j	e_r	e_j	
0.07	0.61	0.10	0.60	200
0.44	1.42	0.50	1.45	500
1.39	2.24	1.50	2.20	1,000
3.03	2.44	3.05	2.40	2,000
4.53	1.46	4.60	1.50	5,000
4.87	0.78	4.90	0.80	10,000

See Fig. 4 for circuit and equation

Although there may seem to be a large number of controls to be set, these do not have to be disturbed after they are once set providing the frequency is not changed. Therefore in the analysis of a complicated circuit at a single frequency, the operation is very simple, only the REAL-REAC switch and the RANGE switch being used.

For example, the complete voltage spiral of a twenty-section artificial telephone line may be obtained in about 15 minutes. On the other hand, if the frequency response characteristic of a network is desired, in general all of the above controls need to be reset at each new frequency. While this resetting slows down the procedure, the method is faster than others.

The agreement between measured and calculated results for the voltage across the resistance in a simple R-C circuit, as a function of frequency, is given by tabulated values in Table II and the curve in Fig. 4. Input voltage was maintained at five volts and was used as the reference.

The instrument described has been in service for a considerable period and has proved itself to be stable in operation and reliable in indication. It represents what is believed to be the first instrument that reads directly the complex value of a voltage in the rectangular coordinate system and establishing polarities of the real and imaginary components as well as their magnitudes. Its limitations are similar to those for any electronic measuring instrument, namely that controls must be set with care and voltages under measurement must be of good sinusoidal waveform and reasonably good frequency stability.

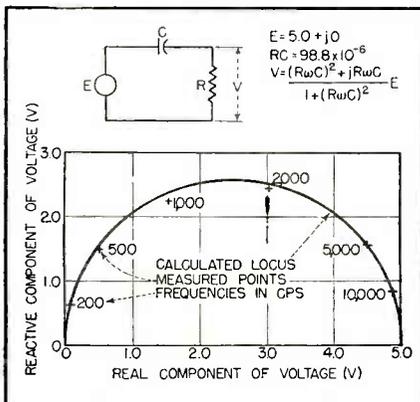


FIG. 4.—Comparison of calculated and measured voltages shows utility of meter

Airborne Radar Specifications

BECAUSE of an interest expressed by numerous readers, **ELECTRONICS** publishes the following table of radar technical specifications as an addendum to the data appearing in the November 1945 issue.

A Presidential directive, issued since compilation of this information, makes the Office of Technical Services, Department of Commerce, Washington 25, D. C., the official source for all information relating to declassified Army and Navy manuals. As the tremendous

task of listing and numbering OSRD, Radiation Laboratory, Service, Intelligence and other reports goes forward, the titles, identifying numbers and brief summaries are published in weekly issues of a running bibliography. Subscriptions to this publication are sold by the Superintendent of Documents, Government Printing Office, Washington 25, D. C., at an initial yearly charge of \$10. The reports are available on microfilm or in photostat form.

TECHNICAL DETAILS OF RADAR SETS RECENTLY DECLASSIFIED BY THE ARMY AIR FORCES AND SIGNAL CORPS

Type Number	AN/APS-10	AN/APS-15	AN/APG-5	AN/APG-13	SCR 717-1	SCR-720-A,-B,-C,-D	SCR 520-A	SCR 517-C	AN/APQ-7
Primary Function	Airborne search with beacon functions	Airborne search, bombing and navigation by beacon	Range only for gun turrets	Range for forward-firing cannon	Airborne surface search with beacon functions. Similar in purpose to SCR 517-B	Air search with beacon function. Similar in purpose to SCR-520-A,-B	Air Search (See SCR-720-A)	Airborne surface search. Also used on small craft	High resolution for blind bombing; also as altimeter and navigational aid
Size, Weight (Pounds)	Air Transportable-100	Air Transportable-349	Air Transportable-95	Air transportable-113	Air transportable-373	Air transportable-415	Air transportable-477	Air transportable-401	Air transportable-775
Carrier Frequency (mc)	10,000	9,375	2,500	2,800	3,300	3,000	3,000	3,000	10,000
Wavelength (λ) (cm)	3	3.2	12	10.7	9.1	10	10	10	3
Peak Power (Pt) (kw)	8	40	0.5	1.5	150	150	60	60	50
Pulse Width (d) (microseconds)	0.8	1 (Beacon, 2)	0.7	0.7	1.125	0.75	1	1 (Beacon, 2.5)	1, 1, 0.4 (Beacon, 20)
Pulse Rate (fr) (pps)	800	650	1,200	1,200	750 (Beacon, 375)	1,500 (Beacon, 375)	2,000 (for 100 mile range, 400)	400	400, 800, 1,600 (Beacon, 400)
Radiator Type, Size Gain (G)	dipole; 18 in. paraboloid modified for \cos^2 coverage below horizontal 700	Cutler feed to 29-in. paraboloid modified for \cos^2 to 70 deg 200	22 in. 18-element end-fire or 12-in. paraboloid. 25-40	End-fire array 35	Horizontal dipole in 29-in. parabola 340	Dipole in 29-in. parabola 340	Vertical dipole in 30-in. paraboloid 340	Dipole with 29-in. parabola 340	Variable-width wave guide feeding dipole array in 16-foot scanner 1,500
Types of Scan	Circular Tilt-18 and + 3 deg	Circular Tilt \pm 20 deg	Range search out to 1,800 or 3,600 yd	not for search	Circular Tilt + 10 to -45 deg	Circular Four types of tilt	Circular (180 deg search) Tilts at 30 deg a second	Circular (180 deg search) Tilts + 5 to -30 deg	Sector \pm 30 deg
Beam Width (b) (degrees)	5	3	28	28	9	10	10	10	0.4 Azimuth 30 Elevation
Horizontal Scanning Rate (rpm)	-	12 or 24	-	-	20	360	360	60	90
Receiver Noise (n) (db above $kt\Delta f$)	15	18	13	-	11-15	11-15	-	19-21	15
Receiver Bandwidth (Δf) (mc)	6	2.5	8	1.9	-	3	-	4	4
Indicators	1 or 2 PPI	1 type PPI 1 type A	Pilot light and linkage to computer	1 type A with step marker	2 type PPI	1 or 2 type B with 2 or 1 type C	-	1 type B Elevation meter	2 type PPI 1 type A
Maximum Range (r max) at 1,000 Feet Altitude, or as otherwise noted (miles)	55	-	(bombers at 10,000 feet) 2	-	-	5 to 10	-	(bombers at 10,000 feet) 5.7	Mounted on fighters 100
Minimum Range (yd)	400	200	-	300	200	100-250	-	125	-
Range Accuracy (yd)	\pm 2 percent	\pm 1 percent	40	\pm 30	\pm 5 percent	\pm 10 percent	-	\pm 10 percent	-
Angular Accuracy (degrees)	2	3	-	-	\pm 3	\pm 5	\pm 3	\pm 3	-
Additional information	Radar and beacon have AFC and require no manual tuning	Precision long-range beacon delay in 10 mile steps	Range unit locks on nearest target in line with guns	Operator tracks target manually	Can supply video signal to bombsight equipment	C-tube shows only targets within limits of range-dial setting	Beacon operation at 10 and 100 miles	Beacon ranges at 25 and 100 miles	PPI shows true ground range instead of slant range. Computer produces slant rangemarker at release point.



No. 2559



No. 56A12533



No. 56B12534



No. 56B12535



No. 2541



No. 2543

CINCH laminated miniature sockets extensively and constantly serve communication requirements; radio sets, auto and home, television... Cinch the complete line, the standard socket. The sockets shown illustrate the large possible variety; center shield, shield plus ground strap, shock proof spring, finder ring eliminated and replaced with two full top plates, and double bottom plate construction; the variation extended with tropicalization or wax impregnation. Cinch "Know How" anticipates the future needs, adequately serves the present requirements. Cinch laminated miniature socket is the standard. Write for samples.

Cinch



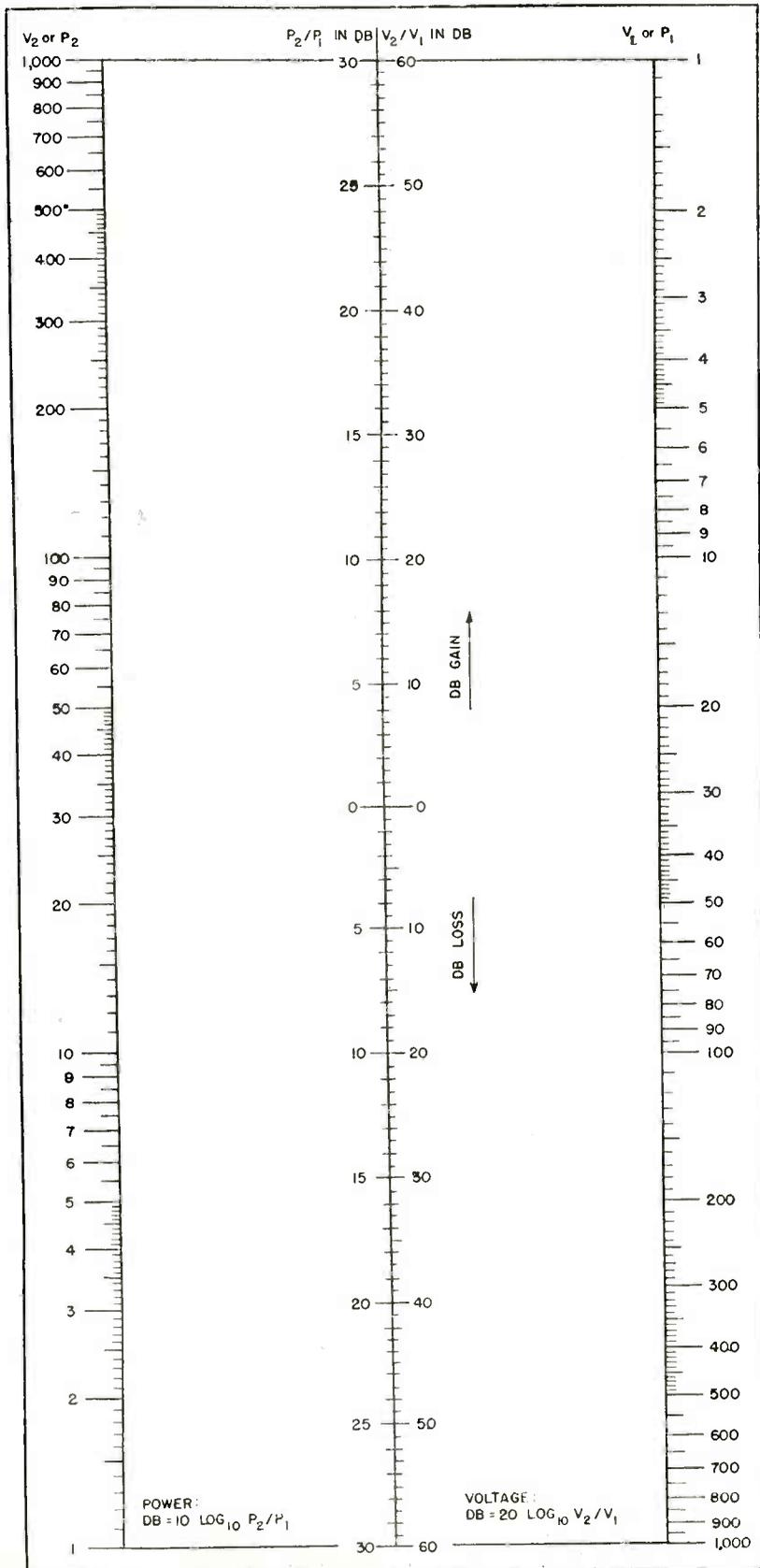
MINIATURE SOCKET

IS THE STANDARD

DB Gain-Loss Calculator

By **LLOYD A. LOHR**

Vacuum Tube Development Section
Naval Research Laboratory
Washington, D. C.



IN WORKING with communications equipment, it is often desirable to know the db gain or loss ratio of two voltages, currents, or powers with a minimum amount of calculation. This nomograph will give the db value directly for any voltage, current, or power ratio up to 1,000 to 1 with only one setting of a straightedge, and the range can readily be extended by using multiplying factors. The converse problem, of finding a ratio that will give a desired db gain or loss, can just as readily be solved.

If V_1 and V_2 are known, place the straightedge to connect their values on the outer scales and read voltage gain or loss in db on the right side of the center scale.

If P_1 and P_2 are known, place the straightedge to connect their values on the outer scales and read voltage gain or loss in db on the left side of the center scale.

If the db value and one voltage or power value are known, connect these values with a straightedge and read the other voltage or power value on the third scale.

The range of the nomograph can be extended by applying a multiplier to one of the log scales and adding to the db scale values as follows:

Multiplier for one log scale	Add to values on P_2/P_1 scale	Add to values on V_2/V_1 scale
10	10	20
100	20	40
1,000	30	60
10,000	40	80
100,000	50	100

Example: What is the db gain for a voltage ratio of 100 to 5? From the nomograph, the db gain is approximately 26.1 db. Checking, $db = 20 \log V_2/V_1 = 20 \log 20 = 26.06$ db.

Save Space . . . Improve Efficiency with a MALLORY *Self-Rectifying* VIBRATOR



MALLORY VIBRAPACK*

Mallory Vibrapacks deliver voltages from 125 to 400 from low voltage sources . . . with high efficiency, low battery drain, ease of installation, long life.

*Reg. U. S. Pat. Off. for vibrator power supplies.

**More Mallory Vibrators
are in use today than all
other makes combined**

If you're a manufacturer of automobile radios, mobile communication systems or of any other equipment using vibrator power supplies, now is the time to consider the Mallory *self-rectifying* vibrator.

Mallory self-rectifying vibrators are identical in size with the interrupter type. But—and here's the important point—they save space and wiring, and give you less components to worry about.

That's not the whole story either. You get top performance with Mallory self-rectifying vibrators. They assure high over-all power supply efficiency and eliminate the voltage drop within the rectifier tube plus the heater load.

Mallory engineers, who have produced more than 15,000,000 vibrators, invite your vibrator problems—will be glad to give you specific information about the self-rectifying type for your particular application. Write for copies of the comprehensive vibrator questionnaire.

P. R. MALLORY & CO. Inc.
MALLORY VIBRATORS
AND VIBRATOR POWER SUPPLIES

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

TUBES AT WORK

Edited by VIN ZELUFF

Guillotine Tuner for F-M.....	136
Radio Beams for Railroads.....	136
Airborne Television Telemetering.....	138
VHF Transmitter Power Measurements.....	158

Guillotine Tuner for F-M

VARIABLE inductance tuning is one answer to the problems arising from the transfer of f-m stations to the higher frequencies. Such a system has been perfected by General Electric engineers.

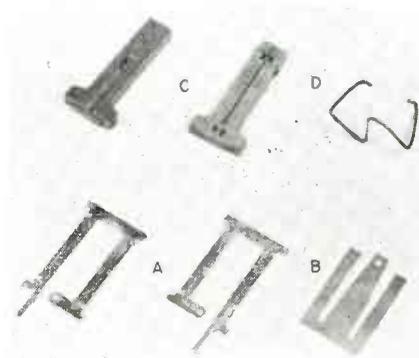
Two identical silver-plated brass frames are used which, when connected at their open ends, form a two-turn inductance. Tuning is done by movement of a silver-plated brass blade between the turns. The inductance of each turn is reduced as is the mutual inductance between them. Slots in the blade provide a means of tracking the oscillator and r-f circuits.

Because the tuner is entirely tool made, precise production control of tracking is possible without high labor content in the cost of manufacture. Both terminals of the tuner project through the receiver chassis to provide a rugged tie point for soldered connections.

Nicknamed the "guillotine" tuner

because of the sliding blade, the unit tunes both f-m bands and two or more short-wave spread bands in General Electric f-m receivers. Other ranges are tuned by adding shunt capacitance and fixed series inductance to the guillotine circuit. With the guillotine tuner it is possible to localize each tank circuit within a small area and to keep r-f chassis currents at a minimum. Since the blade of the guillotine is ungrounded, sliding contacts and pigtailed are eliminated. Little trouble is had from regeneration or alignment difficulty.

Production assembly and testing of the tuners at the factory will be localized in a department set apart from the main chassis production line. Tuners will be assembled, tested and then transported to the chassis assembly lines in much the same manner as engines are handled in an automobile assembly plant. Only two types of front-



A two-turn inductance is formed by the two frames A, and tuning is done by the guillotine blade B, sliding in the grooves of two supports, both sides of which show at C. These support posts are held to the chassis by the clamp D

end assemblies are used to tune eleven different models of General Electric f-m receivers.

The complete tuner is enclosed in a metal box for shielding, and for mechanical protection and dust proofing. Microphonic howl when receiving short-wave stations is said to be completely absent.

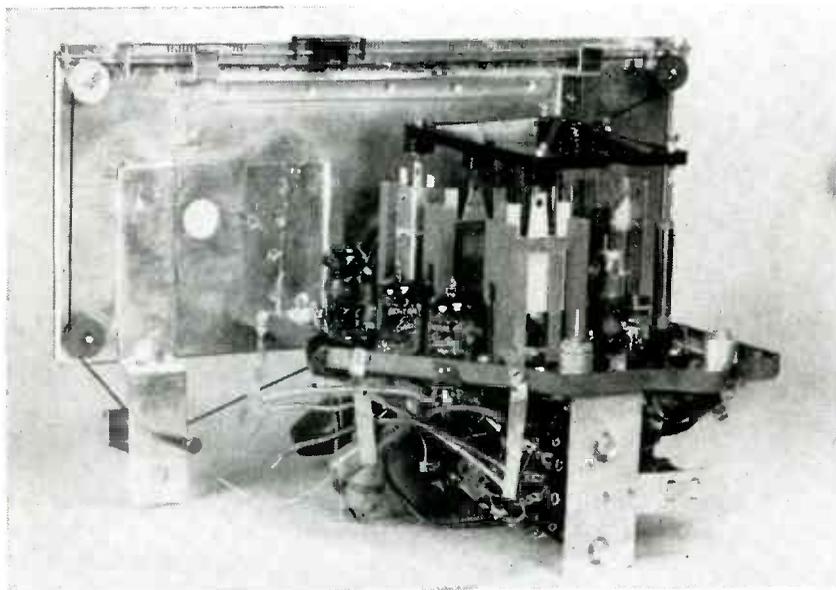
In the receiver, a loop is used on all a-m bands but power line pick-up is used for local f-m reception. Terminals permit outdoor antennas to be used.

Radio Beams for Railroads

BEAMED RADIO, wire, and cable circuits normally employed in carrying commercial messages may be utilized in emergencies to transmit electrical impulses to control railroad switches and signals.

In a recent test conducted at a signal control tower at Red Bank, Pa., the Pennsylvania Railroad employed a special linking of existing wire, cable, and beamed radio circuits extending from the control tower to Pittsburgh, Washington, D. C., Philadelphia, New York, and back to Pittsburgh and the tower.

Normally a centralized traffic control machine in Brady tower near Redbank controls the signaling between Red Bank and Oil City, (53 miles away), by the transmission of d-c pulses. These are arranged to have distinctive character for selecting the desired stations, switches, and signals over a pair of line wires extending throughout

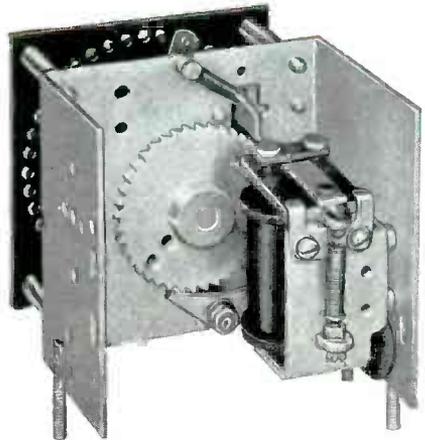


Front end of a General Electric receiver containing the guillotine tuner

HUNDREDS OF CONTROL PROBLEMS SOLVED WITH STEPPING RELAYS

Design engineers are discovering new, efficient, money-saving applications daily for Guardian basic-type Stepping Relays. Typical applications include Automatic Sequence selection of circuits; Automatic Sequence cross connection of circuits; circuit control of Automatic Business Machines; control of Production Totalizing and Conveyor equipment; remote selection of records on Coin Operated Phonographs; Automatic Circuit Selection controlled from a pulsing dial; Automatic Wave Changing on short wave transmitters. This Guardian Stepping Relay is furnished for three basic types of A.C. and D.C. operation: Continuous Rotation—Electrical Reset—Add and Subtract. On each of these types the contact finger rotates in a counter-clockwise direction and all three types are designed to follow 10 pulses per second within the rated voltage range of the relay. Special construction prohibits skipping or improper indexing of the ratchet. Guardian Steppers may be furnished as separate units; in combination with relays, contact switches, solenoids, etc., completely assembled and wired to terminals; mounted on special bases or in enclosures. Any standard Guardian Stepping Relay can be modified to meet practically all "special" stepper control applications where quantities warrant special designing. For complete details write for Bulletin SR.

GUARDIAN  ELECTRIC
 1625-B W. WALNUT STREET CHICAGO 12, ILLINOIS
 A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY



GUARDIAN SERIES R

1 Continuous Rotation

In this type the contact finger advances one step each time the circuit is made and broken. Weight approximately 20½ ozs.

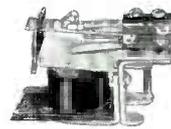
2 Electrical Reset

Resets when a second coil is energized. Weight approximately 23 ounces.

3 Add and Subtract

Steps back one or more contacts at a time instead of resetting completely. Weight approximately 28½ ounces.

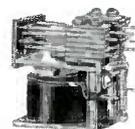
TYPICAL GUARDIAN UNITS AVAILABLE IN COMBINATION WITH GUARDIAN STEPPERS



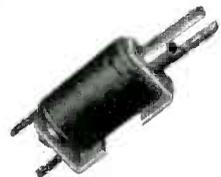
Series 100
Snap-Action Relay



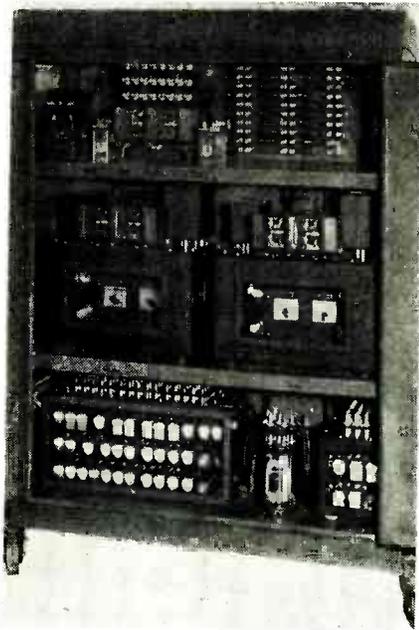
Guardian
Feathered Switch



Series 500
Midget Relay



Series I-A Solenoid



Some of the electronic equipment installed at Brady tower by Union Switch and Signal for the test

the controlled territory from the tower. The operator controls trains while watching lights on a diagram.

The switches and signals have corresponding levers on the control machine which are positioned as desired. Operation of a code-starting button gives the pulses of long and short duration predetermined sequence to select the correct station along the railroad and to operate functional relays at this location. In the test demonstration these pulses were converted to carrier current pulses which were transmitted over a PRR telephone line from Brady tower to Pittsburgh using a frequency of 12.3 kc.

The control pulses were delivered to the Western Union office in Pittsburgh, then transmitted over Western Union carrier-telegraph circuits to Philadelphia by way of Washington. This carrier frequency system has all carrier frequencies below 30 kc, and as many as 36 independent multiplex telegraph messages can be transmitted

in each direction simultaneously on a single pair of line wires. This would permit 144 telegraph operators to send messages simultaneously in one direction and a similar number in the opposite direction. In the demonstration, one multiplex telegraph channel was utilized for the transmission of the pulses while at the same time there may have been 140 telegraph messages on the same pair of wires traveling in the same direction. Repeater stations are placed along the line at intervals of about 150 miles.

Microwave Link

At Philadelphia, the control pulses modulated a microwave transmitter and were beamed toward New York City over the Western Union relay system using two intermediate repeater stations between Philadelphia and New York (ELECTRONICS, Dec. 1945, p 300).

The radio beam can handle 256 multiplex telegraph circuits so 1,024 operators could transmit telegrams simultaneously in one direction. The control code would require the equivalent of only one telegraph channel so that 1,020 telegraph messages could be on the beam at the same time that a control code was being transmitted. The frequencies used between Philadelphia and New York are 3,970 and 4,120 megacycles.

The beamed pulses terminate at the Western Union building in New York. There the pulses are shifted to a carrier transmitted over Western Union lines from New York to Pittsburgh.

At Pittsburgh, Western Union receiving equipment operated Union Switch and Signal Company carrier equipment to send coded 25.4-kc pulses on to a field carrier location at Brady tower. Here a sharply tuned 25.4-kc receiving filter discriminates against other fre-

quencies (two carrier frequencies, 12.3 and 25.4 kilocycles, are transmitted in opposite directions on the one line pair at the same time between Brady and Pittsburgh). After the 25.4-kilocycle pulses are amplified, they are fed through auxiliary apparatus which converts them to d-c pulses and places them on the code line extending to the switch and signal locations.

After a switch and signal respond to the control code, the circuits start an indication signal back to the control point to show what has transpired. This travels back over the same types of circuits.

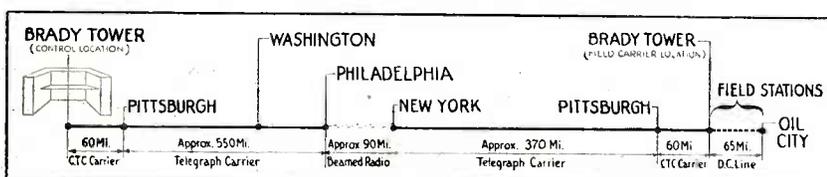
The demonstration suggests the immediate possibility of use of radio as a standby communication channel to insure continuity of centralized traffic control operation in cases of line failure because of flood, hurricane, or storm, because there would be less possibility of interruption than with pole-carried line wires.

Airborne Television Telemetry

TELEVISION TELEMETERING enables observers at a ground station to see by television all instrument recordings and indicators of pressures, strains and structural failures of a test plane in the air. Thus, the pilot is freed from the necessity of keeping a constant check on his test instruments, and can devote his full attention to handling the plane.

To supply the need for a permanent record of test flights, all flight data shown on the television receiver screen on the ground is put on movie film. If serious failures result in the loss of a plane, these pictures, being filmed up to the moment of disintegration, can be studied to establish accurate reasons for the mishap.

The system as developed for the Navy by engineers of Farnsworth and Curtiss-Wright consisted of a television theater and television transmitter in the plane and a mobile television receiving unit on the ground. This equipment trans-

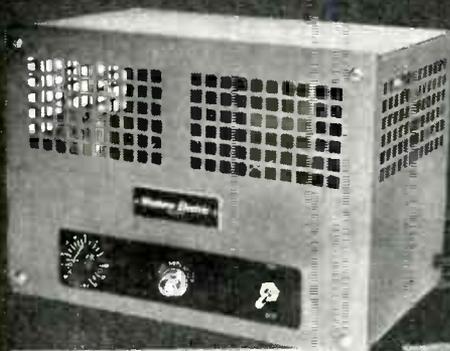


The normal 65 miles of wire line used for traffic control between Brady Tower and Oil City were spread out to over 1,000 miles of carrier current and beamed radio circuits for the communication test

(Continued on p 154)

PACKAGED FOR WIRED MUSIC

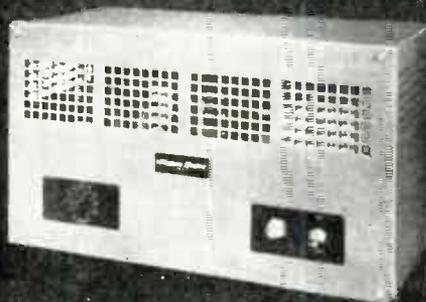
3 new Subscriber Amplifiers



140A single channel a-c-d-c amplifier.



124H two channel amplifier with selector switch.



124J single channel line level amplifier.

These three new amplifiers designed by Bell Telephone Laboratories are the first high quality packaged units ever made specifically for subscriber installations of wired music service.

The 124H and 124J are adaptations of the same general type used so successfully on network program distribution lines and in radio stations and public address systems. They differ only in that the 124H offers a microphone channel in addition to the line channel. The completely new 140A a-c-d-c amplifier, which is the *first* ever to offer the same stability with d-c operation as it does with a-c, can probably be used in 80% of your subscriber installations.

All three units can operate directly from telephone lines because they are equipped with a suitable input transformer. All may be used as fixed or portable equipment, and are suitable for rack or cabinet mounting.

For full information, call your local representative of the Graybar Electric Co., or write to Graybar, 420 Lexington Ave., New York 17, New York.

	124H	124J	140A
Frequency Response	±1 db 50 to 10,000 cycles.	±1 db 50 to 10,000 cycles.	±1 db 50 to 10,000 cycles.
Maximum Gain	63 db (line) 104 db (microphone)	63 db	60 db
Gain Control	Continuously variable.	Continuously variable.	Continuously variable.
Source Impedance	37½, 150 or 600 ohms (line), 30 or 250 ohms (microphone).	37½, 150 or 600 ohms.	150 ohms, 600 ohms or bridging.
Load Impedance	1 to 1,000 ohms.	1 to 1,000 ohms.	(4 windings) 4, 8, 125, 125 ohms.
Signal to Noise Ratio	77 db (line), 48 db (microphone).	77 db	60 db
Output Noise	-37 dbm (line), -8 dbm (microphone).	-37 dbm	-20 dbm
Output Power	12 watts 2% total harmonic distortion for nominal load impedance. 20 watts 5% harmonic distortion if reconnected and Western Electric tubes are used.		6 watts d-c, 10 watts a-c, less than 5% harmonic distortion. 5 watts d-c, 8 watts a-c, less than 2% harmonic distortion. 4 watts d-c, 6 watts a-c, less than 1% harmonic distortion.
Power Supply	105-125 volts, 50-60 cycle a-c.	105-125 volts, 50-60 cycle a-c.	105-125 volts, a-c or d-c.

Western Electric
— QUALITY COUNTS —



Distributed by
Graybar
OFFICES IN 95 PRINCIPAL CITIES

INDUSTRIAL CONTROL

Edited by VIN ZELUFF

Automatic Recording Ultraviolet Photometer.....	140
Electronic Drive for Printing Presses.....	176
Simple Foolproof Production Tester.....	178
Electronic Ignition System.....	184

Automatic Recording Ultraviolet Photometer

BY IRVING M. KLOTZ AND MALCOLM DOLE

Department of Chemistry, Northwestern University
Evanston, Illinois

A RAPID and accurate method of gas analysis involving electronic equipment, amplifiers, photoelectric recorders and the like was developed at Northwestern University in connection with an OSRD sponsored research.

It became highly desirable to be able to follow concentrations of toxic gas in a moving air stream in the laboratory or at some particular point above ground in the open in order to study first, the effectiveness of activated charcoals in adsorbing toxic gases and second, the effectiveness of chemical warfare munitions in producing lethal concentrations when exploded under all kinds of meteorological and geographical conditions.

For analysis in the gaseous state, the property of certain gases to absorb ultraviolet light strongly can be used to detect two or three parts

per million of the gas and to measure accurately greater concentrations. In our apparatus this measurement was accomplished by introducing a balanced double-phototube arrangement with null-point measuring circuit. Provision was made for making an absolute measurement of the intensity of the ultraviolet radiation from a five-watt germicidal lamp which gives 95 percent of its radiation at 2537A. Operating from 110-volt a-c, a portable alternator was used in the field as a power supply. The instrument can be operated on d-c by making a few simple modifications.

The principle of operation of the instrument, whose electrical circuit is illustrated in Fig. 1, is to balance by means of camera diaphragms the light being received by the two phototubes P_1 and P_2 until the emf drop across the resistance

R_1 is zero, and then allow the air containing the toxic gas to flow through an absorption cell. Absorption of some of the ultraviolet light by the toxic gas upsets the balance producing an emf drop across R_1 which could be measured. Calibration of the instrument with



FIG. 2—Professor Klotz (left) and Professor Dole of Northwestern demonstrate the ultraviolet photometer developed by them for gas analysis

known gas concentrations provided an accurate quantitative foundation for the work.

A completely assembled instrument with a General Electric photoelectric recording microammeter is shown in Fig. 2.

Applications

Figure 3 illustrates a record of the concentration of chloropicrin gas in parts per million as a function of time in an experiment study.

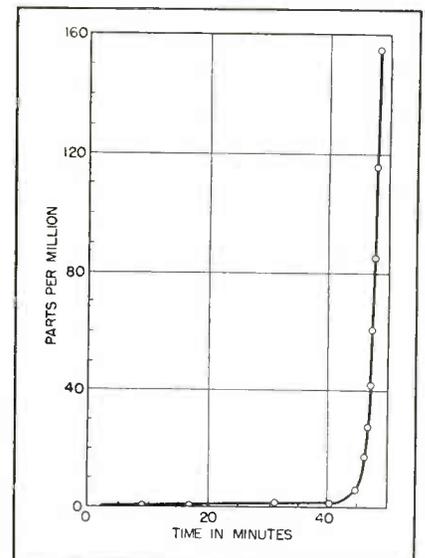


FIG. 3—Chloropicrin effluent concentration as determined by the ultraviolet photometer

(Continued on p 174)

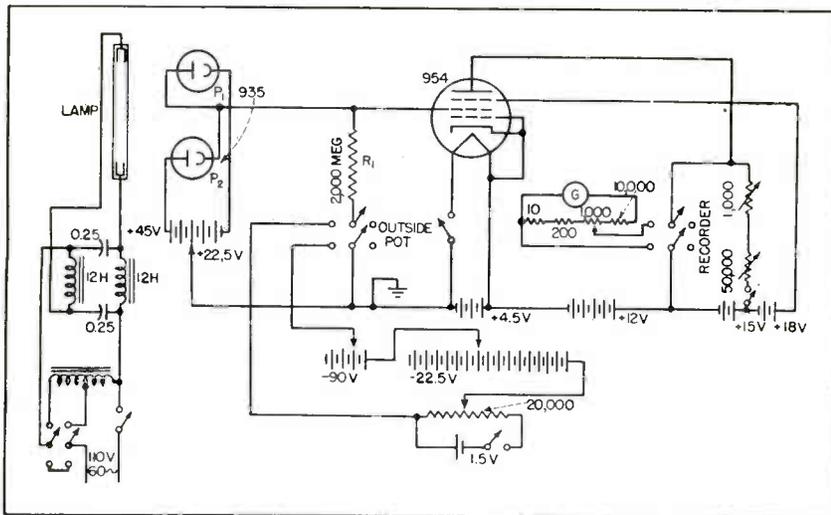
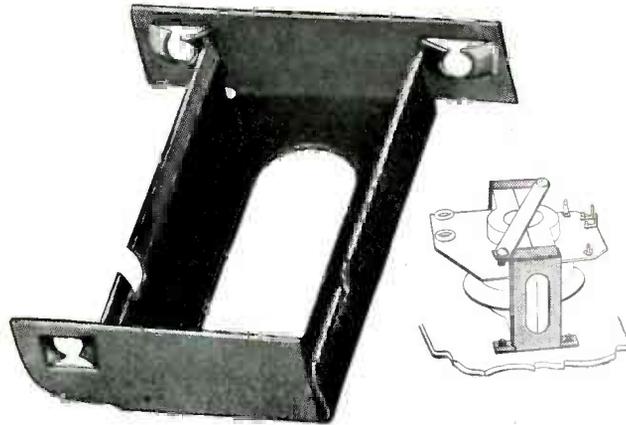


FIG. 1—Wiring diagram of the ultraviolet photometer

This is a **SPEED NUT**.....



and



THIS is also a **Speed Nut!**

Of course you recognize the Standard SPEED NUT shown above, but just look at the "nightmare" our development engineers dreamed up, to provide multiple fastening and operational functions in a single unit! It is used in the assembly and mounting of television transformers (see sketch) and you can readily understand its advantages over special mounting brackets and individual, hard-to-handle threaded nuts and lock washers.

In addition to the widely-used standard types of SPEED NUTS, hundreds more are *functionally* designed to combine assembly operations, eliminate unnecessary handling of parts, speed-up production and thereby reduce final costs. They

are fabricated on specially designed, automatic machines which produce *completely finished* parts at high speeds.

There must be some step in the assembly of your product where, by changing over to SPEED NUTS, your costs could be reduced and your product improved. Why not send us your assembly details, or better still, send in the parts involved. We will be glad to give you a complete fastening analysis . . . at no cost.

TINNERMAN PRODUCTS, INC.
2106 FULTON ROAD • CLEVELAND 13, OHIO

In Canada: Wallace Barnes Co., Ltd., Hamilton, Ont.
In England: Simmonds Aerocessories, Ltd., London
In France: Aerocessoires Simmonds, S. A., Paris
In Australia: Aerocessories, Pty., Ltd., Melbourne

Speed

MORE THAN 4000



Nuts
PATENTED

SHAPES AND SIZES

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

F A S T E S T T H I N G I N F A S T E N I N G S

THE ELECTRON ART

Edited by FRANK ROCKETT

Cathode-ray Tube for Displaying Speech Waves.....	142
Superconductive Radio-Frequency Detector.....	142
Classroom Demonstration of Cathode Follower.....	188
Calibrating Laboratory Standards Against WWV.....	190
Impedance Measurements.....	194
Radio Reflection from the Moon.....	196
Microwave Spectroscope.....	198
Modulation of Concentrated-Arc Lamp.....	202
Electronics in the Food Industry.....	206
Edison Effect.....	208
Variable Electronic Capacitor.....	210

Cathode-Ray Tube for Displaying Speech Waves

DISPLAYING patterns of speech waves on a cathode-ray tube enables the deaf to communicate verbally. The technique is being studied at Michigan State Normal College as a teaching method whereby deaf children can learn to read speech patterns just as they would a printed text. Using the technique, the deaf can enjoy the radio and carry on telephone conversations.

The speech translator tube (*Jour Appl Phys*, p 891 November 1946) consists of a cylindrical tube in which the phosphorescent material is deposited on a peripheral band. The electron gun at the bottom of the tube projects an intensity-modulated beam at the axis of the tube. An external coil on the neck

deflects the beam slightly. The electron beam then passes into an expanded section of the tube. A strong magnetic field perpendicular to the tube's axis deflects the electron beam radially so that it strikes the phosphorescent band. There is an accelerating anode at the top of the tube. The tube slowly rotates to provide the sweep so that, to a stationary observer, the pattern appears to move from right to left. One reads against the motion of the pattern; that is, one reads from left to right. Both intensity modulation of the beam and deflection produced by currents in the coil on the neck provide means for representing the speech wave on the screen. Used in this way the rotating tube constitutes a sound spec-



The modified cathode-ray tube has a long-persistence phosphor on a cylindrical screen. When mounted in a strong perpendicular magnetic field and slowly rotated, the tube displays a continuous pattern of the speech wave

trograph displaying the signal as a continuously moving pattern. Electrical connections to the tube are made through slip-rings.

For displaying visible sound (*Jour Aco Soc Am* p 1-88 July 1946), the speech wave can be modified to incorporate the selective and nonlinear effects introduced by an ear. It is anticipated that by this method the deaf will not only be enabled to hear with their eyes, although of course the sensations they receive will not be that of audibly hearing, but also learn to talk and to interpret the significance of sounds not directly associated with speech such as music and noises.

Superconductive Radio-Frequency Detector

DEVELOPMENT of bolometers has progressed to the point where response times as fast as 5×10^{-4} second are obtained (*Jour Opt Soc Am*, p 518 September 1946). Such bolometers respond to infrared waves intensity-modulated at voice

(continued on p. 186)



Professor Harriet Green speaks into the microphone. Patterns of the speech waves move across the screen of the special revolving cathode-ray tube, the screen of which is at the left inside the light shield. Joyce Arnold and Richard Hudson read the patterns

Improved operation of automobile radios



with radio antenna lead-in cable insulated with

Du Pont **POLYTHENE**

Now, with the use of Du Pont polythene, it is possible to make a lead-in cable, from the antenna to the instrument, that helps to assure proper operation of automobile radios—a lead-in cable that is water-tight, has excellent electrical properties, is economical to assemble, and gives long service.

Du Pont polythene has been successfully used as the insulating material for the shielded lead-in tubing made by The American Brass Company, Waterbury, Conn., because it has low capacitance and is usable over a wide range of temperatures. In addition, Du Pont polythene has these other outstanding advantages:

RESISTANCE TO MOISTURE—Polythene has low moisture permeability, protects

the cable from short circuits caused by moisture.

LASTING FLEXIBILITY—Polythene withstands twisting and bending over a wide range of temperatures.

HIGH "Q"—Electrical losses within a polythene-insulated cable are negligible.

EASE OF HANDLING—Polythene has good extrusion qualities, is economical to assemble.

Your insulating problem may be solved by using Du Pont polythene. Write us for complete information on this light-weight, durable insulating material. E. I. du Pont de Nemours & Co. (Inc.), Plastics Dept. 152, Arlington, N. J.

A Extruded tube of Du Pont polythene, Type PM-1, 0.125" I. D. x 0.200" O. D. (one of many sizes), used for inner core of shielded lead-in tubing for a radio antenna. Polythene is ideal for this core because it is easily extruded, is stabilized, retains electrical properties.

B Tinned copper basket-weave braid is woven over inner core of polythene to incorporate electrical properties necessary in shielded lead-in tubing.

C The outer jacket, Type PM-2 polythene, about .35 mils thick, adds neat appearance, seals out water.

Du Pont manufactures polythene molding powder.

Commercial extruders convert polythene into the forms of





Plastics

BETTER THINGS FOR BETTER LIVING
... THROUGH CHEMISTRY

NEW PRODUCTS

Edited by A. A. McKENZIE

New equipment, components, packaged units, allied products; new tubes. Catalogs and manufacturers' publications reviewed

Dielectric Heater Crystal (1)

NORTH AMERICAN PHILIPS Co., 100 East 42nd St., New York 17, N. Y. A new midget quartz crystal oscillator for controlling the frequency of dielectric heating apparatus measures less than $\frac{1}{8}$ inch in



diameter and is less than $1\frac{1}{4}$ inches long. Frequency coincides with that assigned by the FCC for this service and the unit is completely enclosed with soldering terminals provided for quick connection to the circuit.

UHF Peak Voltmeter (2)

GENERAL RADIC Co., 275 Massachusetts Ave., Cambridge 39, Mass. The type 1802-A crystal galvanometer directly measures 0.1 to 1 volt with an accuracy of ± 5 percent at frequencies up to 1,000 megacycles. Two multipliers are furnished to extend the range to 10 or 100 volts. For the measurement of voltage ratios, the frequency limit can be pushed well above 1,000 megacycles. Functionally, the instrument is a peak-reading device employing a crystal rectifier, d-c



amplifier, and meter. Batteries required for operation are self contained.

Television Lead-In (3)

ANACONDA WIRE AND CABLE Co., 25 Broadway, New York, N. Y. Two types of ATV two-wire polyethylene insulated line are available for television and f-m lead-in use, with characteristic impedances to match various types of antenna ar-

USING THE NUMBERS

Readers desiring further details concerning any item listed in the *New Products* department can obtain the information by using the cards furnished as a stiff, colored insert elsewhere in this department.

Place the number (appearing to the right of the heading) of one item in which you are interested in a circle and then fill out the balance of the card according to directions appearing on the colored sheet.

rays. Complete information and prices are available on request.

Vacuum Leak Detector (4)

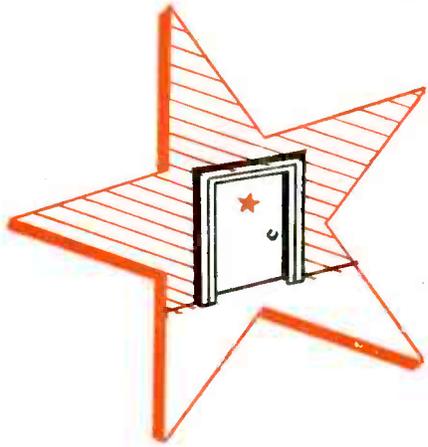
CONSOLIDATED ENGINEERING CORP., Dept. BB, 620 N. Lake Ave., Pasadena 4, Calif. A new portable leak detector model 24-101 for vacuum



or pressure systems that will locate and measure leaks as minute as 0.00000001 cubic centimeters per second works on the mass spectrometer principle. The instrument operates electronically to detect small quantities of helium introduced into suspected areas. The warning system contains an audio signal that changes pitch to indicate magnitude of the leak. The cabinet housing the equipment measures 43x25x22 inches and is mounted on ball bearing casters.

Flaw Detector (5)

GENERAL ELECTRIC Co., Schenectady, N. Y. A new flaw detector that continuously detects weak spots and conducting paths in thin materials such as paper, sheet rubber, plastic material, and enamel films has recently been announced. The apparatus can be used with materials up to 0.025 inch thick moving as fast as 450 feet per minute and wire moving up to 100 feet a minute. Principle of operation depends upon applying an adjustable voltage to the material undergoing test and detecting the flow of current through the material when a flaw



It's PERFORMANCE that COUNTS

*On the assembly line or in the laboratory
Visual Alignment Techniques insure better
performance.*

HIGH FREQUENCY VISALGEN Model 205 TS

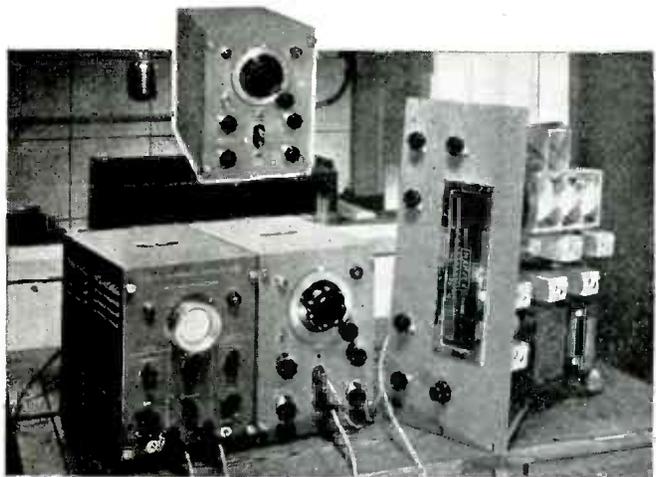
1. Frequency range from 100 kc to 20 mc.
2. Linear frequency sweep deviation adjustable from 0 to 900 kc peak to peak.
3. Vernier frequency control of 100 kc allows zero beat calibration of main tuning dial or for vernier frequency deviation about main dial frequency setting.
4. Output impedance 1 ohm to 2,500 ohms.
5. Voltage regulated supply for internal oscillators.

LOW FREQUENCY VISALGEN Model 204 TS

1. Frequency range from 20 kc to 500 kc.
2. Linear frequency sweep deviation adjustable from 0 to 70 kc peak to peak.
3. Low pass filter in the output to minimize spurious output frequencies.
4. Output impedance constant 200 ohms.
5. Output attenuation: 5-step ladder type — 20 db per step.

OSCILLOSCOPE Model 188 TS

1. New simplified circuit for use with either model Visalgen.
2. Simplified for visual alignment work.
3. Compact design — light weight.
4. Immediately available, also available with either model Visalgen complete in one cabinet.

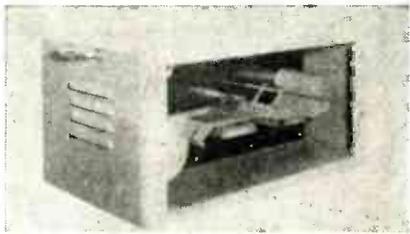


Visalgen Model 205 TS being used with 188 TS oscilloscope to align Harvey Hi-Fidelity FM Receiver.



Inset: New Low Frequency Visalgen Model 204 TS

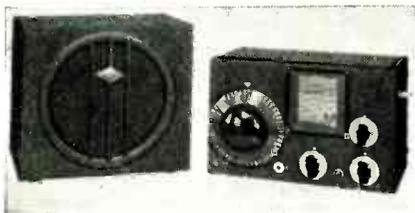
HARVEY RADIO LABORATORIES, INC.
439 CONCORD AVENUE • CAMBRIDGE 38, MASSACHUSETTS



passes. The equipment can be set up close to the manufacturing process in order to spot variations in quality immediately.

VHF Receiver (6)

NATIONAL CO., Malden, Mass. The NC-One-Ten-A radio receiver has been redesigned as a result of radiosonde use and represents an improvement over the original receiver that tuned the spectrum



from one to ten meters. Although the instrument has many practical applications, such as reception in the 118-megacycle aircraft band, it is of particular use to experimenters and amateurs.

High Mu Triode (7)

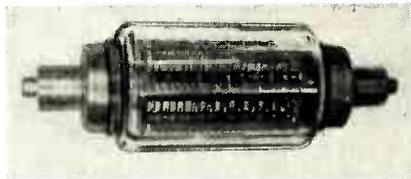
NATIONAL UNION RADIO CORP., 57 State St., Newark 2, N. J. An amplification factor of 500 at plate voltage ratings from 1 to 8 kilovolts is possible with the type 2C53 tube. At plate voltages between 250 and 400 volts, it is possible to obtain single stage amplification from 250 to 300 times. The tube has been particularly designed for



regulation of low-current power supply voltages up to 8 kilovolts, such as in pulse amplifiers, for high-impedance measurements, and in television equipment.

Vacuum Capacitor (8)

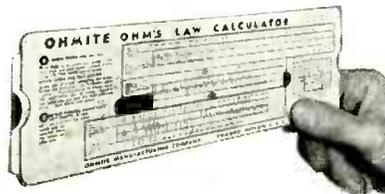
RAYTHEON MFG. CO., Waltham, Mass. The type RC100-20 vacuum capacitor is the first in a new line of high-voltage, high-current components designed for tank circuits in industrial and communications oscillators. The new unit, which has a capacitance of 100 micromicrofarads, can be used at r-f volt-



ages up to 20,000 and will carry an rms current of 60 amperes. Overall length of the capacitor is 7.25 inches and diameter is 2.5 inches.

Ohm's Law Calculator (9)

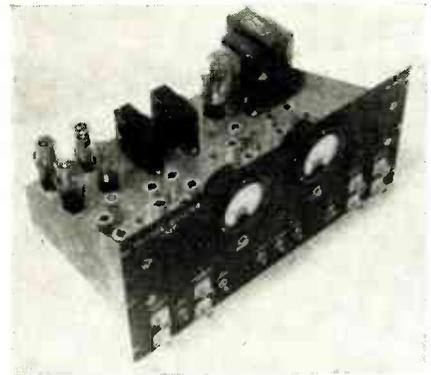
OHMITE MFG. CO., 4937 Flournoy St., Chicago, Ill. A new pocket-size calculator reads directly in ohms, volts, amperes and watts. It will also solve parallel resistance and series capacitance problems, will



multiply, divide and find squares or square roots. Composition resistor color coding is also shown. The calculator measures 3x9 inches and sells for 25¢.

Decade Counter (10)

GENERAL ELECTRIC Co., Syracuse, N. Y. A new decade scaling unit for use with particle detectors will respond to impulses of 0.05 microsecond duration separated by only



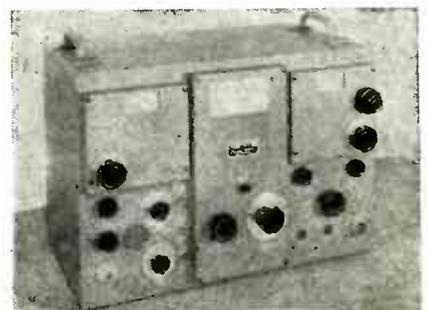
0.1 microsecond. Scaling factor of the type YYZ-1 unit is either 10 or 100, but units can be used in cascade to provide factors of 1,000 or more. Impulse duration and resolution times were incorrectly reported in a previous announcement of this product.

Television Receiving Antenna (11)

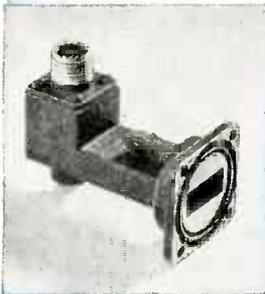
WORKSHOP ASSOCIATES, INC., 66 Needham St., Newton Highlands 61, Mass. Primarily designed for single-channel operation in locations where signal-to-noise ratio is low, the new series of television receiving antennas aims to improve reception only in poor locations. There are separate structures available for each of five bands. Price exclusive of standard coaxial cables is \$28.50 each.

Field Intensity Meter (12)

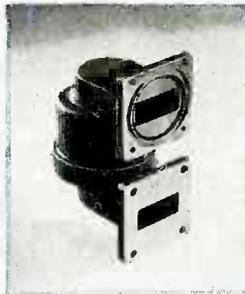
CLARKE INSTRUMENT CORP., 910 King St., Silver Spring, Md. The model 106 field intensity meter for use in the television and f-m bands covers the frequency range 50 to 220 mc. The instrument is direct reading in terms of microvolts per meter over a range of 5 microvolts to 10 volts. Selectivity is adequate for measurements on adjacent f-m



EVERY DE MORNAY-BUDD WAVE GUIDE is Electrically Tested, Calibrated and Tagged



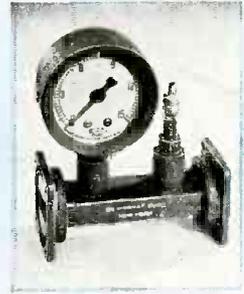
Crystal Mount DB-453



Rotating Joint DB-446



90° Elbow (H Plane) DB-433



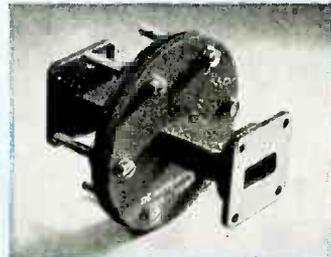
Pressurizing Unit DB-452



Mitered Elbow (H Plane) DB-439



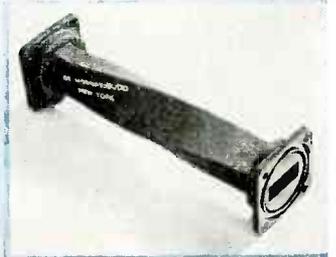
Uni-directional Broad Band Coupler DB-442



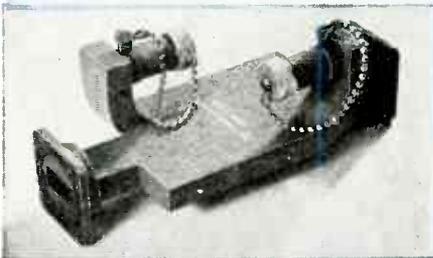
Bulkhead Flange DB-451



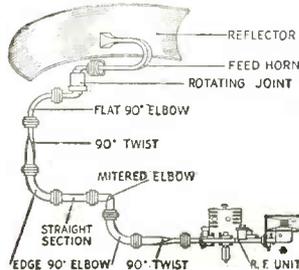
Uni-directional Narrow Band Coupler DB-440



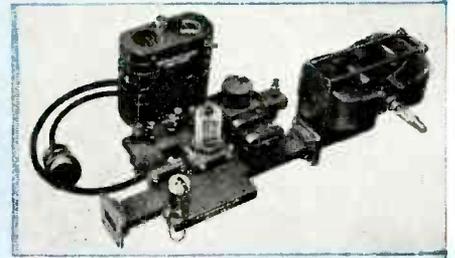
90° Twist DB-435



Bi-directional Narrow Band Coupler DB-441



Typical wave guide assembly illustrating use of De Mornay-Budd components available from standard stocks.



RF Radar Assembly DB-412

When you use any De Mornay-Budd wave guide assembly, you know exactly how each component will function electrically. You avoid possible losses in operating efficiency through impedance mismatches, or breakdown and arcing caused by a high standing wave ratio. (See chart below.)

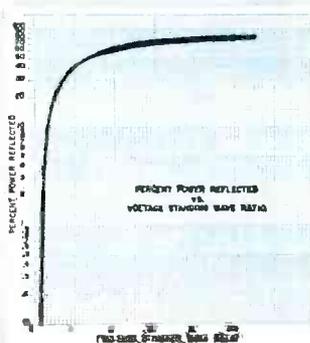
De Mornay-Budd wave guides are manufactured from special precision tubing, and to the

most stringent mechanical specifications. Rigid inspection and quality control insure optimum performance

NOTE: Write for complete catalog of De Mornay-Budd Standard Components and Standard Bench Test Equipment. Be sure to have a copy in your reference files. Write for it today.

The curve shows the manner in which the reflected power increases with an increase in the voltage standing wave ratio. The curve is calculated from the following equation:

$$\% \text{ Power Reflected} = \left(\frac{\left(\frac{V_{\max}}{V_{\min}} \right) - 1}{\left(\frac{V_{\max}}{V_{\min}} \right) + 1} \right)^2$$



De Mornay-Budd, Inc., 475 Grand Concourse, New York 51, N. Y.

channels 200 kc apart. A 110-volt power supply can be substituted for the vibrator supply incorporated in the equipment.

Rectifier Tube (13)

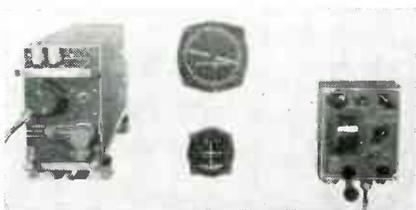
ELECTRONS INCORPORATED, 127 Sussex Ave., Newark 4, N. J. A new half-wave xenon gas-filled rectifier type 16F has been designed for applications in rectifier circuits giving up to 96 amperes d-c at voltages varying from 24 to 600. Characteristics include: average anode cur-



rent, 16 amperes; peak anode current, 96 amperes; peak inverse voltage, 620 volts; average arc drop, 7 volts; filament voltage, 2.5 volts.

Navigation Receiver (14)

RADIO CORP. OF AMERICA, Camden, N. J. The new type AVR-25 aircraft communications and navigation receiver consists of four units—control box, azimuth indicator,



left-right indicator, and receiver proper. The latter unit operates on all the aircraft vhf channels and makes possible the use of two-course visual ranges as well as the omnidirectional range.

F-M Broadcast Tube (15)

WESTERN ELECTRIC Co., 195 Broadway, New York 7, N. Y. The type 5541 air-cooled transmitting triode has been designed particularly for use in the company's 10-kw f-m transmitter, but can be adapted for



use in grounded-plate, grounded-grid, or grounded-cathode circuits. Design features include a thoriated tungsten filament, low-inductance and high-conductivity leads.

V-T Test Set (16)

SYLVANIA ELECTRIC PRODUCTS, Inc., 500 Fifth Ave., New York 18, N. Y. The console unit illustrated includes bridge and auxiliary switch gear mounted on the control shelf,



electronically regulated power channels, bridge signal source, amplifier, meters, and other accessories conveniently located for tube tests and maintenance. The console is 55 inches high, 70 inches long, and 34 inches deep. It weighs 1,500 pounds.

Current Feed Junction (17)

JAMES KNIGHTS Co., Sandwich, Ill. The Impedacoupler is essentially an



insulating block with ends machined to take standard aluminum or dural tubing having 1-inch outside diameter. It is fitted with an Amphenol type 1R receptacle that takes a type 1SP cable connector. The unit has several uses, such as center feed point of a half-wave doublet.

Rugged Speaker Driver (18)

UNIVERSITY LOUDSPEAKERS, INC., 225 Varick St., New York 14, N. Y. A new loudspeaker driver unit capable of handling up to 12 watts of audio power features an Alnico V magnet and one-piece phenolic diaphragm. The voice coil is wound on a duralumin band for maximum heat dissipation. Impedance of the unit is 8 ohms and its frequency



range covers 100 to 6,000 cycles. It is 3 inches high with a diameter of 3½ inches.

Zinc Solder (19)

SUPERIOR FLUX Co., 901 Public Square Bldg., Dept. 1, Cleveland, Ohio. Zinctite is a self-reacting fluxless solder that can be used for soldering copper, brass, steel or zinc pieces to zinc or zinc-base alloys. It comes in the form of a paste in ½, 1, or 5 pound jars.

Crystal Microphone (20)

BRUSH DEVELOPMENT Co., 3405 Perkins Ave., Cleveland 14, Ohio. The model BA-106 microphone is manu-

(Continued on p. 212)

FINISHING WASHERS

Diamond G makes a full line of hollow and flush type finishing washers. Available in all finishes and types of metals.

SPECIAL WASHERS AND STAMPINGS

A complete range of sizes are available in Diamond G special "C" washers. Unusual stampings of all kinds produced in Garrett's modern stamping plant which turns out millions of stampings.

SPRING STAMPINGS

Garrett's modern facilities for stamping and precision heat treating make it possible to produce spring stampings of the highest quality. Producing special spring stampings to exact specifications in an amazingly short period of time is a specialty of Garrett's.

SPRING WASHERS

Diamond G has built an outstanding reputation for producing a wide variety of spring washers. They offer manufacturers an excellent source of supply for special shaped, curved, dished and cupped spring washers.

FLAT WASHERS

Outstanding in the Diamond G line of products are the many flat washers made by Garrett's. It offers industry a quick and dependable source of a complete line of flat washers including SAE, machine-screw, and aircraft washers in all sizes, thickness, metals and finishes. Garrett's also produce a complete line of snap, space and retainer rings for all types of industrial installations.

HOSE CLAMPS

Garrett's line of hose clamps includes both types to provide the manufacturer with the answer to his problems. The Diamond G Multi-Clamp is the ideal clamp of a thousand uses which can be used on automotive, hydraulic, pneumatic, electronic and aviation installations. The Diamond G Auto-Seal Clamp is truly the all-purpose economy clamp for every industrial use . . . is rugged and provides a tight seal on every joint.

SMALL PARTS DIAMOND G MAKES THEM!

Whatever your need in small parts—lock washers, flat washers, special washers, snap and retainer rings, stampings of all kinds and hose clamps, Diamond G is ready to make quick deliveries. Diamond G also offers its complete facilities to produce special parts you may need in your products. Diamond G Engineers stand ready to help you in every way.

Another Diamond G service to industry is the new lock washer specification and data book . . . "How, Why and Where of Lock Washers." A booklet every purchasing agent, design engineer and production man should have. Yours without obligation. Just write to . . .

GEORGE K. GARRETT COMPANY, INC.
1421 CHESTNUT ST., PHILADELPHIA, 2



DIAMOND PRODUCTS

LOCK WASHERS • FLAT WASHERS • STAMPINGS • SPRINGS • HOSE CLAMPS • SNAP AND RETAINER RINGS

NEWS OF THE INDUSTRY

Edited by JOHN MARKUS

Worldwide status of television; production figures; new synchro-cyclotron; three-tube receivers for India; important meetings

Television Equipment Maintenance Course

A COURSE in Operation and Maintenance of Television Equipment is being offered for the first time by New York University, with classes being held Friday evenings at the DuMont television studios under the supervision of S. R. Patremio, chief engineer of DuMont's television station WABD. Fee is \$50 for 15 sessions.

Prerequisite is satisfactory completion of two other NYU evening courses, in Television Circuits (Friday evenings for 15 weeks starting Feb. 7) and Ultrahigh-Frequency Television Circuits (Wednesday evenings for 15 weeks starting Feb. 5). There are no academic requirements, however, for these noncredit courses. Other evening courses offered in the

Spring term cover Elements of Radio and Electronics (Friday evenings), and Applied Electronics (Thursday evenings). Further information can be obtained from S. G. Roth, New York University, Washington Square, New York 3.

French Television Plans

AN EFFORT will be made to set a new higher-line standard for French television by early 1947, according to Andre Ory, director of Television Francaise, the governmental telecasting organization. Present broadcasts from the Eiffel Tower station use 450 lines.

The Societe Radio-Industrie has now developed an experimental set

using 819 lines, with a new small iconoscope. M. Barthelemy, at the Compagnie des Compteurs, is working on a 1,015 line set; Thomson-Houston is perfecting its 500-900 line apparatus. Four-power interlacing has been tried by Television Francaise, but has not worked out.

Cab and Truck Frequencies

THOUGH REQUESTS by representatives of taxicab and trucking groups for five-year experimental radio-telephone licenses have been denied by the FCC, qualified applicants will continue to be granted Class 2 experimental licenses for taxicab operation on 152.27 and 157.53 mc and for truck radio operation on 152.15 and 157.41 mc. Further applications for truck radio systems are invited, to speed the establishment of a permanent service.

FMA is Launched

REPRESENTATION of commercial f-m broadcasters has been taken over by the newly organized Frequency Modulation Association, with Judge Roy Hofheinz of KTHT

(continued on p 250)

IRE Winter Convention March 3-6, 1947—Technical Program

Room	HOTEL COMMODORE			GRAND CENTRAL PALACE	
	East Ballroom	Main Ballroom	West Ballroom	Auditorium I	Auditorium II
Seating Cap.	500	2,000	400	450	450
Monday 2-5 p.m.		Particle Accelerators for Nuclear Studies	Electronic Measuring Equipment	Radar & Communi- cation Systems	F-M Reception
Tuesday 10-12:30 p.m.	Aids to Navigation		Nucleonics Instrumentation	Microwave Com- ponents and Test Equipment	Television A
Tuesday 2:30-5 p.m.	Television B		Electronic Digital Computers	Power Output Vacuum Tubes	Circuit Theory
Wednesday 10-12:30 p.m.	Electronic Controls & Applications	Aids to Air Naviga- tion & Traffic Control On The Professional Status of the Engineer		Microwave Tech- niques and Measurements	Broadcasting & Recording
Wednesday 2:30-5 p.m.					
Thursday 10-12:30 p.m.	Oscillator Circuit Theory		Basic Electronics Research	Wave Propagation and Antennas	Relay and Pulse- Time Systems of Communication
Thursday 2:30-5 p.m.	Receiver Circuits		Vacuum Tubes and Gas Rectifiers	Antennas	Wave Guide Tech- niques

A total of 120 highly technical papers covering most recent developments in radio and electronic engineering will be presented this year by the Institute of Radio Engineers at its annual convention March 3rd to 6th inclusive, in accordance with the above schedule. The accompanying show is at Grand Central Palace this year for the first time, with over 150 manufacturers slated to show their products



VERSATILITY *in the*

Design - Development - Production of LF, HF and UHF Equipment

For Example...

THE ELECTROMYOGRAPH

A Lavoie test instrument designed for the Medical profession. Amplifies minute potentials of the order of microvolts generated by muscles—to the extent that these potentials may be measured and analyzed. Includes calibration circuits to facilitate the taking of accurate data.



LAVOIE LABORATORIES are well prepared with trained personnel and special equipment to handle every phase of design, development and manufacture of LF, HF and UHF equipment. As **SPECIALISTS**, you are assured of precision work based on correct methods and technique developed through years of practical experience.

**FREQUENCY STANDARDS • FREQUENCY METERS • RECEIVERS
TRANSMITTERS • ANTENNAS and MOUNTS**

○ Detailed information and estimates of LAVOIE service
are available promptly without cost or obligation. ○

Lavoie Laboratories

RADIO ENGINEERS AND MANUFACTURERS
MORGANVILLE, N. J.

Specialists in the Development and Manufacture of LF and HF Equipment

Farnsworth RAILROAD RADIO

A MILESTONE IN RAILROAD RADIO!

"Modern railroad transportation systems cannot function to their maximum efficiencies without the use of modern communications networks. That is why the Santa Fe System maintains complete telephone and teletype, as well as telegraph systems along its entire thirteen-thousand-mile right-of-way. It is also the reason for Santa Fe's immediate and careful exploration of all new communications techniques, such as railroad radio, and accounts for the many 'firsts' contributed by the Santa Fe to the railroad communications art."

DeBusca

President

Atchison, Topeka and Santa Fe Railway



"RAILROADS . . .

LIKE A GIANT CONVEYOR BELT"

"The war has emphasized the importance of American railroads. Like a giant conveyor belt, they link up the industrial, agricultural and mining areas of this country with the many thousands of markets that dot our land. With reconversion a fact, far-sighted railroad management is carefully exploring many technical war developments, and, in particular, radio, with the expectation that radio will help keep American railroads the safe, efficient and modern network of transportation which has so ably served the Nation during the war."

S. P. Rossini

President, Detroit Toledo & Eastern R. R. Co.



"THIS PIONEERING EFFORT . . ."

"The Chicago and North Western Railroad, always interested in technological developments which promise improvement in the efficiency and safety of railway operations, participated in the first regular use of very high frequency railway radio. This installation went into operation in our Proviso Yards in September, 1940, and continued for over a year thereafter.

"We are happy that the technical and operating information secured from the pioneering effort was subsequently useful to the Army Ordnance Department and to the operators of the large Army Ordnance Plants in making their decision to use railroad radio in connection with the war effort.

"The case histories provided by the use of radio at Proviso and in the large ordnance plants were later to become an important part of the railroad testimony in the Federal Communications Commission hearing which brought about the present allocation of frequencies for railway use."

William

PRESIDENT

Chicago and North Western Railway System



Farnsworth radiotelephone systems, now ready to serve the Nation's railroads, provide:

(1) RELIABLE RADIOTELEPHONE CIRCUITS

Farnsworth guarantees its railroad radiotelephone systems for a period of one year—the same kind of comprehensive guarantee furnished with U. S. Government war-time radio equipment on which battles and lives depended.

(2) IMPROVED OPERATING SERVICES AND FACILITIES

Radiotelephone circuits between train crews and supervisory personnel permit industrial customer requirements to be fulfilled more rapidly; provide reliable and instantaneous communications even during adverse visibility conditions; enable the quick reporting of equipment failures and the more rapid and efficient dispatching of relief; permit crews instantly to report unscheduled stops to near-approaching trains.

(3) SAVINGS IN OPERATIONS

Railroads using modern radiotelephone circuits have reported through official Association of American Railroads documents convincing proof of the important money-saving, as well as safety-contributing abilities of radiotelephone circuits.

(4) LOW-COST INVESTMENT AND MAINTENANCE

Farnsworth equipment incorporates such important operating and maintenance features as standardized chassis with unitized construction, low-clearance antennas, automatically engaging plug-in type connectors, and special test circuits. The combination of these features, *found only in Farnsworth equipment*, guarantees maximum availability, flexibility, and usefulness with simplified low-cost maintenance. Yet, Farnsworth railroad radio equipment is priced competitively with other quality systems, many of which lack these special features.

For detailed particulars of Farnsworth Mobile Communications Systems, write Farnsworth Television & Radio Corporation, Dept. E-2, Fort Wayne 1, Indiana.

"TO ATTAIN STILL HIGHER STANDARDS OF SERVICE . . ."

"An asset in which the Nickel Plate Road takes great pride is the high standard of service which it renders to the shipping public. With its record for outstanding performance during the war years back of it, the Nickel Plate is looking forward to the utilization of new technological developments, such as radio and teletype, in order to attain still higher standards of service and usefulness."

J. M. Quinn

President

The New York, Chicago & St. Louis R. R. Co.



"Train Radio to Aid in Operation of Pere Marquette's New Streamlined Trains"

"By virtue of their efficient and effective performance during the war, the nation's Railroads have won the respect and goodwill of the American people. It is essential that this public esteem be maintained. That is why progressive railroad managements are planning the use of many technical developments capable of making additional contributions to the safety and comfort of rail passenger service and why the new, streamlined passenger trains which Pere Marquette soon will put into operation are to be equipped with train radio communication systems."

W. H. ...

President

Pere Marquette Railway Company



IS READY TO SERVE THE NATION

November 27, 1946

Mr. John Curtis, Manager
Mobile Communications Division
Farnsworth Television & Radio Corp.
Fort Wayne 1, Indiana

Dear Mr. Curtis:

I wish to thank you for your letter outlining the excellent progress which the Farnsworth Television and Radio Corporation has made in developing and producing various types of equipment for railroad radio communication. I was especially pleased to read that section of your report which quotes various railroad presidents who recognize that radio will enhance safety and efficiency in railway operations.

As you know, the Commission has been convinced for some time that a properly engineered railroad radio system will contribute to safety of life and property, both in preventing accidents and in reducing the seriousness of injury and damage after accidents. While safety is of paramount importance we also recognize and encourage the use of radio as a means of improving the overall efficiency of the railroads.

Sincerely yours,



E. K. Jett,
Commissioner



Commissioner Ewell K. Jett has been a motivating factor in the development of radio communications since the pioneering days of the early 20th Century. From 1911-1929 he participated in the development of the Navy's use of what was then a new communications art. Since 1929, Mr. Jett has been associated with the Federal Communications Commission and its predecessor, the Federal Radio Commission, first as Assistant Chief Engineer; then, since February 1, 1938, as Chief Engineer. On February 15, 1944,

Mr. Jett was appointed Commissioner.

Throughout his career with the Navy and the Commission, Mr. Jett has been alert to the ever-increasing usefulness of radio in mobile operations. More recently, with the development of radio equipment for railway and highway services and Mr. Jett's origination of the Citizens' Radio Communication Service, his activities with the Commission have taken on even more significance to American economy and well-being.

Farnsworth

Television • Radio • Phonograph-Radio

Farnsworth Radio and Television Receivers and Transmitters • Aircraft Radio Equipment • Farnsworth Television Tubes • Mobile Communications and Traffic Control Systems for Rail and Highway • The Farnsworth Phonograph-Radio • The Capehart • The Pahamuse by Capehart



since 1935
the only VOLT METER
featuring a simplified
LOGARITHMIC SCALE

10 MICROVOLTS
to 100 VOLTS

with the

**BALLANTINE
ELECTRONIC VOLT METER
and DECADE AMPLIFIER**

RECOMMENDED

By American Standards Association (Bulletin C75.17-1944) as being exceptionally well-suited for establishing a uniform method of noise-testing fixed composition resistors. The high sensitivity, averaging type of indication, and stable operation make the above combination ideal for making noise measurements. Model 300 Voltmeter reads from .001 to 100 volts and Model 220 Decade Amplifier supplies standardized gains of 10x and 100x. Frequency range 10 cycles to 150 kilocycles.

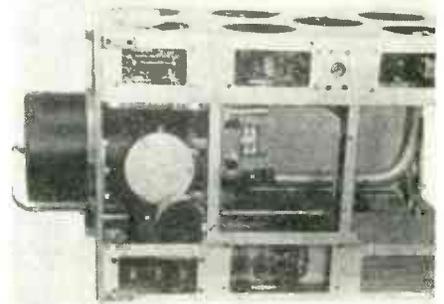
Descriptive bulletin available

BALLANTINE LABORATORIES, INC.
BOONTON, NEW JERSEY, U. S. A.



mitted and received 54 channels of data.

In the plane, dial-type instruments, rows of small galvanometer light-beam indicators, and breakage indicator lights formed the television theater. The dial instruments included an airspeed indicator, altimeter, normal accelerometer, longitudinal accelerometer, rate of pitch indicator, and angle of dive indicator. Forty-eight light beams indicated pressures, strains, positions of control surfaces, volt-



Top view of the conversion-modulator transmitter of the Farnsworth television telemetering system

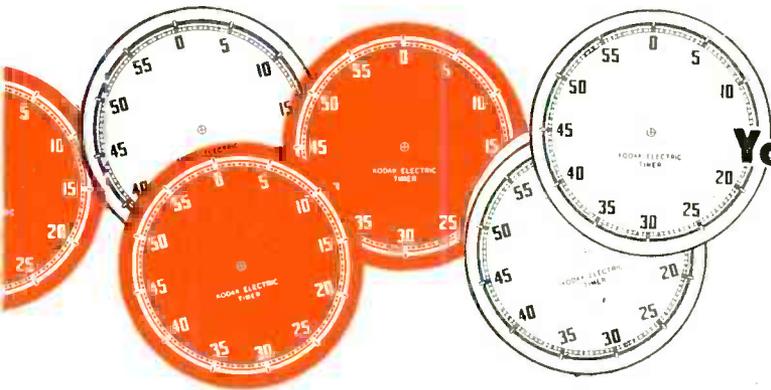
ages, currents, and rates of roll, pitch and yaw. Fifteen breakage indicator lights warned of possible structural failures in flight.

The strongly lighted panel was faced by a 23-tube television camera-transmitter. A complete image of the panel, showing all movements of its dial hands and light beams, was picked up by a Farnsworth image dissector tube for transmission to the ground station.

The television theater and camera-transmitter units were locked together in a sealed aluminum pressure-box, inside which a temperature control system operated to keep the temperature as constant as possible while the outside reading was varying between 75 and -67 F. The pressure-box was designed to operate at an altitude of 60,000 feet.

The transmitting antenna, a crossed-dipole type, had four half-wave radiators phased to give a spherical field and projected straight back from the tail of the fuselage. In this position it was relatively unaffected by shadows cast by the plane in a dive or spin. The average power of the transmitter was 25 watts, and the signal

Here are some of the things you can do with TRANSFAX... KODAK'S new reproduction process



You can make dials...

No matter the size or shape of the scale on your dials, Transfax can produce copies... on a production line basis... that are exact duplicates of the original pattern.

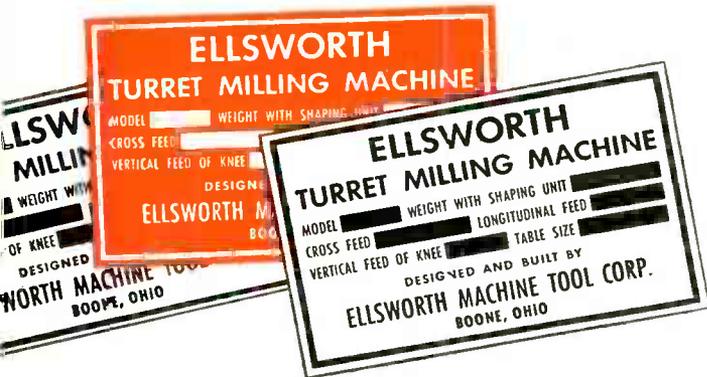
You can reproduce drawings...

With Transfax, you can put fabricating instructions, dimensions, layout lines directly on metal... save time and money whether one or hundreds of transfers are involved.



You can make name plates...

You can reproduce designs, legends, almost any marking. Lettering can be in Transfax white against any color background, or in reverse with Transfax as a white background. An integral part of the product, it won't deteriorate... or discolor... with age.



No darkroom needed—Transfax is a simple process. Transfax is a white, light-sensitive, quick-drying preparation you spray on. It requires a minimum of equipment and space and can be handled by anyone with ordinary skill.

Transfax is fast. Spray it on (some surfaces call for special primers)... place a transparent or translucent original of your pattern in contact with the sensitized Transfax surface. Expose to light... wash the Transfax surface with dilute Transfax Clearing Solution. Dry it. Overcoat it for permanence. The complete operation is done in minutes!

Transfax is durable. Overcoated, Transfax reproductions are rubproof, oilproof, do not deteriorate or change color with age... will resist a cutting flame until the underlying metal melts away.

Do you have a reproduction operation? If you do, write and tell us about your product... its markings... and the type of product surface. We will then be glad to suggest how the Kodak Transfax Process can be applied to your operations.

EASTMAN KODAK COMPANY

Industrial Photographic Division • Rochester 4, N. Y.

KODAK TRANSFAX PROCESS A revolutionary new reproduction method

*To avoid damage
from Oxidation . . .*

protect with **NITROGEN**

LINDE Nitrogen provides an ideal means of protection against oxidation and corrosion by air. For packaging dehydrated foods; for deaerating, processing, storing and packaging fats and oils of all kinds; or for providing an inert atmosphere, free of impurities, for the complete protection of practically any material susceptible to oxidation, use LINDE Nitrogen.

LINDE Nitrogen is 99.7% pure, but is also available bone dry and at higher purity for special applications. It is supplied as a compressed gas in cylinders containing 224 cu. ft. each, or in bulk in tank-truck and tank-car lots as a liquid which is converted into gaseous nitrogen as required. LINDE Nitrogen in bulk offers remarkable savings in cost and eliminates cylinder handling.

Write or call the Linde office nearest you.

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation



30 E. 42nd St., New York 17, N. Y. • Offices in Other Principal Cities

The words "Linde" and "Prest-O-Lite" are registered trade-marks.

LINDE has offices in Principal Cities

Eastern States

Baltimore, Md.
Boston, Mass.
Buffalo, N. Y.
Charleston, W. Va.
New York, N. Y.
Philadelphia, Pa.
Pittsburgh, Pa.

Central States

Chicago, Ill.
Cincinnati, Ohio
Cleveland, Ohio
Detroit, Mich.
Indianapolis, Ind.
Milwaukee, Wis.
Minneapolis, Minn.
St. Louis, Mo.

Southern States

Atlanta, Ga.
Birmingham, Ala.
Jacksonville, Fla.
Memphis, Tenn.
New Orleans, La.

Southwestern States

Dallas, Texas
Denver, Colo.
Houston, Texas
Kansas City, Mo.
Tulsa, Okla.

Western States

Butte, Mont.
El Paso, Texas
Los Angeles, Calif.
Phoenix, Ariz.
Portland, Ore.
Salt Lake City, Utah
San Francisco, Calif.
Seattle, Wash.
Spokane, Wash.

Linde

HYDROGEN · NITROGEN · OXYGEN

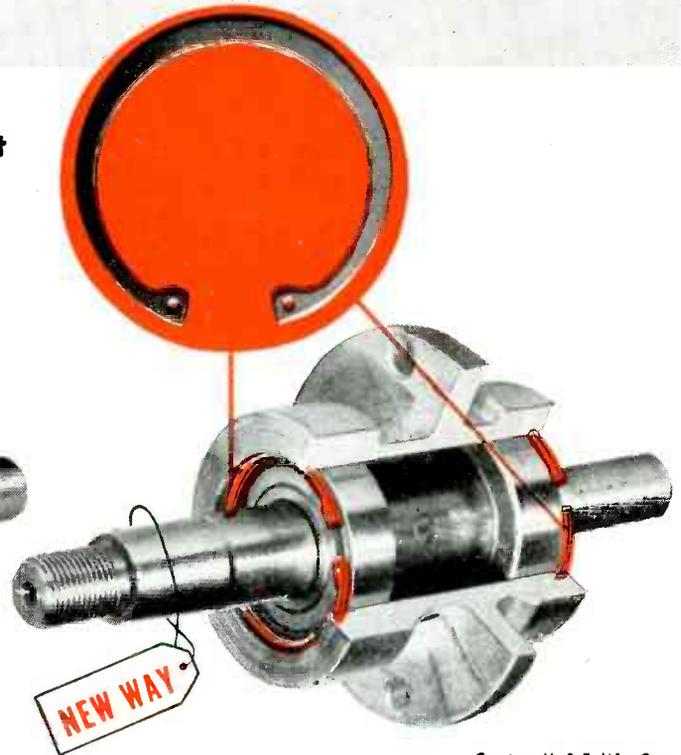
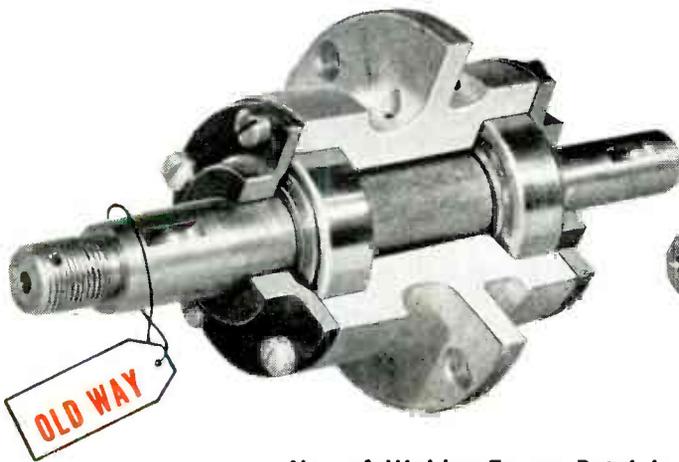
ARGON · HELIUM · KRYPTON · NEON

XENON — *Prest-O-Lite* ACETYLENE

TRUARC trims 13 minutes machining to 6

cuts new exhaust fan bearing unit

- 25% in weight
- 66% in assembly time

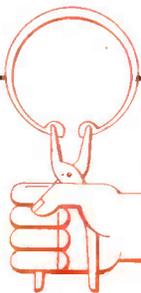


Courtesy M. & E. Mfg. Co.

Use of Waldes Truarc Retaining Rings permits housing re-design—eliminates heavy cast bearing caps and screws requiring drilling and tapping; lowers labor and material cost.

"TRUARC PAYS DIVIDENDS IN SAVINGS!" declares M. & E. Manufacturing Company, of Indianapolis, makers of exhaust fans for industry. "Improvements in design made possible by Waldes Truarc Retaining Rings provide a quieter, freer-running assembly, assure longer life to the entire unit, eliminate the hazards of uneven unnecessary pressure on the bearing and minimize future service requirements. In our experience Truarc has definitely proved itself the better method for doing an important job."

Truarc does a better job on axles and shafts for retaining and positioning wheels, pulleys, cams and gears. In widely varied applications, designers find its never-failing grip, its patented design that assures constant circularity, make Truarc the better way to hold machine parts together. Production and maintenance men in many industries see how Truarc rings cut costs sharply, maintain accurate, unvarying relationship of parts. Send us your drawings; Waldes Truarc engineers will be glad to show how Truarc can help you.



WALDES
TRUARC
U. S. PATENT RE. 19,144
RETAINING RINGS



● Send for new Truarc booklet,
"New Development In Retaining Rings"

Waldes Kohinoor, Inc., 47-10 Austel Place 18-K
Long Island City 1, N. Y.

Please send booklet, "New Development In Retaining Rings" to:

Name _____

Title _____

Company _____

Business Address _____

City _____ Zone _____ State _____

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

NEW
TECH-LAB
DEVELOPMENT

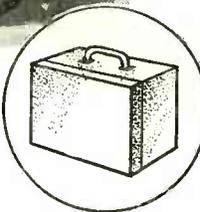
**TYPE 1A
TRANSMISSION
MEASURING SET**

For **RAPID
MEASUREMENT
OF
AUDIO FREQUENCY
GAIN or LOSS**



Completely Self-Contained

PORTABLE • AC OPERATED



With this instrument it is possible to quickly and accurately analyze and service equipment in different locations without fuss in time consuming demounting and transportation of apparatus. It will thus pay for itself in a short time and no modern radio station can afford to be without it. It can also be used to good advantage in factory checking and inspection of audio equipment.

The set combines in a modern efficient manner an accurate vacuum tube voltmeter, an audio oscillator with four fixed frequencies and a precision attenuator all mounted in a handy cabinet easily carried by the operator.

SPECIFICATIONS

- GAIN: Up to 80 db.
- LOSS: 60 db. maximum.
- VACUUM TUBE VOLTMETER:
Range—40 to +40 db.
(1 mv. ref. level)
- AUDIO OSCILLATOR:
Freq. Range; 100 to
10,000.
- PRECISION ATTENUATOR:
Flat to 20 KC; 93 db.
in .1 db. steps.
- DIMENSIONS:
10 1/4" x 16 1/4" x 8 3/4"
- WEIGHT: 30 lbs.
- INPUT: 115 Volts.
60 cycles, 70 watts.



Manufacturers of Precision Electrical Resistance Instruments
337 CENTRAL AVE. • JERSEY CITY 7, N. J.

TUBES AT WORK

(continued)



Pressure box containing the main chassis of the Farnsworth air-borne television transmitter. Excess heat from the chassis at low altitudes is passed to the radiating-fin assembly on one end

radiated had an approximate limit of 25 miles.

The receiving station was mounted on a 1 1/2-ton truck. This vehicle contained a receiver which provided a 350-line picture, a recording unit to film all transmissions, and equipment for two-way voice radio communications with planes in flight. Folding antennas were mounted on the roof.

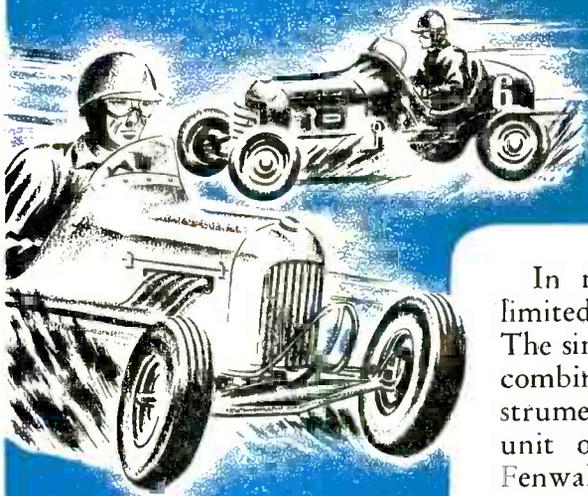
**VHF Transmitter
Power Measurements**

By LEONARD R. MALLING
Seattle, Washington

INCREASING USE of the vhf spectrum has resulted in the need for an accurate and convenient method of measuring r-f power at frequencies ranging from 100 to 500 mc and powers ranging up to 100 watts.

Line of sight limitations, low weight requirements, the use of directive antennas and the need of portability has lead to a figure of the order of 50 watts maximum continuous power output for transmitters designed for vhf use. Pulse power of the order of kilowatts may be conveniently measured if the pulse rate is made low for output power tests.

Except when extreme portability is required, vhf transmitters are designed to work into coaxial cables feeding dipole arrays, so that for maximum efficiency the antenna system should be purely resistive. If we terminate the transmission line in a purely resistive load the power output of the transmitter can be determined by a knowledge of the power dissipation in this resistor. Maximum convenience is obtained by having a power meas-



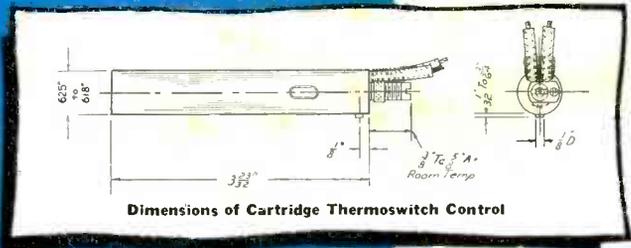
COMPACT DESIGN*

In many temperature control applications, space is so limited that the physical size of the thermostat is important. The simplicity of the basic Fenwal design makes possible the combining of all the essentials of a good Thermotechnic instrument—high sensitivity, ruggedness and accuracy—in a unit of reasonable size and convenient dimensions—the Fenwal THERMOSWITCH Control.

In normal applications, Fenwal's compact units usually may be located in the product or process at the point where most effective control of the entire thermal system is achieved.

The drawing shows the dimensions of the Cartridge THERMOSWITCH Control—the basic THERMOSWITCH unit. Because of their compactness, Fenwal THERMOSWITCH Controls provide effective temperature regulation without interfering with the overall design of the product or process.

Compact Design is one of many features which make the THERMOSWITCH Control outstanding in the fields of temperature detection and regulation. Send for a copy of our Thermotechnics Booklet which describes the "14 Facts in Fenwal's Favor."



Dimensions of Cartridge Thermoswitch Control



CARTRIDGE THERMOSWITCH CONTROL

- ### FOURTEEN FACTS IN FENWAL'S FAVOR
- 1.—Fast reaction time
 - 2.—Large heat sensitive area, small heat storage
 - 3.—Short heat transfer path
 - 4.—Small temperature differential
 - 5.—Built-in temperature anticipation
 - 6.—Enclosed assembly
 - 7.—Minimal vibration effects
 - 8.—Tamper-proof and sealed
 - 9.—Rugged construction
 - 10.—Adjustable over wide temperature range
 - 11.—Minimum size
 - 12.—Directly responsive to radiant heat
 - 13.—Uniform sensitivity over adjustable temperature range
 - 14.—Readily installed

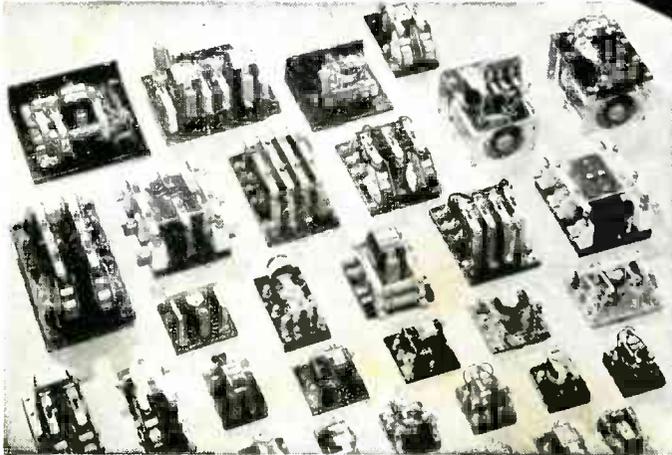
*#11 of the "Fourteen Facts in Fenwal's Favor".



FENWAL INCORPORATED
 43 PLEASANT STREET
 ASHLAND MASSACHUSETTS
 Thermotechnics for Complete Temperature Regulation

RELY ON THE LINE WITH THE RANGE THAT'S WIDE

You can find practically anything you want—in relays, resistors
and rheostats—by selecting from the regular Ward Leonard line.

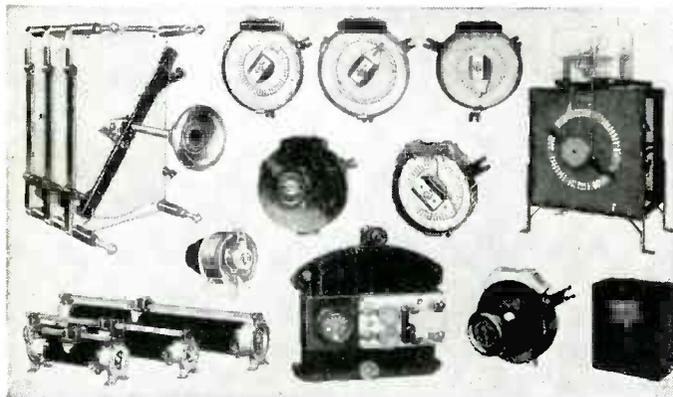
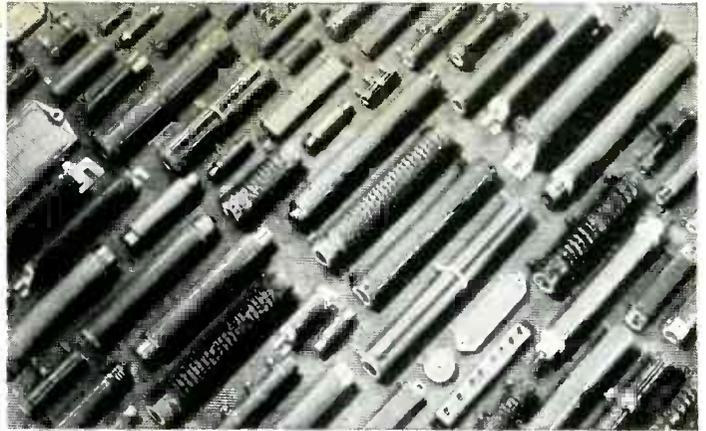


RELAYS

Crisp action, Durable construction. Low power consumption. Light, intermediate and heavy-duty types for sensitive, transfer, time delay, antenna change-over, break-in, and latch-in operation. (Illustration at left)

RESISTORS

Withstand heat, moisture, vibration, and other adverse operating conditions. Regular line includes wide range of types, sizes, ratings, terminals, mountings and enclosures. (Illustration at right)



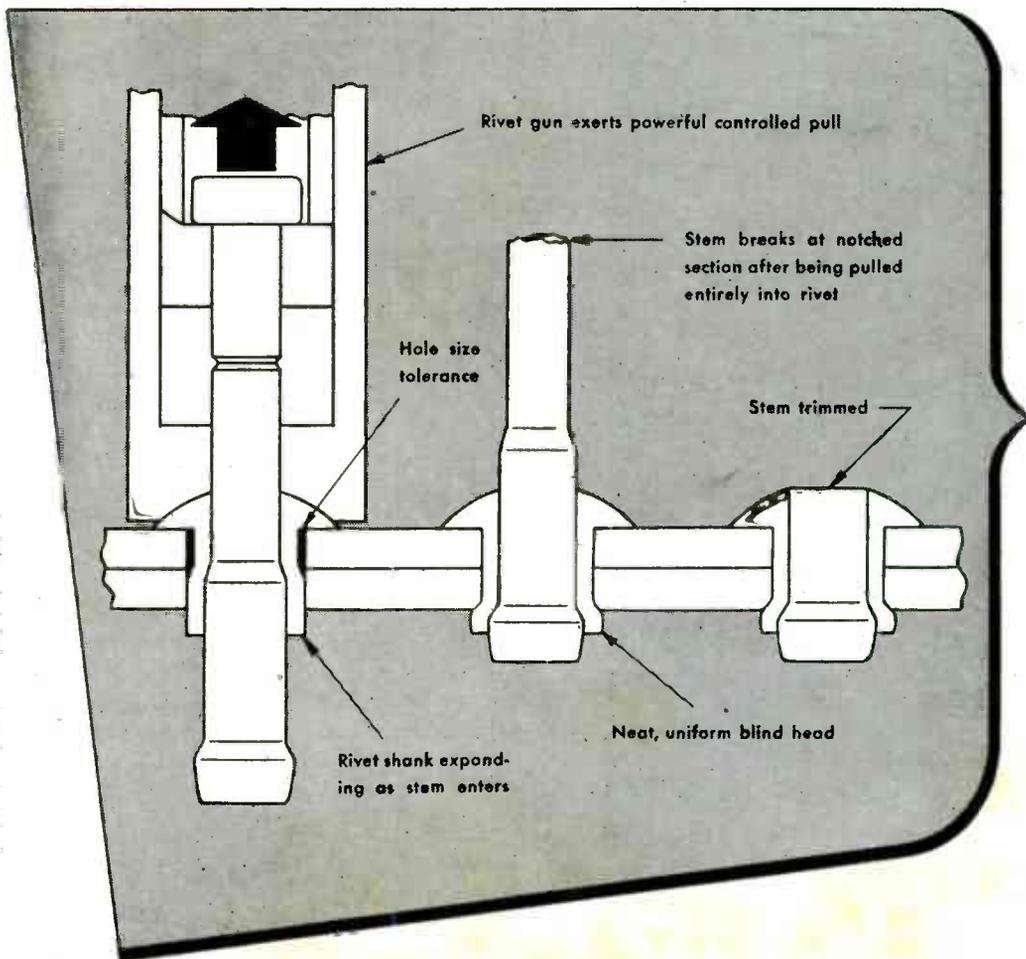
RHEOSTATS

Operate smoothly. Durable contacts. Line includes widest range of sizes, tapers, and current ratings from tiny ring-types for radio to huge multiple assemblies for heaviest industrial use. (Illustration at left)

WARD LEONARD

Electric Control  Devices since 1892

WARD LEONARD ELECTRIC COMPANY • 32 SOUTH ST. • MOUNT VERNON, NEW YORK



DYNAMIC EXPANSION

of the rivet shank is the answer. Greater shank expansion than any other blind fastener. Powerful controlled pull of rivet gun draws stem into rivet shank, forcibly expanding rivet to fill hole *tightly*. Joint is strong, tight, permanent.

HOW *Strong* CAN A BLIND RIVET BE? HOW *Tight* CAN A BLIND RIVET BE?

CHERRY BLIND RIVETING has stirred up enormous interest since its inception during the war. This remarkable new fastening technique is so fast and the results are so uniformly positive that it has spread from industry to industry at an astonishing rate. To those who are familiar with the basic characteristics and many possibilities of Cherry Blind Riveting, its virtues are implicit . . . but others, not yet having experienced its advantages, still wonder about certain basic questions. Strength and tightness, for example.

Tight, Strong Joints — There are three types of

Cherry Blind Rivets. The *self-plugging* type is comparable in strength to solid rivets and is recommended for structural applications. The *pull-through hollow* type is for tight, rigid joints on non-structural jobs. The *regular hollow* is a tacking rivet that clinches very tightly.

Cherry Blind Rivets have (a) greater shank expansion and (b) greater allowable variance in material thickness . . . than any other blind fastener. This means uniformly tight, strong joints under actual shop conditions where hole sizes and sheet thicknesses cannot always be controlled closely.



High-strength, self-plugging type Cherry Blind Rivet.



Tight-clinching, pull-through hollow type Cherry Blind Rivet.

CHERRY RIVETS. THEIR MANUFACTURE & APPLICATION ARE COVERED BY U. S. PATENTS ISSUED & PENDING



Get this Illustrated Manual. Write to Dept. B-120, Cherry Rivet Company, 231 Winston Street, Los Angeles 13, Calif.

uring device that does not require tuning.

Resistive Termination

Two difficulties arise in the termination of a transmission line with a resistor; power dissipation in the resistor, and correct matching of the resistor to the transmission line. The power dissipated in the resistor may be found from a measurement of temperature rise, voltage or current. Of the three, voltage measurement is the most convenient but the capacitive input of the voltmeter must then be compensated to obtain effective resistive termination of the transmission line.

For the termination, one type of resistor is of particular interest, a $\frac{1}{2}$ -watt carbon resistor having brass endcaps and contained in a ceramic case. The length of the carbon mix between brass caps is 0.5 cm, the diameter 0.3 cm.

Assuming a resistor of 50 ohms with these dimensions, the resis-

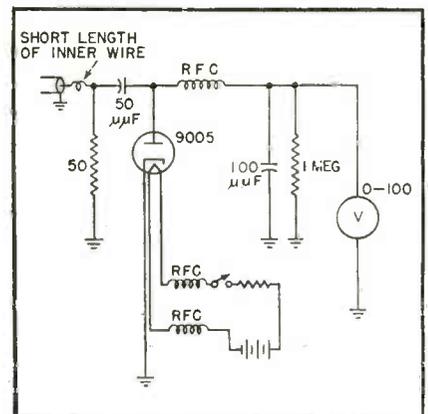


FIG. 1—Circuit of vhf wattmeter

tance per cm cube is seven ohms and the skin depth is 0.6 cm. The skin effect may thus be neglected as we can expect substantially uniform current distribution.

Knowing the current distribution enables us to determine the inductive effect of the resistive rod, a value of 0.001 microhenry or an inductive reactance of 2.5 ohms at 500 mc. Thus the terminating impedance gives a standing wave ratio of 1.05 on the transmission line. Sufficiently accurate power measurements may be made when the standing wave ratio is less than 1.1, a value rarely achieved even with the best antenna designs.

The 9005 diode having a resonant

ELECTRONS INCORPORATED
127 SUSSEX AVENUE
NEWARK, N. J.

ELIC
RECTIFIER

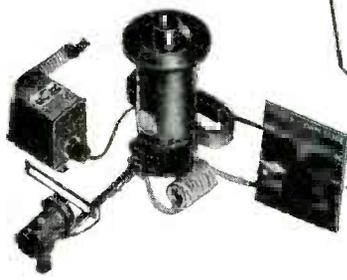
P. I. V. 725
PEAK AMPS. 4.0

CHOOSE YOUR HIGH-VACUUM GAUGE FOR ITS...*RANGE*

Seven fine gauges for measuring high-vacuum pressures are shown on this page. They are all D.P.I. Gauges—all sensitive instruments designed to provide accurate readings. Their important differences lie in their **RANGE OF MAXIMUM SENSITIVITY**. In the chart, the line below the name of each gauge indicates its full range. The **RANGE OF MAXIMUM SENSITIVITY** is indicated by the widest portions of that line.



DPM-36 Ionization Gauge



Knudsen Gauge



Philips Gauge



McLeod Gauge



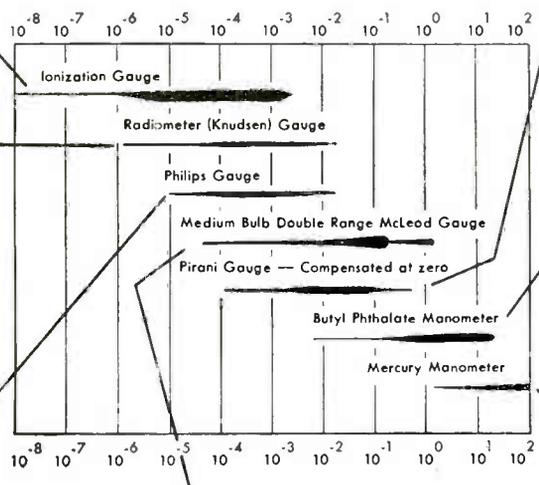
Pirani Gauge



Butyl Phthalate Manometer



Mercury Manometer



Let us help you choose the D.P.I. Gauge best suited to your specific job. Write—

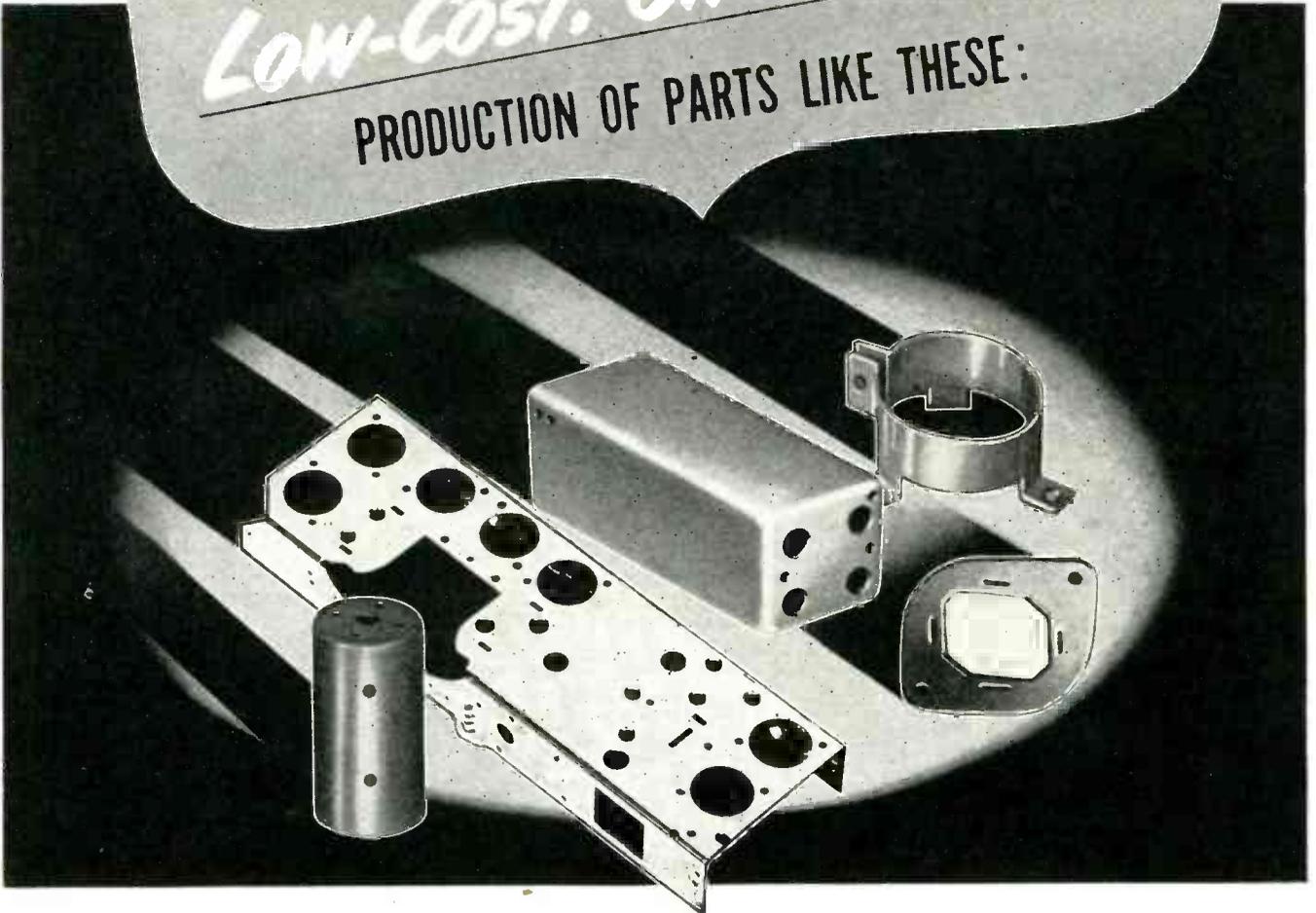


Vacuum Equipment Division
DISTILLATION PRODUCTS, INC.
Rochester 13, New York

PAUL and BEEKMAN *Division*

CAN GIVE YOU

Low-Cost. On-Schedule
PRODUCTION OF PARTS LIKE THESE:



Paul and Beekman Division can relieve you of production headaches . . . save you time in manufacturing electronic parts like those illustrated. We specialize in the large-volume, low-cost production of electronic parts and assemblies. We make them economically because we have just the plant and the machines necessary for the job. We make them to pre-

cise specifications because we have the skilled engineers and operators.

Let us show you how Paul and Beekman, by acting as your parts division, can help you make your product faster and better, at less cost. Write us about your needs. Our engineers are available to advise you impartially, with no obligation to you.

WHAT PAUL & BEEKMAN DIVISION MAKES

Condenser shells, coil shields, transformer housings, cans, chassis, complete or sub-assemblies, mounting clamps and mounting plates . . . STANDARD or to specifications . . . from Copper, Aluminum, Steel, Stainless Steel, Brass.

PAUL and BEEKMAN *Division* 1810 COURTLAND ST., PHILADELPHIA 40, PA.

PORTABLE PRODUCTS CORPORATION
MANUFACTURERS OF: LAWN MOWERS • ELECTRICAL APPLIANCES • PRECISION STAMPINGS
INDUSTRIAL INSTRUMENTS • RADIOS • SAFETY EQUIPMENT



Are you in the know on GLOW?

THESE QUICK FACTS ON G-E NEON GLOW LAMPS MAY HELP YOU PRODUCE A MORE SUCCESSFUL PRODUCT

2

HERE IS A HOT ONE

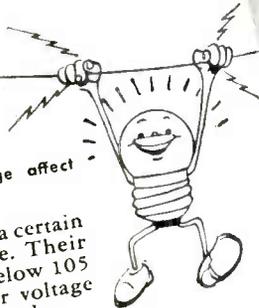


QUESTION—How are glow lamps used?

ANSWER—They're ideal as indicators. Such applications include annunciators, control panels, electrical appliances, testing devices, warning signals, pilot lights. Glow lamps also provide a source of low illumination for night lights, exit lights, dial lights, etc.

4

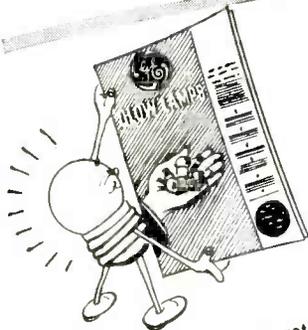
HIGH VOLTAGE



QUESTION—How does voltage affect glow lamp application?

ANSWER—Glow lamps need a certain minimum starting voltage. Their use is not recommended below 105 volts, but there is no upper voltage limit if resistors are provided.

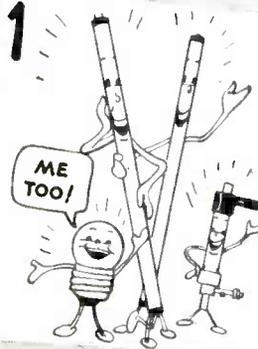
6



QUESTION—Where can you get full information on G-E Neon Glow Lamps and their application to your product?

ANSWER—Write to Nela Specialty Division, Lamp Dept., General Electric Company, 1 Newark Street, Hoboken, N. J.

1



QUESTION—What is a neon glow lamp? What makes it glow?

ANSWER—It is the "baby" of the electrical discharge lamp family—and consists of twin electrodes sealed within a bulb containing neon gas. When the gas is ionized by application of a voltage, an orange-red glow covers the cathode.

3

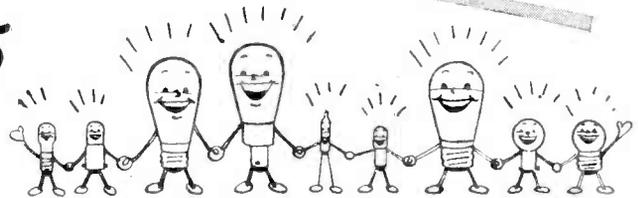


3000 HRS. OLD AND STILL PLENTY O'GLOW

QUESTION—What are the main advantages of glow lamps from the product designer's standpoint?

ANSWER—(a) Distinctive orange-red glow—high visibility.
 (b) Dependable performance and long life—rated at 3000 hours.
 (c) Very low current consumption—as little as 1/25-watt.
 (d) Low brightness, low heat.
 (e) High resistance to shock and vibration.
 (f) Can be installed in small space.
 (g) Operate directly from regular 105-125, and 210-230 volt circuits, a-c or d-c.

5



QUESTION—In what sizes are glow lamps made?

ANSWER—General Electric makes a complete line of neon glow lamps, in a wide variety of miniature bulb sizes, and in wattages from 3 watts to 1/25 watt, with both screw bases and bayonet bases.

G-E LAMPS

GENERAL ELECTRIC

Nela Specialty Div. Lamp Dept., 1 Newark St., Hoboken, N. J.

**WRITE FOR YOUR
COPY TODAY!**



**Akra-Ohm
Resistors**
Accurate Fixed
Wire Wound
Types

*This New Bulletin
tells you what you
want to know about*
**ACCURATE FIXED
WIRE WOUND
RESISTORS**

**DIMENSIONAL SPECIFICATIONS • MOUNT-
ING AND TERMINAL DESIGNS • POWER
DISSIPATION • TEMPERATURE COEFFI-
CIENT OF RESISTANCE • MAXIMUM
RESISTANCE CHARTS • RESISTANCE
ALLOYS • MOISTURE AND FUNGUS
PROOFING • HERMETIC SEALING**

*Shallcross Types Designed to
Meet JAN-R 93 Specifications*

SHALLCROSS MFG. CO.

DEPT. E-27 COLLINGDALE, PA.

ENGINEERING • DESIGNING • MANUFACTURING

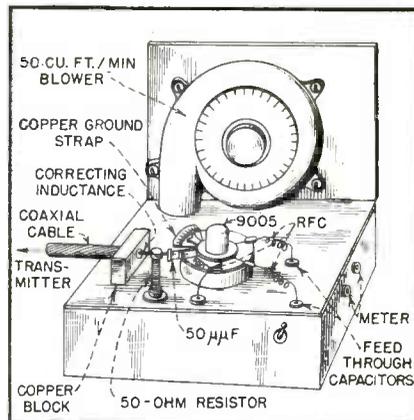
TUBES AT WORK

(continued)

frequency of 1,500 mc and a voltage rating of 117 volts maximum makes a peak diode voltmeter for the measurement of voltage across the resistor. For the moment we are concerned with the input capacitance of this diode and, allowing for socket and stray capacitance, a value of one μmf may be assumed. The mismatch due to this capacitive reactance may be neutralized by a corresponding inductive reactance.

The shunt capacitive reactance may be converted to an equivalent series reactance of three ohms at 200 mc for which the equivalent inductance is 0.002 microhenry. Difficulties in making a completely noninductive connection to the transmission line are now avoided as we may leave a short length of the inner conductor equivalent to this value for making the connection to the resistor. With RG-8/U 50-ohm concentric cable, having a 7/21 copper conductor, the length of conductor is approximately 0.5 cm from the end of the cable to the resistor.

With the relatively small values of correction used the slope of the inductive and capacitive reactance curves may be assumed to be constant so that the compensation will hold over a wide band of frequen-

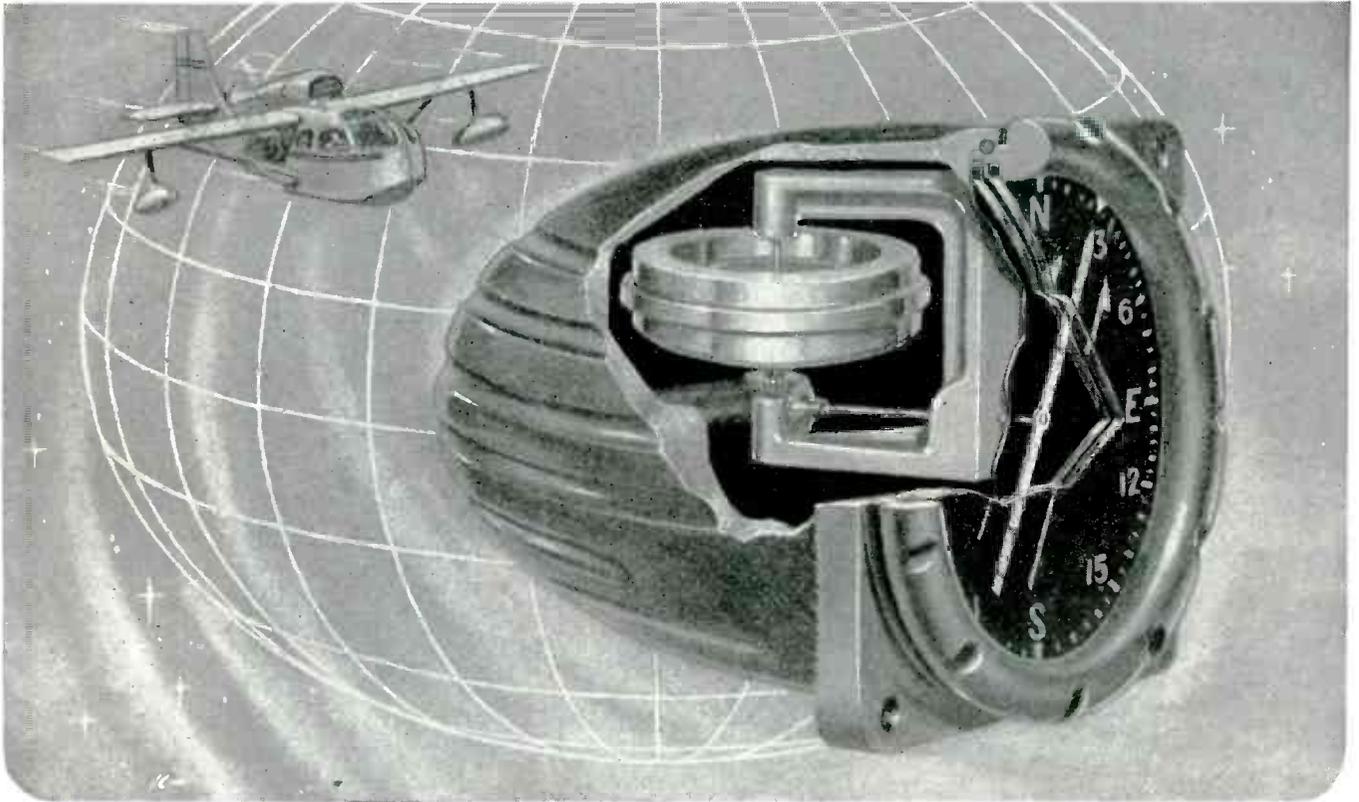


Mounting of components in wattmeter
cies, certainly from 100 to 500 mc.
The correction is made in approxi-
mately the middle of this band.

Accuracy

With a high resistance load, one megohm, and a small r-f bypass capacitor of 100 μmf , the meter reading will indicate peak voltage across the terminating resistor. Because of electron transit time and internal diode resonance, the meter indication at 500 mc will be a few

PERMANENT MAGNETS MAY DO IT BETTER!



*Sectional View of Skyguide Aerial Navigator's Compass
Courtesy G. M. GIANNINI Company*

CHART YOUR COURSE WITH PERMANENT MAGNETS

THE Skyguide points the way through unknown reaches with pinpoint accuracy. As a vital aid in the navigation of modern commercial airplanes, the Skyguide is typical of many such scientific instruments in use today, which rely upon the permanent magnet in their important function.

Actually millions of magnets serve us daily . . . in industry, transportation, and communication. Every time you call on the phone or turn on the radio, a permanent magnet goes to work for you, silently and unseen.

Although the magnet is one of man's oldest servants, it is as modern as radar, as facsimile

transmission or television. Our research engineers invite you to consult with them on the new uses of "packaged energy." Only by investigation will you know how this independent source of power may do some job or process better in your industry.

Over 24,000 applications of "packaged energy" have been made by *The Indiana Steel Products Company*, the world's largest sole producer of permanent magnets. For information on methods, materials and comparative product energy curves, write for our free "Permanent Magnet Manual." Your request will receive our prompt attention.

Copyright 1947, The Indiana Steel Products Co.

★ **THE INDIANA STEEL PRODUCTS COMPANY** ★

PRODUCERS OF "PACKAGED ENERGY"

6 NORTH MICHIGAN AVENUE • CHICAGO 2, ILL.



SPECIALISTS IN PERMANENT MAGNETS SINCE 1910

PLANTS

VALPARAISO, INDIANA
STAMFORD, CONN. (CINAUDAGRAPH DIV.)

THE NEW FM SIGNAL GENERATOR

Model 202-B

**FREQUENCY RANGE
54 to 216
MEGACYCLES**



The design of this FM Signal Generator has been completed after many months of painstaking research on the part of Boonton Radio Corporation to develop a precision instrument meeting the rigid requirements set forth by leading FM and television engineers throughout the country.

Frequency coverage from 54 to 216 megacycles is provided by two ranges, 54 to 108 megacycles and 108 to 216 megacycles. A front panel modulation meter having two deviation scales, 0-80 kilocycles and 0-240 kilocycles, permits accurate modulation settings to be made.

Although fundamentally an FM instrument, amplitude modulation from zero to 50%, with meter calibrations at 30% and 50%, has been incorporated. This AM feature offers increased versatility and provides a means by which simultaneous frequency and amplitude modulation may be obtained through the use of an external audio oscillator.

The internal AF oscillator has eight modulation frequencies ranging from 50 cycles to 15 kilocycles, any one of which

may be conveniently selected by a rotary type switch for either amplitude or frequency modulation.

The calibrated piston type attenuator has a voltage range of from 0.1 microvolts to 0.2 volts and is standardized by means of a front panel output monitor meter.

The output impedance of the instrument, at the terminals of the R.F. output cable, is 26.5 ohms.

Careful consideration has been given to the positioning of the main frequency dial and various controls, with modulation and output monitor meters located at eyelevel for maximum readability. Dimensions have been chosen to permit greatest economy of laboratory space. For complete details write for Catalog "D".

The design of this instrument was described on pages 96-101 of the November issue of ELECTRONICS. Reprints of this article are available upon request.

BOONTON RADIO

BOONTON · N.J. · U.S.A.

Corporation



DESIGNERS AND MANUFACTURERS OF THE Q METER · QX CHECKER
FREQUENCY MODULATED SIGNAL GENERATOR · BEAT FREQUENCY GENERATOR AND OTHER DIRECT READING INSTRUMENTS

TYPE TS-56

Screw Type. For applications where wires must be attached and detached quickly and conveniently at intervals. Supplied plain or marked to customers' specifications. Also available with Knurled Head screws.

Contacts—Brass, cadmium plated
Screws—Steel, cadmium plated
Plates—1/16" XP Phenolic sheet

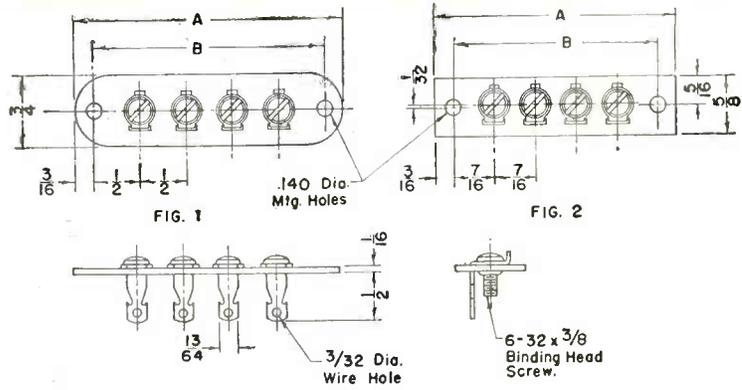
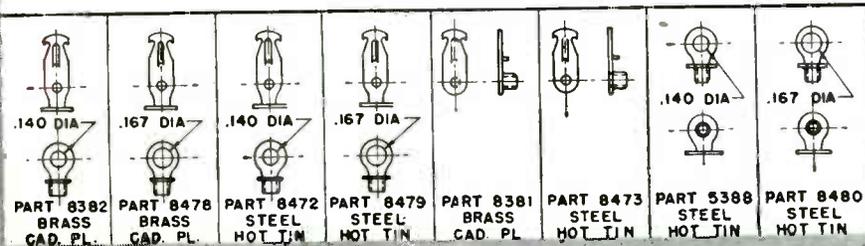
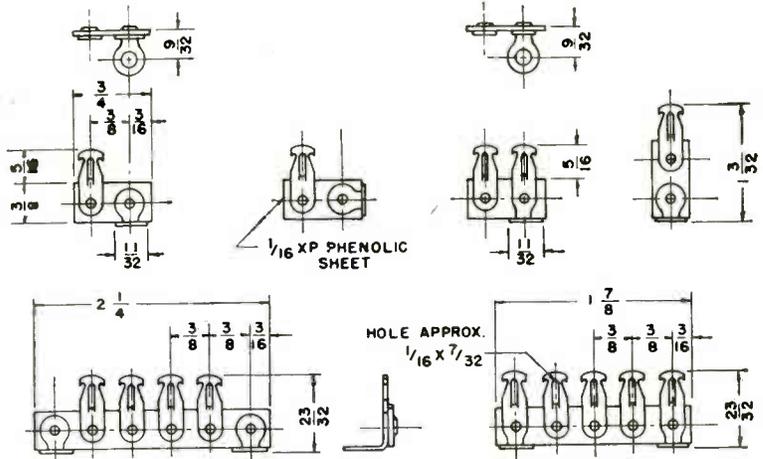


FIGURE NO	CATALOG NO. BINDING HEAD SCREW	CATALOG NO. KNURLED HEAD SCREW	NO. OF TERMINALS	OVERALL LENGTH 'A'	MTG. HOLES CENTERS 'B'
1	8513	8523	1	1 3/8	1
1	8514	8524	2	1 7/8	1 1/2
1	8515	8525	3	2 3/8	2
1	8516	8526	4	2 7/8	2 1/2
1	8517	8527	5	3 3/8	3
1	8518	8528	6	3 7/8	3 1/2
1	8519	8529	7	4 3/8	4
1	8520	8530	8	4 7/8	4 1/2
1	8521	8531	9	5 3/8	5
1	8522	8532	10	5 7/8	5 1/2
2	8706	8711	1	1 1/4	7/8
2	8710	8712	2	1 11/16	1 5/16
2	8610	8713	3	2 1/8	1 3/4
2	8707	8714	4	2 9/16	2 3/16
2	8708	8715	5	3	2 5/8

EBY TERMINAL STRIPS

TYPE TS-58

Tie Point. Used throughout industry for tying in a wide variety of components. Available in any combination of terminals or brackets as shown up to and including 14. Holes are spaced 3/8" apart with 3/16" between end holes and edge of board. Terminals available with elongated hole for threading or notched for wrap-around assembly. Plates are of XP Phenolic sheet.



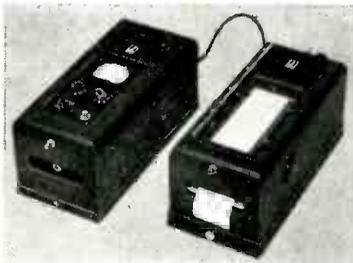
HUGH H.
EBY
INCORPORATED

18 West Cheltenham Avenue
Philadelphia 44, Pa.

Brush Magnetic Oscillographs

**make direct-writing
recordings of strains
and pressures
instantaneously!**

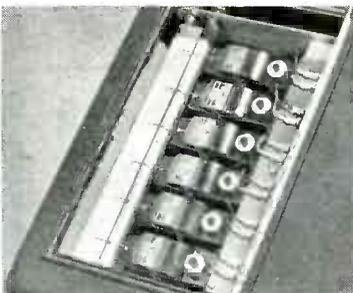
Instantaneous, permanent, ink-on-paper recordings by Brush Oscillographs make their use almost unlimited. Accurate recordings of strains, pressures and countless electrical phenomena can be made over a frequency range of D.C. to 100 c.p.s. Either A.C. or D.C. circuits can be measured. Whenever desired, recordings may be stopped for notations on chart-paper.



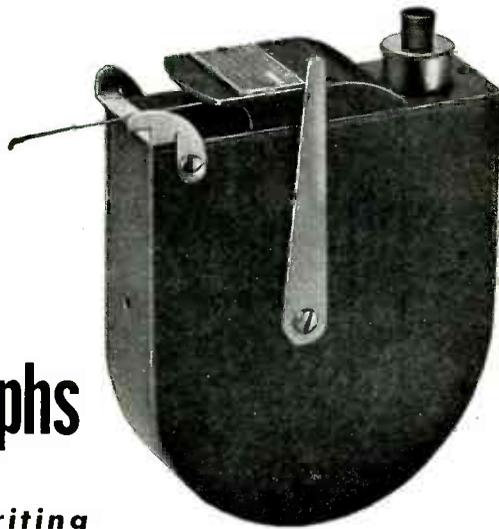
Brush Single-Channel Magnetic Oscillograph with amplifier. Especially suited for strain-gauge applications, counting, surface analysis and similar applications. Three-speed paper drive, 5, 25, 125 mm per second. Chart paper 2 3/8" wide.



Brush Double-Channel Magnetic Oscillograph for use where two simultaneous recordings are desired—as in synchronizing problems. Three-speed paper drive, 5, 25, 125 mm per second. Chart paper 3 1/8" wide. Rugged construction.



Brush Six-Channel Magnetic Oscillograph. Excellent for strain-gauge recordings. Dust-proof case. Interchangeable gear paper drive. Your choice of paper speeds from 1/8" to 5" per second. Chart paper 12" wide. Compact design.



The remarkable new Brush Magnetic Recording Pen Motor—heart of the Brush Direct-Inking Oscillograph. Highly stable. May be used under virtually any climatic or temperature conditions. Exceptional accuracy.

Brush Oscillographs are compact, portable and ruggedly constructed for ease of handling and operation. Investigate them now. Brush engineers will gladly co-operate in determining their application to your problems. Write for technical information for complete details of this equipment. Special bulletins are available on strain-gauge use.

The Brush Development Co.

3415 PERKINS AVENUE
Cleveland 14, Ohio

Canadian Representatives:
A. C. Wickman, (Canada) Ltd.,
P. O. Box 9,
Station N, Toronto 14

percent low with correspondingly less error at lower frequencies. This error has been described as the premature cutoff error and is dependent on the characteristics and geometry of the tube.

Diode resonance is caused by the series inductance of the tube leads resonating with the plate-to-cathode capacitance. Resonance checks are best made by a variable-frequency signal generator as unavoidable external lead inductance will lower the resonant frequency of the diode. Resonance with the 9005 may thus occur at 1,000 mc. At 500 mc, the meter indication may be 30 percent high, at 100 mc the error will be one percent. A calibration chart may be made covering the band.

Construction Details

To aid heat dissipation in the resistor, the diode assembly may be placed on a copper plate to which the resistor is soldered using an ample supply of metal. This ensures good thermal and radio conductivity. With an air blower supplying 50 cu ft/min to the copper plate, the resistor may be operated at ten or twenty times its normal rating in free air or much higher for short periods.

Figure 1 shows the wiring arrangement of the diode power head. Use of a battery for heater power

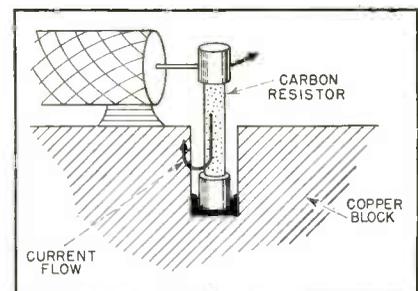


FIG. 2—Method of reducing the effective inductance of a carbon resistor.

avoids long a-c supply leads. The meter may be any high-resistance d-c voltmeter, preferably with a multiplier switch. For peak pulse power measurements the voltmeter may be replaced by a calibrated oscilloscope.

If large resistors introduce error because of excessive inductive reactance, the resistor may be sunk in a hole in the copper as shown in Fig. 2 to provide reversal of current in the restricted area.

**THIS SPRAGUE
KOOLOHM...**



**...DOES THE WORK
OF AN ORDINARY
RESISTOR
THIS SIZE!**

ARE YOU BUYING LARGER RESISTORS THAN YOU ACTUALLY NEED?

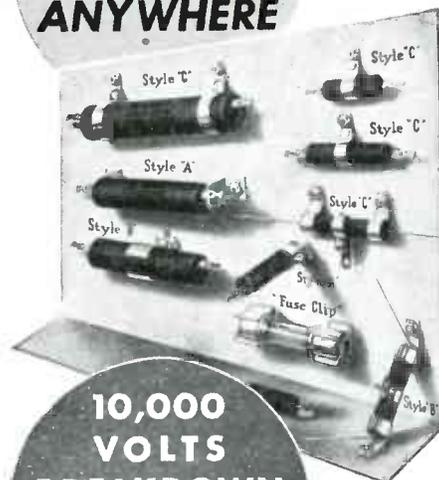
The job called for an actual rating of 4.7 watts on a wire-wound resistor to be used in an enclosed space. As usual, the manufacturer planned to use a conventional 10-watt coated resistor—until a Sprague field engineer proved beyond doubt that a 5-watt Koolohm would do the trick with ample safety margin. This instance is typical of savings made possible by Koolohms. Wound with ceramic insulated wire, they dissipate heat faster, they're easier to mount—and can safely be used at full wattage ratings. Write for Catalog 10EA.

Sprague Electric Co., Resistor Division, North Adams, Mass.

**SPRAGUE
KOOLOHM**

Trademark Reg. U. S. Pat. Off.

**MOUNT
THEM
ANY WAY—
ANYWHERE**

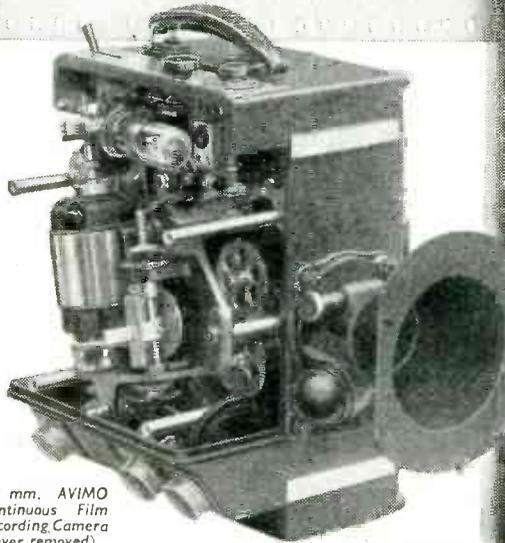
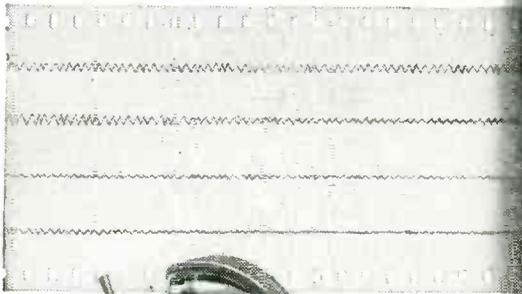


**10,000
VOLTS
BREAKDOWN
INSULATION**

From ceramic
outer shell to
ground

WIRE WOUND RESISTORS

4 Oscillograph traces on 70 mm. paper.



35 mm. AVIMO Continuous Film Recording Camera (cover removed).

9016E

RECORDING TRANSIENT PHENOMENA

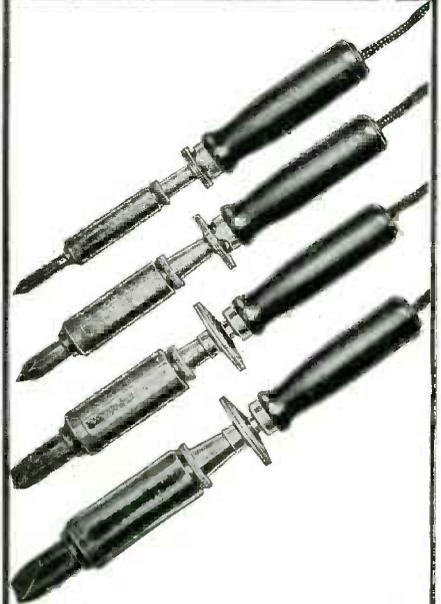
The behaviour of moving parts under actual working conditions may be studied by means of standard commercial oscillographs, which translate mechanical or electrical variations into evanescent traces on a fluorescent screen. Avimo cameras record these traces on continuous film or paper, so that they may be subsequently checked, examined, and measured. Write for Publication C3, giving full details of AVIMO Cameras including types with built-in cathode ray tubes.



AVIMO Ltd., TAUNTON
(Eng.) Tel. 3634

Designers and Manufacturers of
Scientific Cameras

American Beauty



ELECTRIC SOLDERING IRONS

are sturdily built for the hard usage of industrial service. Have plug type tips and are constructed on the unit system with each vital part, such as heating element, easily removable and replaceable. In 5 sizes, from 50 watts to 550 watts.

TEMPERATURE REGULATING STAND

This is a thermostatically controlled device for the regulation of the temperature of an electric soldering iron. When placed on and connected to this stand, iron may be maintained at working temperature or through adjustment on bottom of stand at low or warm temperatures.



For descriptive literature write

111-1

**AMERICAN ELECTRICAL
HEATER COMPANY**
DETROIT 2, MICH., U. S. A.

ZOPHAR

Waxes, Compounds and Emulsions



Materials for potting, dipping or impregnating all types of radio components or all kinds of electrical units. • Tropicalized fungus proofing waxes. • Waterproofing finishes for wire jackets. • Rubber finishes. • Inquiries and problems invited by our engineering and development laboratories.

Zophar Mills, Inc. has been known for its dependable service and uniformity of product since 1846.

ZOPHAR MILLS, Inc.

ESTABLISHED 1846

117 26th STREET, BROOKLYN, 32 N. Y.

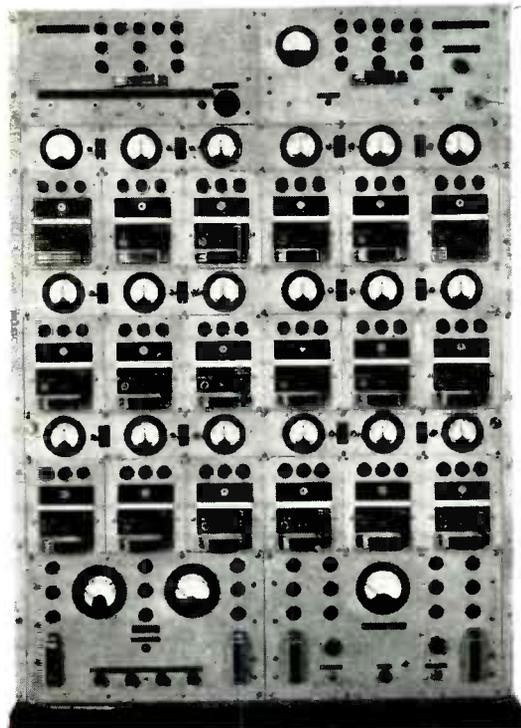


Piloted

▶ AN ANNOUNCEMENT ON **TELEMETERING**



Pilotless

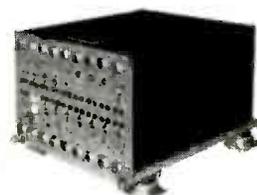


Complete Ground Receiving Equipment,
Front Panel

The makers of famous war proved NDRC Type II Model A telemetering system are now in a position to supply this and other tried and proven systems for your particular use.

The same engineers who designed and engineered this system are now available to assist you on your telemetering problems.

Licensed manufacturers NDRC Type I Model B, Type II Model A, and other telemetering systems.



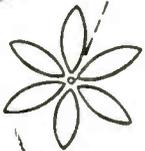
Airborne Transmitter
Commutator

RADIO ENGINEERING PRODUCTS

A DIVISION OF RAYMOND ROSEN & CO., INCORPORATED
32ND & WALNUT STS., PHILADELPHIA 4, PA.

**ATTENTION
INSTRUMENT
MANUFACTURERS**

**File your rectifier
specifications with
Conant *Now!!***



“Specials” have always been a Conant specialty. Conant designs and laboratory production methods permit the production of special rectifier assemblies at regular prices. If your specifications are on file at Conant, you can be sure of receiving rectifiers which will fit the job. Your specifications must contain the following information.

- 1 The maximum range of forward resistance at a definite value of current.
- 2 The maximum inverse current per disc.
- 3 The ambient temperature at which above values are to be measured.
- 4 A definite statement of the method used to make the above measurements and a schematic of your test circuit.

The above can then be interpreted to fit Conant test methods.



Instrument Rectifiers

ELECTRICAL LABORATORIES

6500 O STREET, LINCOLN 5, NEBRASKA, U. S. A.

20 Vesey St., New York 7, New York 518 City Bank Bldg., Kansas City 8, Mo. 1526 Ivy St., Denver, Colo.
 85 E. Gay St., Columbus, Ohio 1212 Camp St., Dallas 2, Texas 4214 Country Club Dr., Long Beach 7, Cal.
 600 S. Michigan Ave., Chicago 5, Ill. 378 Boulevard N. E., Atlanta, Ga. Export Div., 75 West St., New York 6, N. Y.
 1215 Harmon Pl., Minneapolis 3, Minn. 4018 Greer Ave., St. Louis, Mo. 50 Yorkmouth Rd., Toronto, Canada

ing the rate at which chloropicrin gas penetrated a tube filled with charcoal adsorbent. Note the complete removal of the gas up to the time when the “break” occurred, when chloropicrin began to pass through the charcoal in significant quantities.

Figure 4 illustrates a continuous record of phosgene concentrations obtained on the desert in Utah on the occasion of the bursting of a 1,000-lb bomb charged with phosgene. Note the amazingly rapid fluctuations in concentration which the ultraviolet photometer was able to resolve.

The dashed line demonstrates the

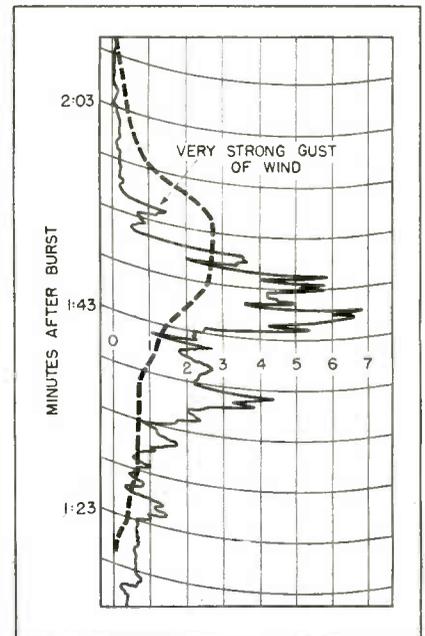


FIG. 4—Automatic record of phosgene concentration obtained downwind from the burst point of a 1000-lb. bomb charged with phosgene. The dashed line shows the response of a conductivity gas analyzer

response of a conductivity gas analyzer, an analyzer which measured the phosgene concentration by measuring the electrical conductance of water in which the phosgene was continuously dissolved. This method missed most of the details of the phosgene concentration fluctuations.

The two examples cited are typical applications to practical problems. Other analogous possibilities readily suggest themselves. In the design of large-scale reactors in chemical-engineering processes, information on smaller models is generally required. For example, in evaluating the performance of adsorbent beds in solvent recovery or

The Rauland **VISITRON** 10FP4/R6025

... the NEW Picture Tube with
Unprecedented Brilliance



No Ion Trap
Required

Virtually
Flat Face

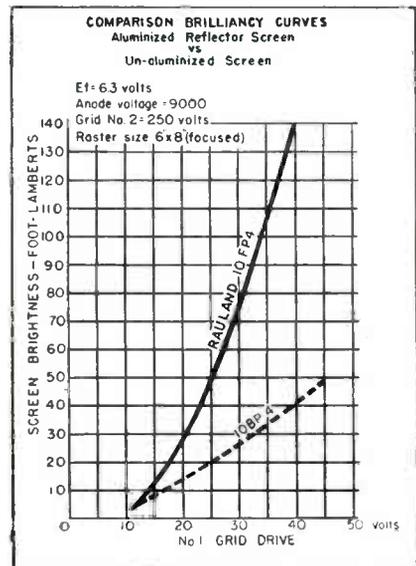
Direct
Viewing

NEW!
**ALUMINIZED
REFLECTOR-SCREEN**

Doubles the Brilliance
Highlight: 75 Foot Lamberts (avge.)
Contrast Range: Over 100 to 1
No Ion Spot—No Cathode Glow

Specifications of the Rauland Visitron 10FP4/R6025

Heater Voltage	6.3 A.C. or D.C.
Focusing Method	Electromagnetic
Deflection	Electromagnetic
Deflection Angle	50 Degrees
Screen	Phosphor P4 Aluminized Reflector
Bulb Diameter (Max.)	10 ⁵ / ₈ " at screen end
Length	17 ⁵ / ₈ " ± 3/ ₈ "
Base	Small Shell Duodecal 7 Pin
Anode Terminal	Cavity
Anode Volts (Max.)	13,000
Anode Volts (Operating)	9,000
External Coating (Optional): 500 mmf.	



• WRITE FOR INTERESTING BULLETIN •

RADIO • RADAR • SOUND •

Rauland

COMMUNICATIONS • TELEVISION

Electroneering is our business

THE RAULAND CORPORATION • CHICAGO 41, ILLINOIS



WIRES

at work

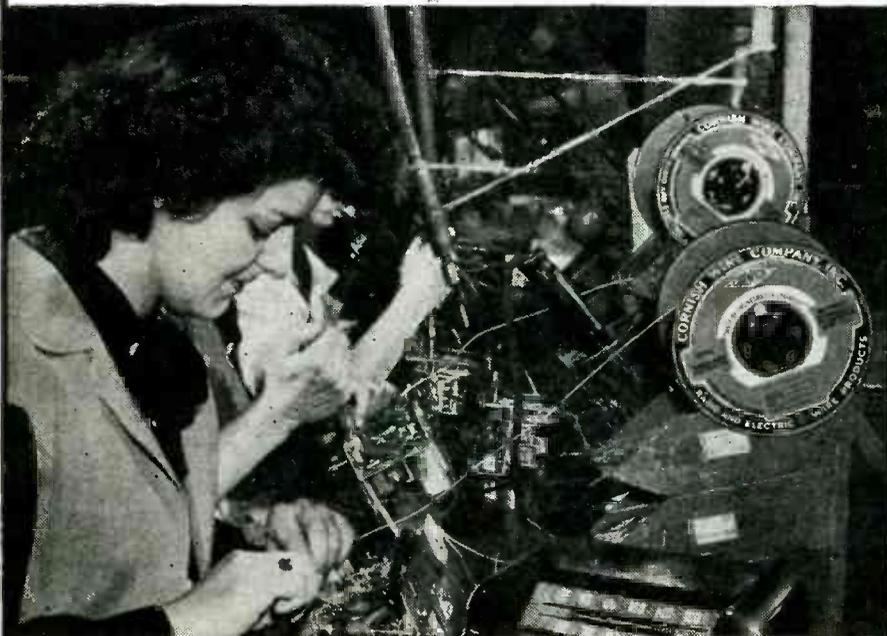


Photo courtesy of EMERSON Radio & Phonograph Corp.

WHY ARE CORWICO WIRE PRODUCTS SPECIFIED BY THIS LARGE RADIO MANUFACTURER?

Because their ENGINEERING Department values their faithful performance of the requirements of insulation resistance and voltage breakdown . . .

Because their PRODUCTION Department finds that they possess the essential qualities which permit easy pushback or mechanical stripping . . .

Because their PURCHASING Department finds that these quality products, backed by dependable service, are sold at prices that spell true economy . . .

CORNISH WIRE CO., INC.

15 Park Row • New York City, 7

toxic-gas protection, the ultraviolet photometer is particularly convenient when substances such as acetone, butadiene, benzene or phosgene, with ultraviolet-absorbing properties, are under study. Similarly, it is frequently necessary to have a constant check on the concentration in air of volatile materials in various industrial processes, and for this purpose the automatic-recording apparatus is especially suitable.

In addition the ultraviolet photometer has proved convenient in investigations of a number of fundamental scientific problems. It has been used, for example, in a study of the rate of conversion of NO into NO₂. Similarly it is now being applied to an investigation of the kinetics of the decomposition of hydrogen peroxide. In general it is applicable to any problem requiring the analysis of a substance which absorbs ultraviolet radiation.

Electronic Drive for Printing Presses

THE *Philadelphia Inquirer* is the first newspaper to install a new type of electronic drive for increased flexibility, minimum speed variation with load, and maximum efficiency over a wide range of operating speeds. It will be applied to 61 rotogravure and 44 newspaper press units at the new plant of the newspaper.

The drive system operates directly from a 440-volt plant circuit and consists of a sealed-ignitron tube panel and a magnetic control panel, motor selector switches, and the necessary d-c drive motors. Except for the drive motors, the equipment is completely static. This contributes to compactness, eliminates the necessity of special foundational and structural supports, and facilitates incorporation with modern load-center power distribution equipment.

With this new General Electric drive, especially adapted for use with high-speed rotary web presses, adjustable voltage is supplied to adjustable-speed d-c drive motors which may be mounted coaxially with the main shaft of the press. Stepless speed control—including jogging, slow threading speed,

EARL C. ANTHONY, INC (KFI) LOS ANGELES • NATIONAL BROADCASTING COMPANY • DECCA RECORDS
 NORTHERN ELECTRIC COMPANY, MONTREAL • 20TH CENTURY FOX FILM CORPORATION • NORTHERN
 MARYLAND BROADCASTING SYSTEM • SWEDISH BROADCASTING COMPANY • BENDIX RADIO COMPANY
 NAVAL RESEARCH LABORATORIES • COLUMBIA RECORDING COMPANY

COLLINS RADIO COMPANY
 WESTINGHOUSE ELECTRIC COMPANY

FREDERICK HART COMPANY
 RUDOLPH WURLITZER

RADIO RECORDERS • COLUMBIA BROADCASTING SYSTEM
 U. S. DEPARTMENT OF STATISTICS

BENDIX RADIO COMPANY
 MGM INTERNATIONAL • BELL TELEPHONE LABORATORIES

DECCA RECORDS • NORTHERN ELECTRIC COMPANY
 WOR RECORDING • EARL C. ANTHONY, INC

WCAE, PITTSBURGH • NATIONAL BROADCASTING COMPANY
 WDAY, FARGO, N. D. • GENERAL ELECTRIC

COLLINS RADIO COMPANY
 RCA, CAMDEN, N. J. • SWEDISH BROADCASTING COMPANY

COLUMBIA BROADCASTING SYSTEM
 FREDERICK HART COMPANY

NATIONAL BROADCASTING COMPANY
 FILM CRAFTS ENGINEERING

BELL TELEPHONE LABORATORIES
 WESTINGHOUSE ELECTRIC COMPANY

MARYLAND BROADCASTING SYSTEM
 NAVAL RESEARCH LABORATORIES

EARL C. ANTHONY, INC (KFI) LOS ANGELES
 FILM CRAFTS ENGINEERING • WESTINGHOUSE ELECTRIC COMPANY

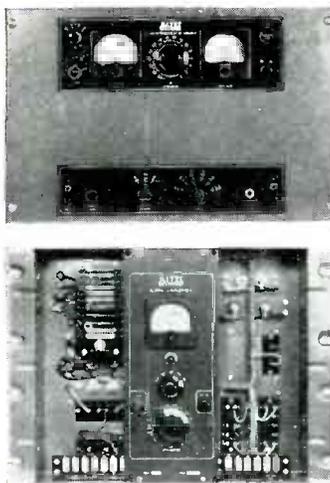
FREDERICK HART COMPANY • NATIONAL BROADCASTING COMPANY
 COLUMBIA BROADCASTING SYSTEM • VOGUE RECORDS • DECCA RECORDS

GENERAL ENGINEERING LABORATORY, INC • WESTINGHOUSE ELECTRIC COMPANY • RCA, CAMDEN, N. J.
 "KEEP ADVANCING WITH ALTEC LANSING"
 COLUMBIA RECORDING COMPANY • NAVAL RESEARCH LABORATORIES • BELL TELEPHONE LABORATORIES

Testimonials

without adjectives

One good way to raise the eyebrows of progressive engineers is to have other leaders in the industry utilize your product. A singular piece of equipment like the Altec Lansing Intermodulation Analyzer can't be bought on the basis of glib recommendation. You should be convinced of its magnitude by application to your own problem . . . or by studying the names of the organizations where it is now in use.



SEE THE ALTEC LANSING INTERMODULATION ANALYZER AT THE I. R. E. SHOW.

Originally developed for film studios, the Altec Lansing Intermodulation Analyzer is rapidly being adopted by broadcasting and recording studios as well as sound research laboratories. It supplements present methods of checking audio-distortion where quick and frequent intermodulation checks are necessary to maintain low distortion in high quality systems.

ALTEC
 LANSING CORPORATION
 1161 N. Vine St., Hollywood 38, Calif.
 250 W. 57th St., N. Y. 19, N. Y.

INTERNATIONAL
 RADIO COMPANY

CAMDEN, N. J.
 CORPORATION

BROADCASTING SYSTEM
 MONTREAL

LOS ANGELES
 FOR RECORDING

WCAE, PITTSBURGH
 RADIO COMPANY

(KFI) LOS ANGELES
 VOGUE RECORDS

BROADCASTING COMPANY
 BROADCASTING SYSTEM

MONTREAL
 ENGINEERING

LABORATORIES
 BROADCASTING SYSTEM

FREDERICK HART COMPANY
 20TH CENTURY FOX FILM CORPORATION

SWEDISH BROADCASTING COMPANY
 WOR RECORDING

BELL TELEPHONE LABORATORIES
 BROADCASTING SYSTEM

RCA RADIO COMPANY

acceleration, deceleration, and dynamic braking—is provided without the necessity of speed-regulating resistors or auxiliary starting motors. The drive is operated by conventional push-button stations, including an emergency control station and an automatic safety signal system.

Simple Foolproof Production Tester

by MARTIN F. BEAVERS
General Electric Company
Pittsfield, Massachusetts

ENGINEERS who have qualms about having sensitive equipment used by nontechnical workers doing production-line testing can substitute the device to be described in a dozen applications where use of extremely accurate and expensive instruments is not warranted.

The voltmeter covers a range from approximately 50 to 500 volts, a-c or d-c, and employs only a 500,000 ohm potentiometer and a small neon lamp. Instead of using the brilliance of the neon lamp as an indication of the voltage, the voltage is read from a scale on the instrument. Figure 1 shows the voltmeter circuit but because of its simplicity, no detailed construction information is deemed necessary.

Operation is based on the inherent characteristic of a neon glow lamp that a certain voltage is necessary to make it glow. In most neon lamps, this ignition voltage may vary slightly from one applica-

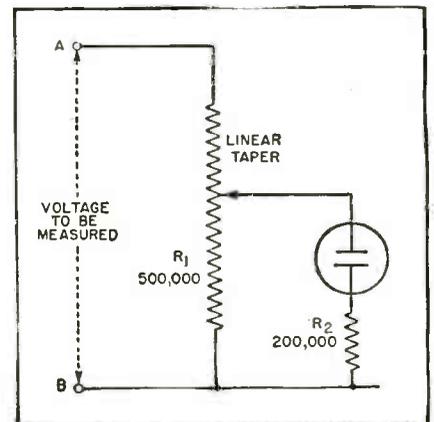
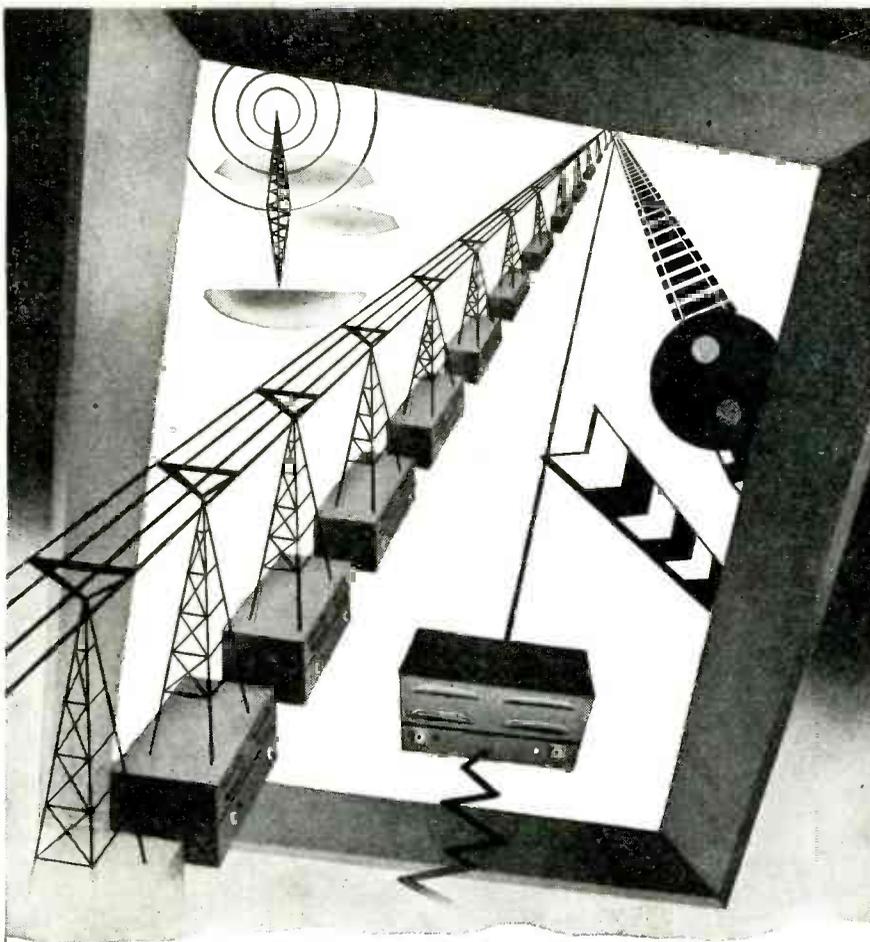


FIG. 1.—A potentiometer having a linear change of resistance versus rotation and a neon lamp form the foolproof voltmeter



A MILLION MILES OF STRAIGHTENED VOLTAGES *Without Moving a Muscle*

Sorensen Voltage Regulators guarantee many miles of speed with safety by constantly and automatically stabilizing voltages that operate vital communications equipment on surface and air transportation lines.

Wire and radio contact systems depend upon quick, accurate response to even the smallest variation to attain peak performance. No moving parts in a voltage regulator means no time consuming adjustments, no wear and a minimum of maintenance.

These are just a few reasons why Sorensen Voltage Regulators are chosen as the perfect power guardian for the millions of miles of communications so essential to safe transportation.

Investigate the many advantages of Sorensen regulators applied to your unit. Write today for your copy of the new, complete Sorensen catalog M-L. It is filled with schematic drawings, performance curves, photos and contains in detail, "Principles of Operation."



SORENSEN & COMPANY, INC.
STAMFORD, CONNECTICUT

A LINE OF STANDARD REGULATORS FOR LOAD RANGES UP TO 30 KVA.
SPECIAL UNITS DESIGNED TO FIT YOUR UNUSUAL APPLICATIONS.

ELECTRICAL
Mitchell-Rand
INSULATION HEADQUARTERS

S I N C E 1 8 8 9

VARNISHED TUBINGS
FIBERGLAS and STAPLE FIBER COTTON YARN

M - R THE
 ELECTRICAL
 INSULATION
 HEADQUARTERS
 FOR 58 YEARS.



meet or exceed
SPECIFICATIONS

set by

VARNISHED TUBING ASSOCIATION

and

AMERICAN SOCIETY FOR TESTING MATERIALS

M-R FIBERGLAS (INORGANIC) VARNISHED TUBINGS are made in four grades: Standard; Double Saturated; Triple Strength and Impregnated.

STANDARD GRADE for maximum flexibility, has little varnish and is recommended for high temperatures where dielectric strength is not a factor.

DOUBLE SATURATED has all qualities of the Standard Grade but with additional coats of varnish to bring the dielectric rating up to 1500 volts.

TRIPLE STRENGTH is built up with coats of especially flexible insulation varnish for dielectric ratings up to 2500 volts and is particularly suited where assembly operations include the possibility of rough handling.

IMPREGNATED is the Optimum in Superiority for high gloss, non-hydroscopic, resistance to high temperatures, oils, acids, etc. **IMPREGNATED** has a dielectric rating beyond 7000 volts and is unequalled for Long Life Under Most Severe Conditions. Write For Samples.

FOR USERS OF COTTON YARN VARNISHED TUBINGS The Mitchell-Rand **MIRAC** and **HYGRADE** Varnished Tubings of long staple fiber yarn are comparable to Fiberglas Tubings in dielectric ratings, tensile strength, flexibility and long life. Write For Samples.

MITCHELL-RAND in its improvement of Varnished Tubings, took as its starting point the specifications established by the Varnished Tubing Association and the Society for Testing Materials . . . and today produces Varnished Tubings that meet or exceed the known specifications for Dielectric, Tensile Strength, Flexibility, Non-Fraying, High Gloss, Non-Hydroscopic Resistance to High Temperatures, Oils, Fats, Acids, etc.

Write today for your free copy of the M-R WALL CHART with its engineering tables, electrical symbols, carrying capacities of conductors, dielectric averages, thicknesses of insulating materials, tubing sizes, tap drills, etc.



MITCHELL-RAND INSULATION COMPANY, INC.

51 MURRAY STREET

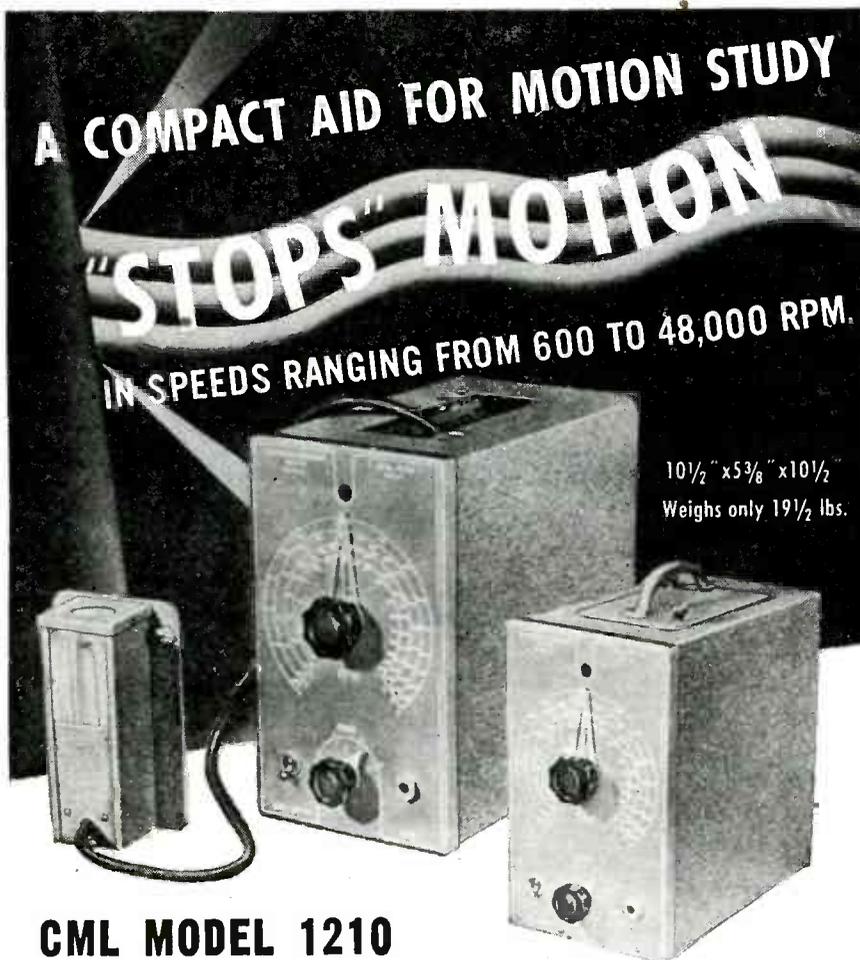
Cortlandt 7-9264

NEW YORK 7, N.Y.

Fiberglas Varnished Tape and Cloth
 Insulating Papers and Twines
 Cable Filling and Pothead Compounds
 Friction Tape and Splice
 Transformer Compounds

A PARTIAL LIST OF M-R PRODUCTS
 Fiberglas Saturated Sleeving, Varnished Tubing
 Asbestos Sleeving and Tape
 Varnished Cambric Cloth and Tape
 Mica Plate, Tape, Paper, Cloth, Tubing

Fiberglas Braided Sleeving
 Cotton Tapes, Webbing and Sleevings
 Impregnated Varnish Tubing
 Insulating Varnishes of all types
 Extruded Plastic Tubing



CML MODEL 1210

PORTABLE STROBOSCOPE

This newly developed stroboscope employs a novel circular arrangement, using a self-blocking oscillator. Rotary or vibratory motion can be "stopped" when the moving object is examined with stroboscopic light source. The speed covered is from 600 to 48,000 RPM (10-800 CPS), in 4 ranges. A synchronized reed is provided for accurate calibration against the line frequency.

A valuable aid in industry for the slow-motion study of rotating, reciprocating, or vibratory mechanisms, CML 1210 is also useful for studying mechanical stresses and strains under dynamic conditions.

The light source is contained in a probe attached to a 4-foot flexible cable. This unusual feature makes CML 1210 especially useful when using the Stroboscopic light in small out-of-the-way places. The light probe and cable are housed in the cabinet when the Stroboscope is not in use. The handle of the probe is then used to carry the instrument.

Inquiries Invited. Descriptive Bulletin Available

COMMUNICATION MEASUREMENTS LABORATORY

120 GREENWICH STREET, NEW YORK 6, N. Y.

Sales Offices: CHICAGO: 612 N. Michigan Ave.—WASHINGTON: 924 19th St., N.W.
PHILADELPHIA: Van Dam Building, 10th and Market Sts.

tion of voltage to another. However, for practical purposes, this variation is relatively small and readings are obtainable within three percent accuracy. Another characteristic of the neon lamp is that once it is ignited, the voltage will have to be lowered somewhat below the ignition voltage in order to extinguish the lamp. Due to the fact that each individual neon lamp may have a slightly different ignition voltage, no definite value can be given; however, ignition voltages of the order of 50 volts a-c or 70 volts d-c may be expected from lamps such as the GE, NE-51, neon glow lamp (resistorless).

When d-c voltage is applied, only one of the two electrodes will glow—the one which is connected to the negative side of the source; thus, polarity may be determined by noting which of the electrodes glows. However, when connected to an a-c source, both electrodes glow.

There may be a slight difference in ignition voltage depending upon which electrode is connected to the negative side of a d-c source. The electrode which has the lowest ignition voltage is preferable, and the meter should be marked with polarity indications; otherwise the calibration may not be correct if the polarity is reversed on d-c measurements.

Other types of neon lamp may be used in this voltmeter circuit. Experimentation with a lamp will enable one to quickly ascertain its particular characteristics. In general, a small wattage lamp is more satisfactory than a large wattage lamp. If the lamp has a protective resistor built into the base, the 0.2

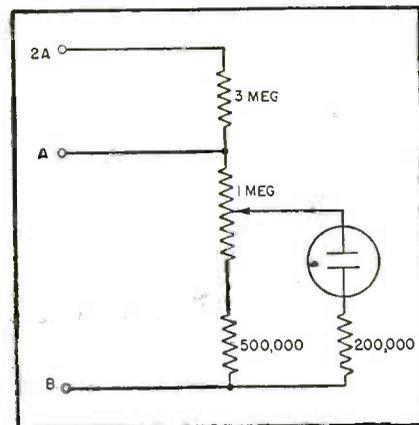
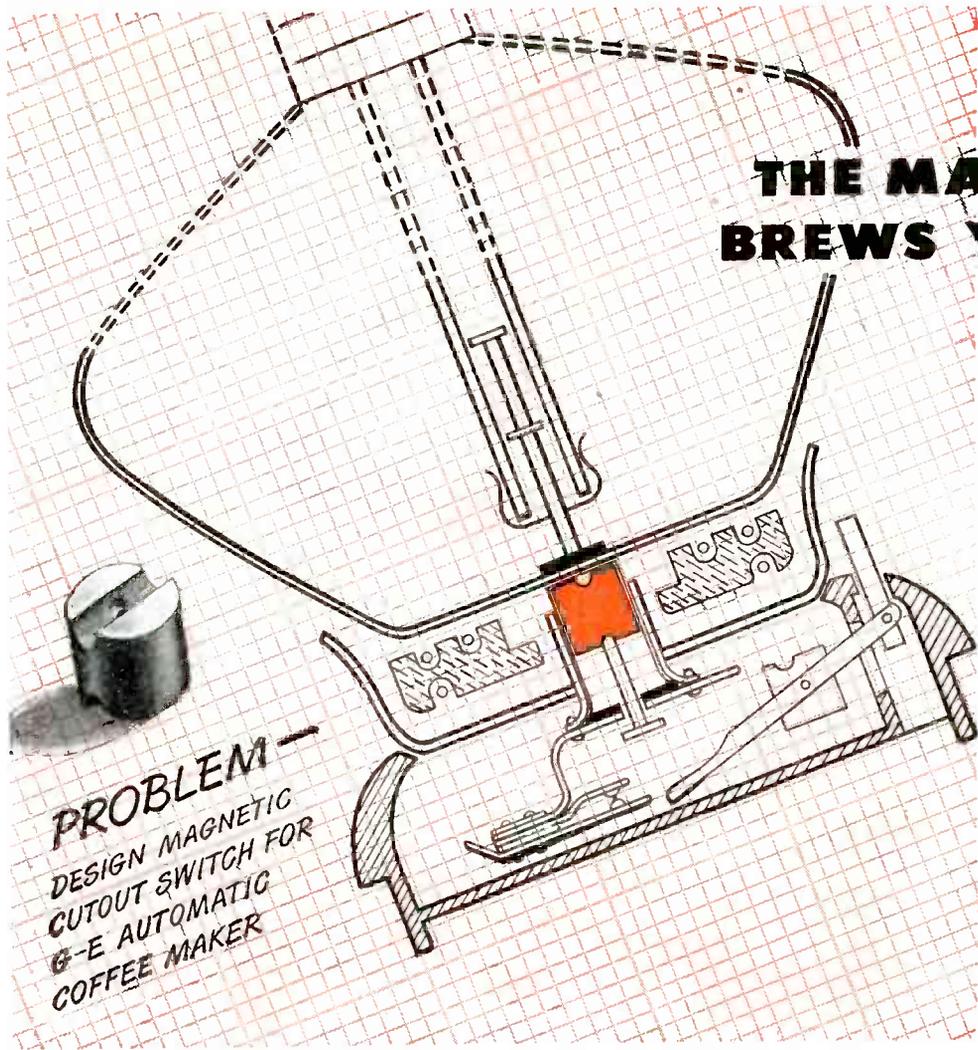


FIG. 2—Improved readability and two ranges are provided by this circuit

YOU GET QUALITY PLUS ENGINEERING SERVICE WITH G-E PERMANENT MAGNETS



THE MAGNET THAT BREWS YOUR COFFEE



The heart of the G-E Automatic Coffee Maker is a tiny but powerful sintered ALNICO 2 magnet. At precisely the right moment, it shuts off the current and the coffee is ready! Pressing the button raises the magnet to the position shown, where it is held by attraction through glass to the nickel disc at the bottom of the siphon tube. When enough pressure is developed, boiling water surges up the tube, pulling the disc assembly with it. Its top magnetic support gone, the ALNICO magnet drops and opens the contact switch.

PROBLEM —
DESIGN MAGNETIC
CUTOUT SWITCH FOR
G-E AUTOMATIC
COFFEE MAKER

G.E.'s precise quality control methods used throughout magnet production, plus accurate testing and rigid inspection assure you of receiving magnets of the highest uniform quality for your application.

Greater flexibility of magnet design is possible with the many G-E permanent magnet materials now available. The large group of sintered and cast ALNICO alloys has been augmented by the lightweight, non-metallic mixture, VECTOLITE, and by the ductile permanent magnets, CUNICO, CUNIFE and SILMANAL. From such a wide choice of materials, you may now find a magnet better suited for your application or a material which will make possible new designs heretofore impractical or impossible.

General Electric engineers, backed by research and application experience, have acquired years of "know-how" in selecting the best permanent magnet material and properly designing magnets for thousands of products. These engineers are at your service.

For detailed information about G-E permanent magnet materials, fill out and return the coupon to Metallurgy Division, Chemical Dept., General Electric Co., Pittsfield, Mass.

ELIMINATE YOUR MAGNET SUB-ASSEMBLY PROBLEMS

Consult General Electric for the design and manufacture of carefully calibrated permanent magnet sub-assemblies, ready for your final product. G-E magnet sub-assemblies will benefit you in the following ways:

- Eliminate your assembly line rejects.
- Eliminate calibration problems in your factory.
- Eliminate cost of production and testing equipment.
- Eliminate breaking and chipping losses on brittle magnetic materials.
- Eliminate expense of shipping special trays for semi-finished magnets.

We shall be glad to send you additional information about G-E permanent magnet sub-assemblies upon request.

METALLURGY DIVISION
CHEMICAL DEPARTMENT
GENERAL ELECTRIC COMPANY
PITTSFIELD, MASS.

Please send me your bulletin, GES-3337A, "Permanent Magnet Materials."

NAME

TITLE

COMPANY

ADDRESS

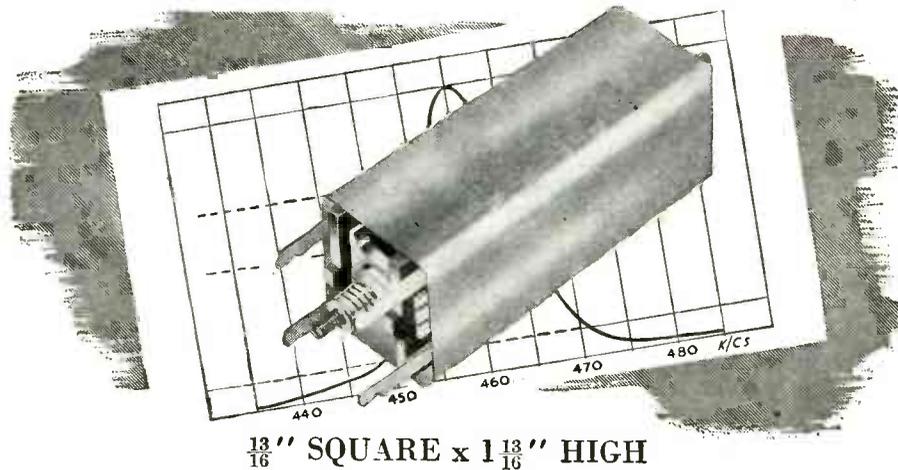
CITY STATE



**PERMANENT
MAGNETS**

GENERAL ELECTRIC

CD47-JA2



$\frac{13}{16}$ " SQUARE x $1\frac{13}{16}$ " HIGH

NOT A SCALE DRAWING... IT'S FULL SIZE!

Though small in size, this I.F. Transformer by Wright & Weaire gives the perfect performance and is ideal when layout space is limited as in 'personal' receivers, "Walkie-Talkie", and similar equipment. It packs complete reliability into its small compass — $\frac{13}{16}$ " square by $1\frac{13}{16}$ " high. Constructed of the finest materials, allied to up-to-the-minute production technique, it will pass all tests. Write to-day for full details . . . they're interesting. Prompt deliveries can be guaranteed.

SPECIFICATION

Primarily designed for use with valves of the LR5, LT4 and LS5 Series. High gain and selectivity with stability are obtainable. Permeability tuning is employed with enclosed type cores and the necessary fixed condensers 'built in'. Coils are impregnated and can be used with

confidence in the tropics. Available in the following preferred frequencies with various degrees of coupling:—460 Kc/s, 1.6 Mc/s, 2.1 Mc/s, 4.86 Mc/s. The response curve shown is for Type M400 and is typical of the whole series. Nominal frequency is 460 Kc/s but is adjustable from 420 to 530 Kc/s approx.



MINIATURE I.F. TRANSFORMERS

WRIGHT & WEAIRE LTD., 740, HIGH ROAD, TOTTENHAM, LONDON, N.17, ENGLAND. CABLES: WRITWEA, LONDON
FACTORY: SIMONSDALE WORKS · SOUTH SHIELDS · CO. DURHAM · ENGLAND

★ This Trade Mark is well-known in Britain as that of a Company who are responsible for the Design, Development and Manufacture of Transformers, Vibrators, Switches and Coils. This particular component of real miniature dimensions, yet maintaining highest efficiency, is the latest development of their Engineering Dept. and is backed by 26 years experience in the manufacture of Radio and Electronic components.

megohm resistor shown in Fig. 1 may be omitted.

Principle of Operation

As the slide of the potentiometer is moved from terminal *B* toward terminal *A*, the voltage across the lamp increases until a point is reached when the lamp bursts into a glow. Suppose that this point is reached when the slide is just one-quarter of the way from terminal *B*. Then, due to the voltage divider action of *R*₁, the applied voltage across *A* and *B* must be four times that required to ignite the neon lamp. After the lamp has ignited, the divider ratio is upset due to the shunting action of the lamp, but the correct position of the slide is obtained just before the upsetting takes place.

The ohmic value of the potentiometer is not critical. Any value from 100,000 ohms to five megohms should give satisfactory results. The value shown in Fig. 1 was chosen since it provides a meter resistance of 1,000 ohms per volt at the maximum voltage of 500 volts to be measured.

An alternative circuit is shown in Fig. 2. This has the advantage of employing the full use of the potentiometer for voltage indication and also spreads out the readings, especially in the higher voltage part of the scale. If the ignition voltage of the lamp is 70 volts d-c, the voltage range, when applied across terminals *A* and *B*, is 70 to 210 volts; if voltage is applied across terminals 2*A* and *B*, the range is 210 to 630 volts d-c. Other combinations of divider ratio and resistances may be employed.

Calibration

This type of voltmeter is a peak-reading instrument and, if the calibration is made with d-c, an a-c scale can be drawn alongside the d-c scale using values equal to 0.707 times the d-c scale values. It is desirable to calibrate with both a-c and d-c if practicable, since a little time lag is inherent in these lamps on alternating current which may produce a small error in the calculated a-c scale.

Having a variable source of known voltages connected across terminals *A* and *B*, and the knob of

MYKROY

Extends a cordial invitation . . .

You are cordially invited to visit Booth No. 27 at the I.R.E. Show where Mykroy products will be exhibited by Electronic Mechanics, Inc.



THIS invitation really is cordial. Your stop at the Electronic Mechanic's booth will be rewarded with a friendly welcome. Meet the men who engineer Mykroy. See this perfected Mica Ceramic insulation on display, in both machined and molded form. See the latest moldings. We may have the answer to some of your particularly tough insulation problems. Drop in anyway and say hello!

MYKROY IS SUPPLIED IN SHEETS AND RODS . . . MACHINED OR MOLDED TO SPECIFICATIONS

MADE EXCLUSIVELY BY

ELECTRONIC MECHANICS
INC.

70 CLIFTON BOULEVARD • CLIFTON, NEW JERSEY
Chicago 47, 1917 NO. SPRINGFIELD AVENUE.. TEL. ALBANY 4310

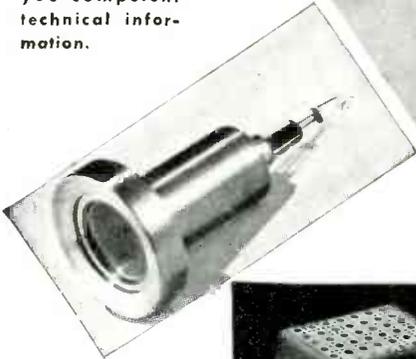
Export Office: 89 Broad Street, New York 4, N. Y.

Summarizing a few recent developments culminating our twenty-year background in the factual "know how" of instrumentation used in radiation physics.

Have you a radiation measuring problem? Our staff of radiation physicists offers you competent technical information.



Model 337 Geiger - Mueller Counter Scale of 64. Offers a high degree of stability and permanence with a pre-amplifier and special voltage regulation added features.



Model 311— Geiger - Mueller Tube. Our background in fine tube production offers close reproducibility of tube characteristics.



Model 348 Voltage regulator unit. A bank of seven subminiature voltage regulator tubes arranged in one unit for precision voltage regulation.



Model 338 Electronometer. An electronic instrument which replaces electrostatic electrometers. Input resistance 10^{12} Ohms.



Hi-megohm resistors of stability and accuracy for the difficult applications. Vacuum sealed in glass with special surface treatment. Values 100 to 10,000,000 megohms.

This advertisement merely serves to introduce these new instruments and tubes to you. For complete information, prices and deliveries write us and you will receive a prompt reply.



THE VICTOREEN INSTRUMENT CO.
5806 HOUGH AVENUE
CLEVELAND 3, OHIO



Subminiature electrometer vacuum tubes (actual size) offer an expanding conception of circuit development. Available as:

Diodes
Triodes
Tetrodes
Pentodes

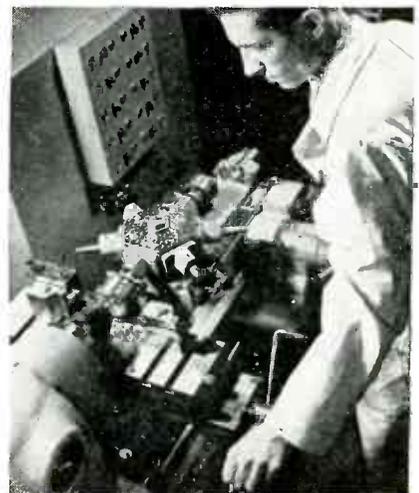
the potentiometer turned to one extreme position so that the moveable contact is at terminal A, the applied voltage is raised until the neon lamp glows. This is the minimum voltage which can be measured. The applied voltage is raised in uniform steps, and at each voltage step, the potentiometer knob is turned sufficiently to extinguish the lamp, then turned back until the lamp glows. This position of the knob pointer is marked on a scale.

Electronic Ignition System

AN ELECTRONIC ignition system for aircraft was produced experimentally at the end of the war by the Bosch firm in Reichenbach, Germany, according to report PB-22653, Office of Technical Services, Department of Commerce. The system is said to eliminate many of the deficiencies of conventional magneto systems.

In the circuit a capacitor is charged through a resistance, and discharged through a grid-controlled tube to the primary of the high tension coil at the spark plug. After completion of the discharge, the grid voltage prevents further passage of current between the anode and the cathode of the tube, thus enabling the capacitor charge to be built up again.

ELECTRONIC LATHE



Control box and head of 10-inch lathe using electronic control of spindle speed and made by Monarch Machine Tool Company of Sidney, Ohio

FEDERAL'S *Intelin* HIGH-FREQUENCY COAXIAL CABLES offer you all three...

1. LOW LOSSES
2. FLEXIBILITY
3. DURABILITY



K-12 ... the most popular cable for FM and AM antenna transmission lines.

- Copper Conductor — solid or stranded.
- Polyethylene Dielectric between central conductor and outer braid.
- Copper Braid, closely woven over dielectric sheath.
- Outer Jacket of Federal's IN-102, a plasticized vinyl resin, extremely durable with remarkable abrasive resistance, and highly resistant to most acids and alkalis, smoky atmospheres, oils and greases.

INTELIN COAXIAL CABLES are especially designed for high-frequency transmission line service — the vital link between transmitter and antenna.

Their unusually low attenuation losses, obtained by careful selection of dielectrics, conductor spacings, and rigid quality control, assure the most efficient transfer of energy with minimum radiation. They are extra flexible, too — can be bent without cracking at

temperatures as low as minus 30°C. Whatever your operating conditions, you'll find that the extra durability of Intelin cables — their outstanding resistance to abrasion, weathering and corrosion — means long uninterrupted service.

Federal's complete line of many sizes and types of coaxial cables enables you to select the *right* transmission line for practically every field of application. Write today for Bulletin D514 giving complete data and specifications.

PARTIAL LIST OF FEDERAL CABLES COVERING POLICE, BROADCAST AND AMATEUR BAND

High-Frequency Coaxial Cable Data														
Type Number	Characteristic Impedance Ohms	Capacitance Per Ft. mmf	Attenuation Db. Per 100 Ft.					Power Rating Kilowatts					Physical Dimensions	
			Frequency In Megacycles					Frequency In Megacycles					Conductor Dia.	O.D. Over Jacket
			1.0	1.7	30	100	300	1.0	1.7	30	100	300		
K12	52	29	.066	.086	.425	.83	1.70	39	30	8.50	3.0	1.5	.188"	.885"
K13	52	29	.058	.076	.320	.69	1.45	51	43.8	13.5	5.4	2.3	.250"	1.135"
K14	71	21	.070	.092	.460	.93	1.90	36.5	27.8	5.55	2.71	1.34	.114"	.885"
													Stranded Copper	
K45	52	29	.155	.202	.900	2.1	4.20	13	9.9	2.4	.96	.480	.086"	.415"
K49	75	20	.182	.237	1.03	2.1	3.80	9.1	6.9	2.1	.79	.435	.048"	.415"

Federal Telephone and Radio Corporation

In Canada:—Federal Electric Manufacturing Company, Ltd., Montreal
Export Distributor:—International Standard Electric Corporation



Newark 1,
New Jersey

* Reg. U. S. Pat. Off.

Electronic Regulated POWER SUPPLIES



- * Precision
- * Accuracy
- * Performance

SPECIFICATIONS

INPUT—115 v. 50-60 cycle

REGULATION—Less than 1/20 volt change in output voltage with change of from 105-140 V.A.C. input voltage & from NO-LOAD to FULL-LOAD (over very wide latitude at center of variable range)

RIPPLE—Less than 5 millivolts at all loads and voltages

DIMENSIONS—Fits any standard rack or cabinet (overall: 19 in. wide; 12 1/4 in. high 11 in. deep; shipping wt.—100 pounds)

TYPE A—VARIABLE FROM 210-335 V.D.C. @ 400 M. A.

TYPE B1—VARIABLE—TWO RANGES: 400-600 V. D. C. @ 125 M. A. and 600-890 V. D. C. @ 125 M. A.

CONSTRUCTION FEATURES

Weston model 301 (or equal) milliammeter and voltmeter. Separate switches, pilot lights, and fuses for FIL & PLATE VOLTS. All tubes located on shockmount assemblies. Fuses mounted on front panel and easily accessible. Can vary voltage by turning small knob on front of panel. Can modify Type B1 from POSITIVE to NEGATIVE output voltage. Individual components numbered to correspond with wiring diagram.

Rigid construction: components designed to withstand most severe military conditions—physical & electrical; were greatly under-rated. (Adapted to civilian use from RADAR Power Supply RA-57.)

Tube complement: } Type A: 2-836; 6-6L6; 2-6SF5; 1-VR150; 1-VR105
 } Type B1: 2-836; 2-6L6; 2-6SF5; 1-VR150; 1-VR105

IMMEDIATE DELIVERY

NET PRICES—F. O. B. BALTIMORE

TYPE A—\$179.00

TYPE B1—\$175.00

Complete with tubes and ready to plug in—Prices subject to change without notice

NATIONAL RADIO SERVICE CO.

Reisterstown Rd. & Cold Spring Lane

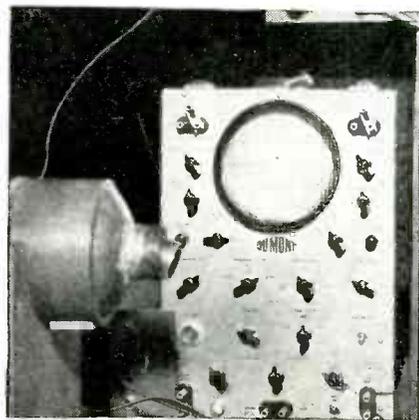
Baltimore 15, Md.

frequencies. In experimenting on a bolometer, the sensitive element of which was a strip of columbium nitride a centimeter long in a cryostat cooled to about 15 degrees Kelvin (ELECTRONICS, p 226 June 1946), Dr. D. H. Andrews of Johns Hopkins University observed that the bolometer received and detected radio waves when it was operating at the transitional temperature between conductivity and superconductivity. The exact cause of the action is not yet determined.

The observation was made while measuring the inherent noise of the semi-super-conductive bolometer element. A trace on an oscilloscope was ten times the amplitude that would be expected if random motion of electrons at the low temperature were the sole cause of bolometer output. To ascertain the nature of the noise, a loudspeaker was connected to the amplifier. The broadcast from a local station was heard.

Stations at 1,090, 1,200, and 1,400 kc were received and detected by the bolometer. In addition, the performance was explored in the range 0.2 to 30 mc using a standard signal generator. Maxima were observed at 0.9, 2.9, 5, and 16 mc; minima at 2, 4, and 8 mc, the latter one being quite broad. Above 20 mc the action fell below the threshold of measurability.

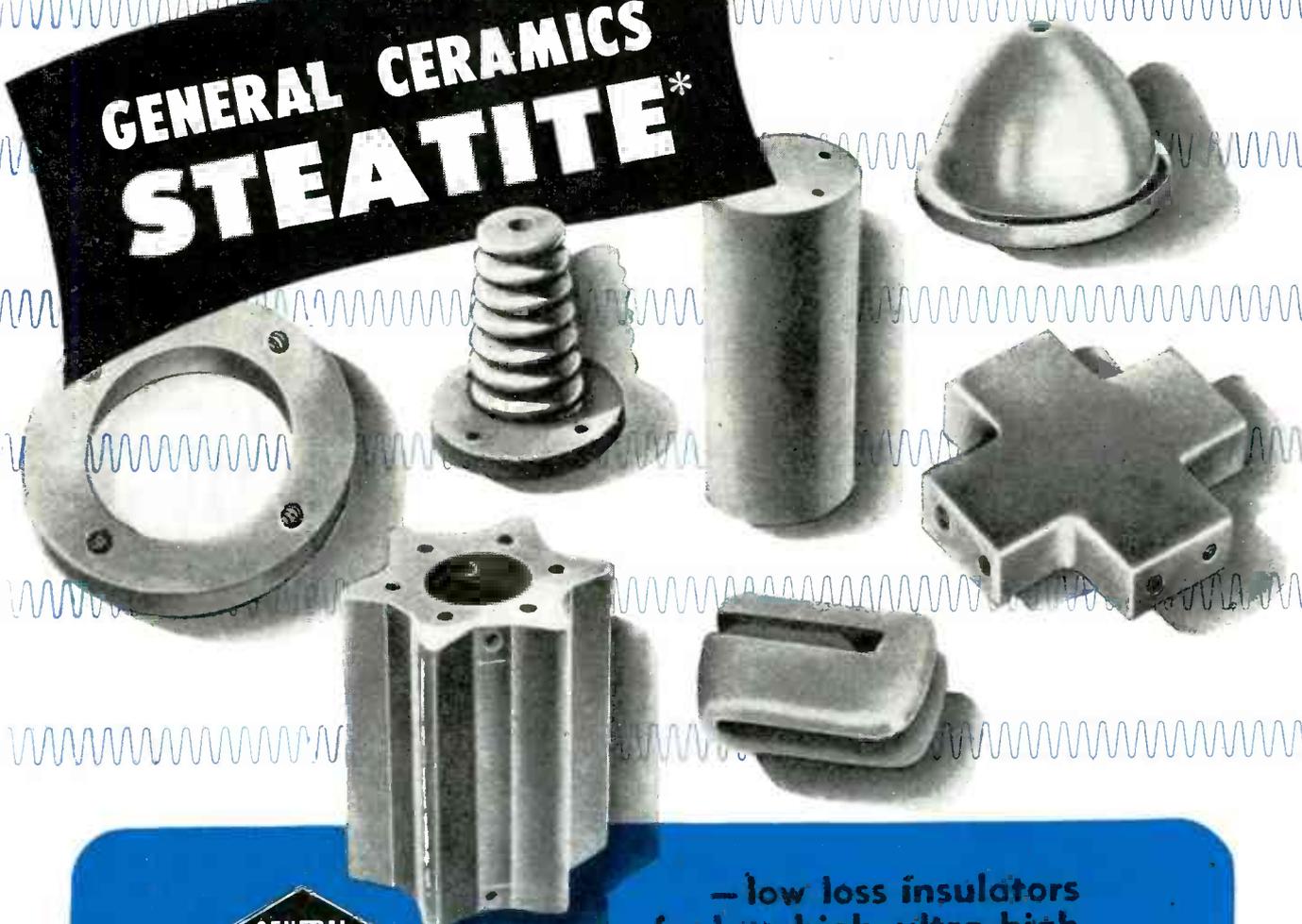
The columbium nitride bolometer changes its resistance at the rate of about ten ohms per degree Kelvin in the region between 14.34 K



Radio detecting bolometer is inside the cooling chamber to the left. The output of the bolometer and of a communications receiver were fed through an electronic switch to the oscilloscope and observed to be the same, indicating that the bolometer receives and detects radio waves

Shorter and shorter wavelengths require better and better dielectrics —

GENERAL CERAMICS STEATITE*



— low loss insulators
for low, high, ultra-high
and very high frequencies!

If you require low loss insulators with demonstrated ability to function efficiently in any frequency range, and with mechanical characteristics capable of meeting practically any conditions of exposure, shock or vibration, GENERAL CERAMICS steatite products merit first consideration. In many cases, a standard GENERAL CERAMICS insulator will be found available to exactly meet your needs. The specifications of these stock items, which are mass-produced to standards that represent the highest attainments in ceramic fabrication, can effect economies of vital importance. Where

unusual electrical or mechanical requirements demand an insulator of special design, our engineers will gladly assist in its development. Also, GENERAL CERAMICS production facilities are geared to produce it promptly, accurately and at moderate cost. Your inquiries are invited — write today, no obligation.

* Steatite has a low loss factor — 0.7% at 1000 KC; no moisture absorption; high surface and volume resistivity; high tensile strength. Compressive strength is comparable to cast iron. Practically any size or shape is feasible in Steatite.

General CERAMICS and STEATITE CORP.
GENERAL OFFICES and PLANT: KEASBEY, NEW JERSEY

MAKERS OF STEATITE, TITANATES, ZIRCON PORCELAIN, ALUMINA, LIGHT-DUTY REFRACTORIES, CHEMICAL STONWARE



Silent and chatterless

...just like an Adlake Relay!

Silent, positive action is just one of many Adlake Relay advantages!

Other important ones are:

- Hermetically sealed contact mechanism—impervious to dust, dirt and moisture.
- Liquid mercury-to-mercury contact—no burning, pitting or sticking.
- Armored against outside vibration or impact—designed for either stationary or moving equipment.

Remember, *whatever* your relay needs may be, there's an Adlake Relay to do the job. So write today for free, illustrated folder. No obligation, naturally. Address: The Adams & Westlake Company, 1107 N. Michigan, Elkhart, Ind.



ADLAKE RELAY MODEL NO. 1040

THE Adams & Westlake COMPANY

Established 1857 • ELKHART, INDIANA • New York • Chicago

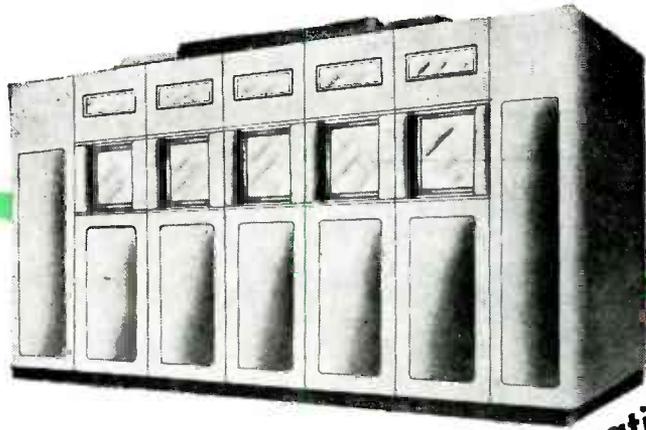
Manufacturers of Adlake Hermetically Sealed Mercury Relays for Timing, Load and Control Circuits

and 14.38 K, this change in resistance being detected in a bridge. In detecting infrared waves the bolometer absorbs the infrared waves, which may either cause the observed change in resistance by changing the temperature of the bolometer or by altering the electronic state within it. As a detector of r-f, the bolometer develops the demodulated signal directly when operated within a region 0.03 K wide at 14.33 K. Less than a milliamperere of current through the bolometer stops the detection, either because of electrical polarization or by heating. That detection could be from bimetallic contact is doubtful. That the bolometer should develop a noticeable signal from the r-f is especially remarkable in that it is within a refrigerating chamber that shields it. The rock salt window through which infrared waves are focused on the bolometer was shielded and the output leads were shielded, but the reception of r-f was unimpaired.

Because of the very low resistance of the sensitive element of the bolometer at the low temperature of operation, electrical losses within the bolometer are low. As the energy of the incoming r-f is amplitude modulated, it is understandable that some action similar to that of changing the intensity of incident infrared waves would be produced. However, the remarkable sensitivity of the element to r-f and its production of a demodulated signal indicate a phenomena of which scientists are unfamiliar. The bolometer makes possible the detection for measurement or reception of extremely weak r-f fields.

Classroom Demonstration of Cathode Follower

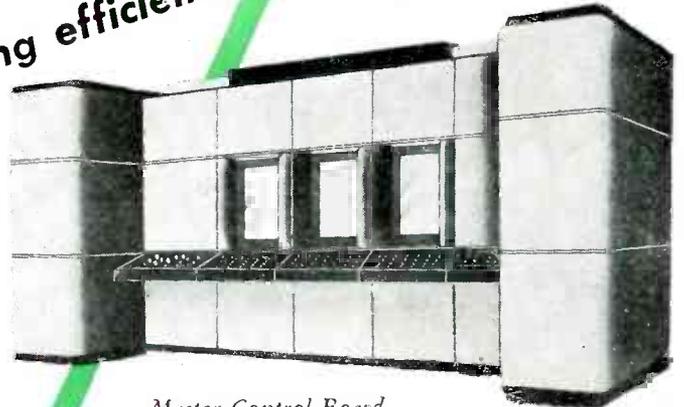
HIGH INPUT IMPEDANCE of a cathode follower can be convincingly demonstrated by the circuit shown below. The 60-cps power line voltage is fed in at A. The first tube clips the wave, delivering a square-wave to the second tube, which is the cathode follower. The input to the cathode follower is taken off at B and observed on an oscilloscope. With switch S open, the conductive



Television Transmitter

This unit is manufactured to furnish ranges of 250 watts and upwards, and in power ranges coinciding with power tube development. Individual bays of additional power can be incorporated as needed. Except where additional bays may be required, however, the complete unit can be controlled by a single licensed operator.

maximum operating efficiency
with minimum personnel!



Master Control Board

This unit includes five video channels, or as many as desired. It also includes dissolving, shading, blanking controls. Simplicity of design enables the master control board to be operated by a single technician. A sync generator and monoscope are integral parts of this unit.

SHERRON
Television Studio and Transmitting Equipment!

Efficient operation by a minimum of personnel! That is the achievement of the improvements both in technical details and design which distinguish Sherron Television Studio and Transmitting Equipment. Unnecessary controls and duplication of executive supervision are eliminated. . . All Sherron equipment is designed, developed and manufactured to the individual manufacturer's specifications.



Audio Control Console

In this Sherron unit all controls are centrally located. Under usual conditions, a single control operator can meter and monitor the aural program with complete ease. Ordinarily, this unit may be adjacent to the studio control console. Thus, the control operator may receive aural instructions from the program director or, if remotely located, by inter-communication.

A cordial invitation to visit our factory is extended to all IRE members attending the IRE convention.



Studio Control Console

This unit is especially designed to afford exclusive control to the program director in charge of the broadcast. The director need not be a technician. His sole concern is the quality of the broadcast. He does not operate the controls but transmits his instructions, by inter-communication, to the master control and studio camera men.



SHERRON ELECTRONICS CO.

Division of Sherron Metallic Corporation

1201 FLUSHING AVENUE • BROOKLYN 6, NEW YORK



Micah is Long-Lived . . .

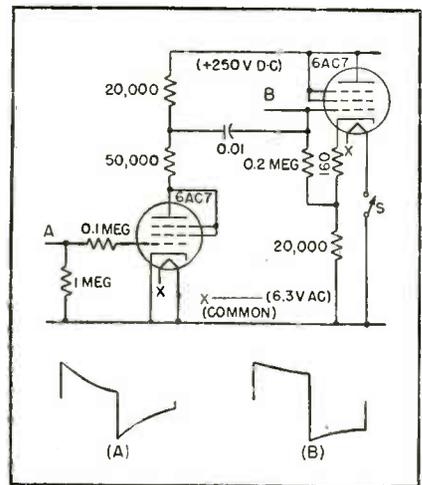
Micah is long-lived. This perennial juvenile has drunk from the proverbial fountain of youth and eschews vitamin pills and glandular extracts. Gray-bearded old men remember him when they were still in swaddling clothes! It's youth! Youth! Youth!

And mica (without the "h") is long-lived, too. Motors and such may wear out, coils and wire may disintegrate, but mica marches on, unchanged by the years. Nothing else lasts as long, nothing else performs as well. There is no substitute for mica. And there is no substitute for *Macallen Mica!*

When You Think of MICA, Think of MACALLEN



CHICAGO: 565 W. Washington Blvd. CLEVELAND: 1231 Superior Ave.



High input resistance of a cathode follower can be demonstrated by closing the switch

input to the cathode follower so loads the clipper tube that the wave shape at (A) is obtained, but after *S* is closed and the cathode follower becomes operative, the wave shape changes to that at (B) showing the increase in apparent input resistance introduced by the cathode current. (The Input Impedance of a Cathode Follower, F. Duerden. *Electronic Engineering*, p xiv, Nov. 1946).

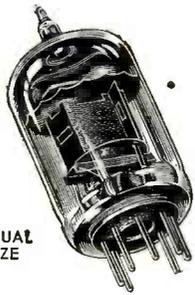
Calibrating Laboratory Standards Against WWV

By GARDNER P. WILSON
Naval Ordnance Test Station
Pasadena, California

FREQUENCY STANDARDS in laboratories can be simply and rapidly calibrated against radio station WWV's short-wave broadcasts by using an oscilloscope as a watch with a second hand revolving 100 times a second. The technique reduces observational errors.

Propagation Effects

At great distances from WWV, signals are received by sky-wave reflections from the ionized layers. Variations in apparent elevation of these layers change the path length of the radio waves. Often these variations in path length are rapid so that the standard carrier or tone arrives at the receiver at a different frequency from the original. This Doppler effect introduces considerable error on short observations made several thousand miles from the transmitter. For long du-



ACTUAL
SIZE

... Impromptu Discussions about Miniature Tubes



"No matter how you look at it, Joe, those TUNG-SOL Miniature Tubes are a far better bet than the old larger types. Better service for the user, more compact equipment for the set builder and less storage space for the dealer are obvious advantages, but that is only the beginning.

"TUNG-SOL Miniatures stand up better under shock and vibration. You see they are more rigid . . . built with smaller, lighter parts. Then there is

the glass button base. It not only can't come loose, but it has much better dielectric properties than the old style base.

"Now take high frequency circuits. You know how important they have become. TUNG-SOL Miniatures are doing jobs you couldn't even begin to do with old fashioned tubes. The shorter

leads on the Miniature make for low lead inductance and low inter-element capacities.

"Joe, if you want your equipment to be modern you ought to consider using Miniatures. TUNG-SOL engineers will be glad to help you plan the circuits and select the tubes. You can talk to them in confidence."



TUNG-SOL

vibration-tested

ELECTRON TUBES

TUNG-SOL LAMP WORKS, INC., NEWARK 4, NEW JERSEY
Sales Offices: Atlanta • Chicago • Dallas • Denver • Detroit • Los Angeles • New York
Also Manufacturers of Miniature Incandescent Lamps, All-Glass Sealed Beam Headlight Lamps and Current Intermittors

Immediately Available

**AT
LONG
LAST!**

THE ANDREW FOLDED UNIPOLE

Greeted with a flood of orders when introduced last year, the popular Andrew Folded Unipole Antenna now is flowing off the production line at a rate which permits immediate shipment from stock.

Used for transmitting and receiving in the 30 to 44 MC and 72-76 MC frequency ranges, it easily outperforms other antennas selling at sev-

SEND IN YOUR ORDER NOW

eral times its price. Here is the ideal communications antenna for police, fire, forestry, railroad and aviation services.

Here's why this antenna is unusually satisfactory:

- Perfect impedance matching eliminates tricky adjustment of loading. Users report transmitter loads the same on antenna and dummy, regardless of line length.
- Improved signal strength over ordinary coaxial or other dipole antennas.
- Grounded radiating element provides static drain, improving signal to noise ratio and minimizing lightning hazard.
- Weighs only 20 pounds with clamps. Easy to install.
- Inexpensive. Antenna costs only \$60.00, mounting clamps \$6.00, transmission line adaptor kit \$6.00 (specify size and type of Line).

ANDREW
ANDREW CO.
363 EAST 75th STREET • CHICAGO 19

For effective solutions to your antenna problems consult Andrew Co., designers, engineers and builders of antenna equipment. Expert factory installation service available.

ration observations, average received frequency is identical to that transmitted.

Because the standard frequency arrives at the receiver by several different paths, fading occurs, which at times causes the signal to disappear and reappear with large phase shifts. The phase shift is very apparent when using an oscilloscope to view the received wave. These fades and shifts make it extremely difficult to observe sinusoidal waves for enough time to determine average frequency and keep a particular reference crest or hollow of the received signal on oscilloscope screen.

Attempts to use either carrier or modulation of WWV as reference for calibration of laboratory standards in Pasadena, California, approximately 2,500 miles from the source, gave unreliable results because of the above difficulties. Doppler frequency shifts of about one part in 10,000 were observed on all short waves and on the tone modulation frequencies.

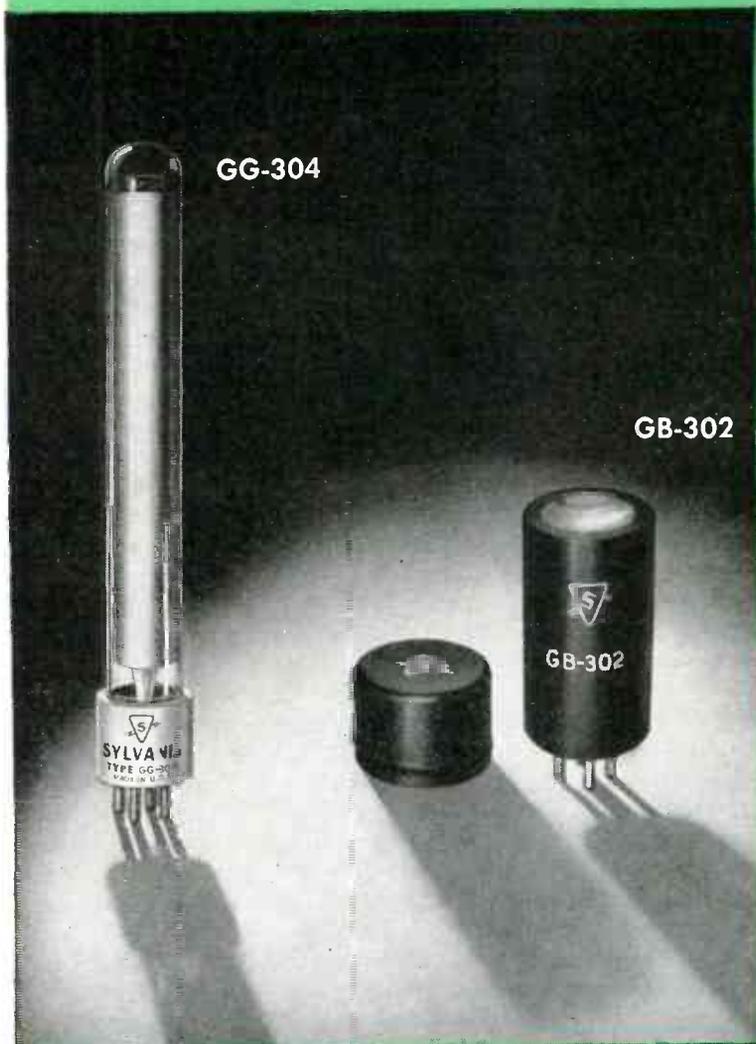
Observational Method

One possibility of minimizing effects of fading and momentary frequency shift is to divide the ticks transmitted for 0.005 sec every second by WWV to run a synchronous electric clock. This procedure requires extra equipment and necessitates taking observations over a period of many days to obtain suitably high accuracy; it gives no information about short time errors in the laboratory standard, such as crystal oven temperature cycling or line voltage variations.

A more satisfactory method is to feed the 100 cps signal from the laboratory standard, which usually has outputs of 10,000, 1,000 and 100 cps in addition to the generated 100,000 cps, to the vertical plates on an oscilloscope, and to the horizontal plates by way of a 90 deg phase shifting circuit (an 0.05 μ f capacitor in series with a 4,000 ohm resistor) so as to produce a 100 cps circle on the oscilloscope, comparable to a hand of a watch that makes 100 rps. In addition, audio output of a communications receiver tuned to WWV is applied to one set of deflection plates of the oscilloscope. One second tick from WWV then appears as a wave ex-

NEW SYLVANIA G-M TUBES

... FOR DETECTION AND MEASUREMENT OF RADIOACTIVITY!



For the first time, counter tubes of *stable, uniform characteristics* are now available for practical use in the field of radioactivity.

Formerly, tubes of this type were hand-made — delicate, variable products of the laboratory glass-blower. Through Sylvania research and development, vacuum tube production techniques have now been adapted to their manufacture, with the resulting advantages of stability during tube life, and uniformity from tube to tube.

Use of Sylvania laboratory and manufacturing techniques enables the external quench circuit tubes to be produced in quantity, to bring the customer the advantages of stability and much longer life.

FEATURES

LONG LIFE UNIFORMITY
DEPENDABILITY STABILITY
CONVENIENCE

APPLICATIONS OF SYLVANIA GEIGER-MUELLER TUBES

Sylvania Tube GB-302 is a beta-ray counter, utilizing a thin but rugged window of metal foil. It is extremely sensitive to the beta-radiation of the majority of available radioactive isotopes.

The GB-302 will be particularly valuable in tracer techniques, and is also well adapted to medical diagnostic and therapeutical uses.

Sylvania Tube GG-304 is the gamma-ray counting companion to the GB-302. It is useful in radiological safety surveys and other applications where gamma radiation must be efficiently measured. In addition, Sylvania Tube GG-304 can be used for cosmic ray studies, especially in coincidence work.

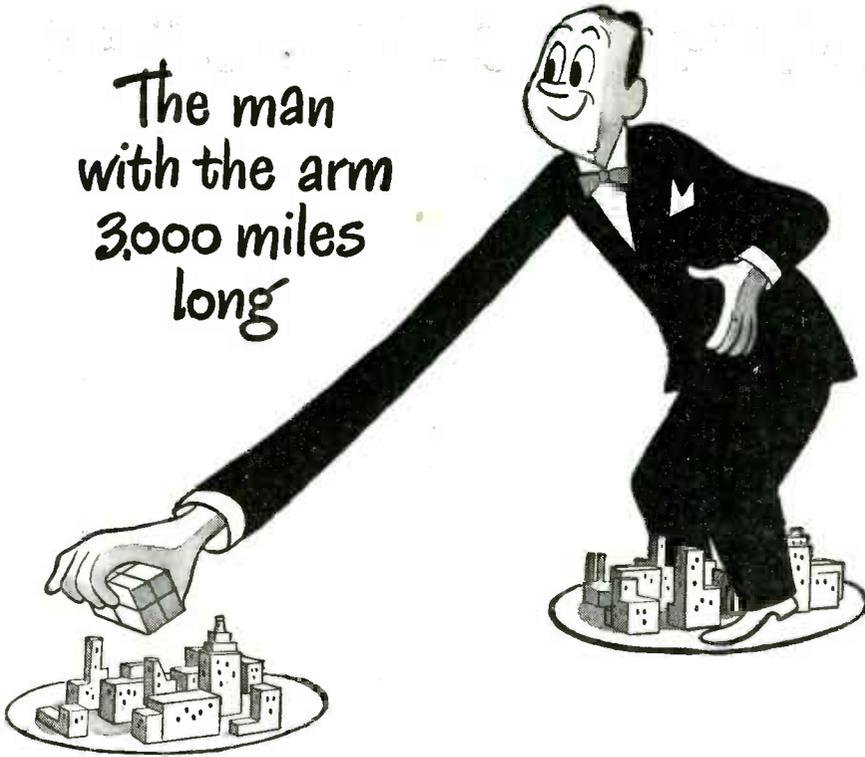
Write for full details.

SYLVANIA ELECTRIC

Electronics Division . . . 500 Fifth Avenue, New York 18, N. Y.

MAKERS OF ELECTRONIC DEVICES: RADIO TUBES; CATHODE RAY TUBES; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES; ELECTRIC LIGHT BULBS

The man
with the arm
3,000 miles
long



In his business — just like yours these days — he is always running out of supplies and parts he needs in a hurry. Yet customers have to be satisfied.

Well, he doesn't have a nervous breakdown. He doesn't lose customers. Instead, he gets *what* he needs *when* he needs it by specifying Air Express delivery.

"Air Express," he said, "is like reaching out to any supplier's warehouse *wherever* it is — and picking up just what's wanted. Air Express puts the most distant suppliers *right next door*."

Specify Air Express—it's Good Business

- Low rates. • Special pick-up and delivery at no extra cost.
- Direct by air to and from principal U. S. towns and cities.
- Air-rail to 23,000 off-airline communities.
- Direct air service to and from scores of foreign countries.

Just phone your local Air Express Division, Railway Express Agency, for fast shipping action . . . Write today for Air Express Rate Schedules containing helpful shipping aids. Address Air Express, 230 Park Avenue, New York 17, N. Y. Or ask for them at any Airline or Railway Express Office. Air Express Division, Railway Express Agency, representing the Airlines of the United States.

Rates are low
To Air Express a 5 lb. package 1349 miles costs only \$2.32! Heavier weights similarly inexpensive. Investigate!

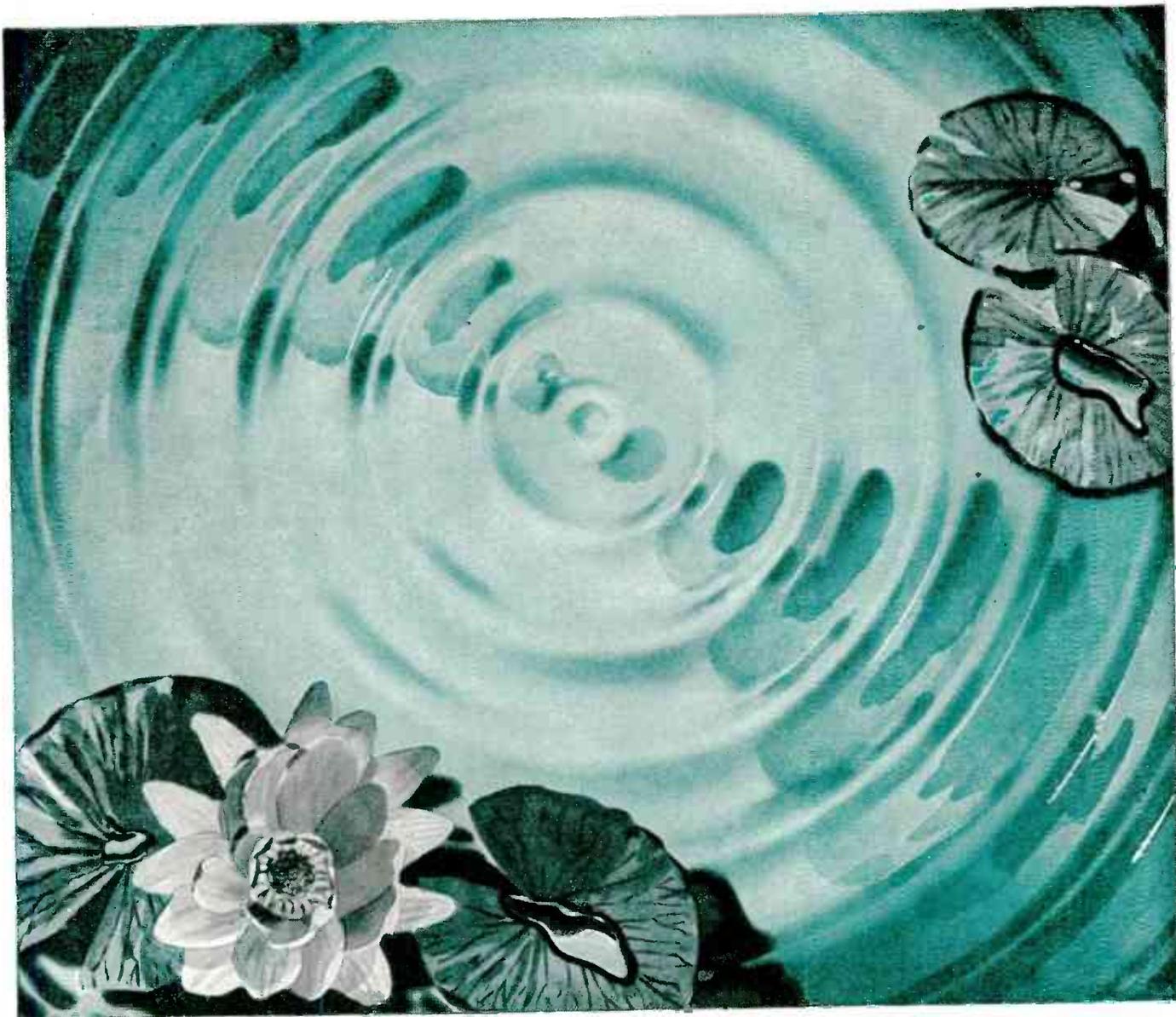
tending half way around the circle and repeating itself every 100 revolutions. If the laboratory standard is precisely on frequency, the wave will appear stationary, however any drift will appear multiplied 100 times, simplifying observation of errors. If the beginning of the tick is used as the reference point, and if the reference point drifts 36 deg. in 100 sec., the laboratory standard is in error one part in 100,000. Shorter intervals can be used for observations and good accuracy obtained for checking oven cycling and line voltage variation effects on the laboratory standard.

Accuracy of the one second tick from WWV for any one second is within 0.00001 sec. (one part in 100,000). An observation 100 sec. long will reduce this error to one part in 10,000,000. The longer the observation, the smaller the error becomes in comparison with other fixed errors. Changes in radio path length affect arrival time of ticks in the same manner as they do the carrier. The variation introduces random movement of the tick wave around the 100 cps circle, usually within five degrees of arc. However, the average point can readily be seen. Fading will often cause the tick wave to disappear in part or altogether, but it will reappear and the reference cycle can easily be identified.

It is wise precaution when making these measurements to make a rough check that one second ticks are not appearing every 99 or every 101 revolutions of the oscilloscope trace. A Lissajou pattern using the tone modulation and the local 100 cps will give a quick check. Best receiver tuning for viewing the tick is with the receiver exactly centered on the carrier frequency, half way between tone modulation sidebands. This tuning can easily be verified by oscilloscopic observation as the receiver is tuned.

Impedance Measurements

ELECTRICAL IMPEDANCES, whether they are resistances, inductances, or capacitances, can be quickly measured by varying a known impedance to produce a squarewave trace on a cathode-ray oscilloscope. The circuit for making such meas-



CONCENTRICITY...

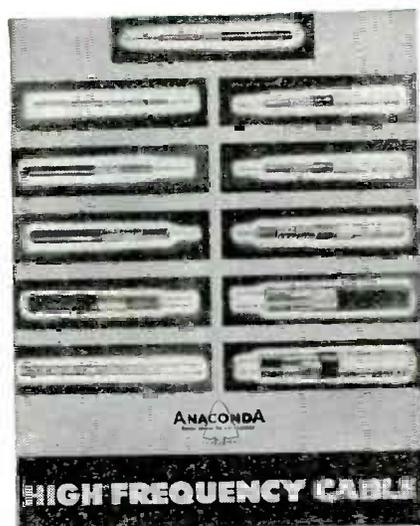
For Uniform Transmission Characteristics in High Frequency Lines

IN COAXIAL CABLES, more than in any other types, accurate relationship between the component parts is essential.

Concentricity and uniformity of conductors and dielectric join in Anaconda Coaxials to effectively fulfill the objectives of electrical designers.

Each type is specifically designed to serve best in the intended application. All electrical characteristics are held within close limits to uniform standards assuring accurate surge impedances.

In addition to manufacturing standard types of coaxial cables, Anaconda offers research and engineering facilities to meet needs for specialized types.



ANACONDA WIRE & CABLE COMPANY

GENERAL OFFICES: 25 Broadway, New York City 4
Subsidiary of Anaconda Copper Mining Company

CHICAGO OFFICE: 20 North Wacker Drive 6 • Sales Offices in Principal Cities

ANACONDA
from mine to consumer

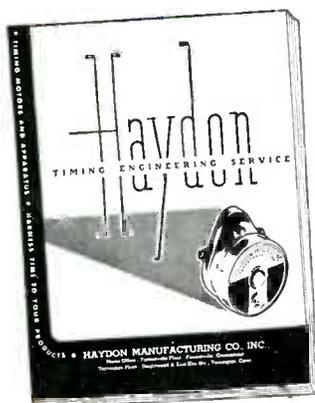
Write for these useful, new folders containing characteristics of Anaconda high-frequency coaxial cable and television lead-in lines. Address: Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y.



HAYDON Automatic Reset

For applications such as time delay relays, where automatic re-setting is required, HAYDON engineers have built into the #1600 series gear unit a magnetically operated counterbalanced gear shift. This automatically engages and disengages the gear train when the motor field is energized and de-energized. The drive shaft is then reset back to starting position by an external spring. It gives uniform engaging and disengaging action, irrespective of the mounting position of the motor.

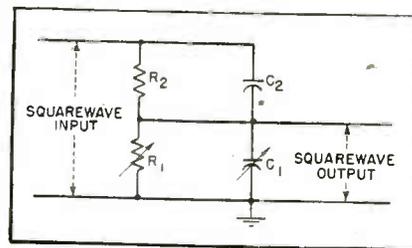
- This construction is available in speeds from 15 RPM down to one revolution in 10 minutes.



Write for the new HAYDON catalog for detailed description of this and other HAYDON timers.

TIMING ENGINEERING SERVICE
Haydon

MANUFACTURING COMPANY
 INCORPORATED
 Forestville, Connecticut
 SUBSIDIARY OF GENERAL TIME INSTRUMENTS CORPORATION



Impedances can be measured in a balanced attenuator by adjusting for the condition at which a complex input wave-shape is reproduced in the output

urements is shown in the accompanying drawing, where the two capacitors could be replaced by two inductors if desired. It should be noted that if inductors are used, their inherent resistances can be used for R_1 and R_2 , obviating the need for connecting separate resistors.

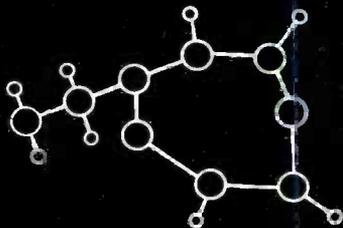
The circuit operates as a balanced attenuator. A squarewave of any convenient frequency is applied to the input. The output is connected to the vertical deflection channel of an oscilloscope the saw-tooth sweep of which is synchronized to the squarewave. Impedances of the measuring network are adjusted until a squarewave is displayed on the oscilloscope, under which condition $R_1C_1 = R_2C_2$ or $R_1L_2 = R_2L_1$, where these values are effective, including stray impedances. Any of the impedances can be varied, preferably one that is grounded. If the reactance across the lower portion of the network is too large, the output squarewave will be peaked at its rising edge; if that reactance is too small, the output will be rounded at the rising edge. (U. S. Patent 2,409,419 granted 15 October 1946 to Peter S. Christaldi, assignor to Allen B. DuMont Lab., Inc.)

Radio Reflection from the Moon

By ZOLTAN BAY
 Technical University
 Budapest, Hungary

EXPERIMENTS to observe reflection of 120-mc radio waves from the moon, started in the summer of 1944 but interrupted until August 1945, succeeded on February 5, 1946. Theoretical considerations indicated that a long transmitted pulse and a narrow received bandwidth prior to detection were re-

"The things that are unseen are eternal"
II Corinthians IV-18



SCIENTISTS ARE SAYING TO ENGINEERS

What Paul said to the Greeks about spiritual things applies also to electrons, protons, and long and short waves. They too are unseen, eternal, and obedient to immutable laws.

They are forever going somewhere. They can heal or kill. They can give light and sound and heat and power if we control them.

Insulating materials are one of our most important tools for this job. For more than thirty years Formica has been one of the best tools for many such purposes, and definitely the very best for some.

You are the judge, but good as its reputation is, you will not try to judge Formica for your purpose without

examining the properties and specifications of the various grades, and considering their strength, durability, workability and cost. Why not ask us to send this information on a grade we can recommend for the purpose you mention in your letter. It might call for one of the grades that are too new for you to know what it could mean for you.



THE FORMICA INSULATION COMPANY 4661 SPRING GROVE AVENUE, CINCINNATI 32, OHIO

quired for high signal-to-noise ratio. However, it was necessary to use a broadband receiver because of anticipated drift of transmitter frequency.

To obtain a signal despite the noise, a method of cumulation was used. As conventionally used in radar, cumulation is provided by long-persistence cathode-ray tubes; the signal luminescence is integrated but the noise luminescence is averaged. Thus the improvement in signal-to-noise is a function of the time over which integration is carried.

Calculations indicated that it would be necessary to perform the integration for about an hour. Capacitance circuits were considered unsatisfactory, so an electrochemical method of cumulation was used. A bank of hydrogen coulometers were sequentially switched to the receiver output and timed so that the same one would always be connected when the reflection was received. In operation, four percent more hydrogen was separated in the coulometer receiving the signal than in the others, with a probable error of one percent. The signal-to-noise ratio obtained in this way corresponds to the theoretically computed ratio. The equipment is being used to measure solar radiation at 2.6 meters, which is being correlated with solar activity.

Microwave Spectroscope

USING WAVELENGTHS between 1.2 and 1.6 cm generated by a klystron oscillator, complex hydrocarbon molecules can be nondestructively identified. The equipment consists of the elements shown in Fig. 1. The oscillator and the trace of the cathode-ray tube are swept in synchronism by the sweep generator. Microwave energy passes through the 15-ft. waveguide, containing the gas to be analysed, to the crystal detector.

The gas selectively absorbs frequencies that are characteristic of its molecules. Thus the output developed by the crystal and displayed on the crt as a function of frequency is indicative of the gas under test. To obtain high selectivity, the gas is at low pressure, about 0.1 mm of mercury. The

Beyond . . .

... "the great undiscovered ocean of truth" . . .

We can venture into the UNKNOWN in any branch of research only as fast as we can MEASURE each new conquest.

New Hathaway instruments are being developed and standard designs are being constantly improved to keep abreast of the expanding demands of modern research.

Whatever your requirements may be in special instruments for measurement or control let Hathaway instrument engineers help you.



Hathaway Type S8-B
12-element oscillograph—
one of a complete line of
recording oscillographs

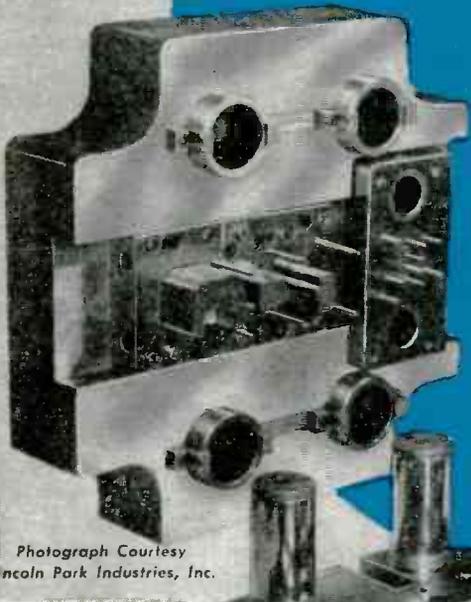
You can rest assured that you will find in any Hathaway instrument the *most advanced design*, and the *most exacting craftsmanship*.

WRITE FOR TECHNICAL BULLETIN SP-165

Hathaway
INSTRUMENT COMPANY
1315 SO. CLARKSON STREET • DENVER 10, COLORADO

How COLGATE *Engineered Service*

is breaking the
bottleneck
of the
metals
shortage



Photograph Courtesy
Lincoln Park Industries, Inc.

MANY MANUFACTURERS have asked us whether it is possible to make an assembly or part in another metal *temporarily*, and still use the fabricating and stamping tools, when the time comes, for the preferred metal.

It's not only frequently *possible*... Colgate is *doing it*. By designing double purpose dies so that they may be used, during this interim period with a second-choice material, and later converted, Colgate is breaking the bottleneck of the metals shortage.

Dies engineered to serve a double purpose is just one example of Colgate *Engineered Service* in sheet metal fabricating and stamping of aluminum, magnesium, stainless steel and many other light metals.

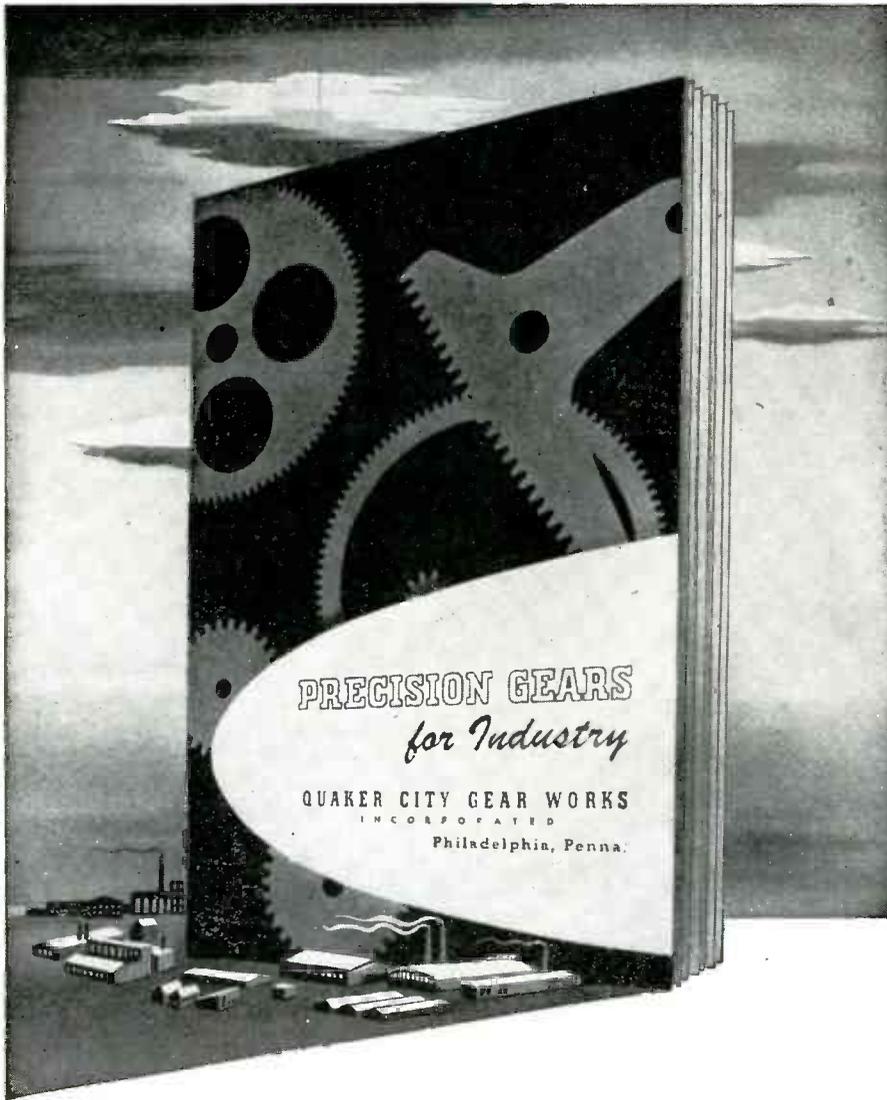
If your product is ordinarily made of steel (let's say), perhaps some other material could be used. Then, when steel becomes *available*, in many cases the tools can be converted, at reasonable cost, through Colgate's *Engineered Service*. Write for more information.

STAMPING • FORMING • DRAWING • WELDING • FINISHING • ASSEMBLING

COLGATE *Manufacturing Corporation*

AMITYVILLE, LONG ISLAND, NEW YORK.

LIGHT METALS PRODUCTS

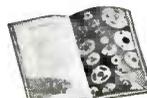


Yours for the asking

A new informative booklet on gears.

It has illustrated sections  on

practically every known form of gearing,

together with  many reference

tables and formulas. Write for your copy

today on your company stationery. 

 **Quaker City Gear Works**
INCORPORATED

1910 N. Front Street, Philadelphia 22, Pa.

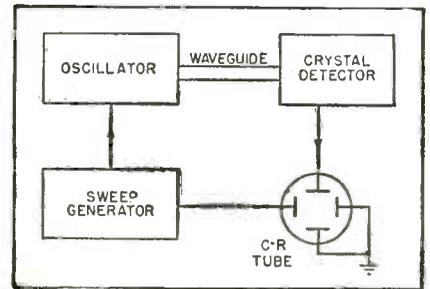


FIG. 1—Basic components of microwave spectrograph

collision frequency of the gas molecules should be less than the operating frequency.

Ammonia, observed to absorb microwaves about ten years ago (*Phys Rev*, p 234 45 1934), has been found to have 30 different absorption lines in the region of operation of the microwave spectrograph developed by Dr. William E. Good, physicist at Westinghouse Research Laboratory. Water vapor, acetone; cyanogen bromide, and carbonyl sulfide have also been identified by the technique. Other molecules, especially organic gases having dipole moments, can be identified by the spectroscope.

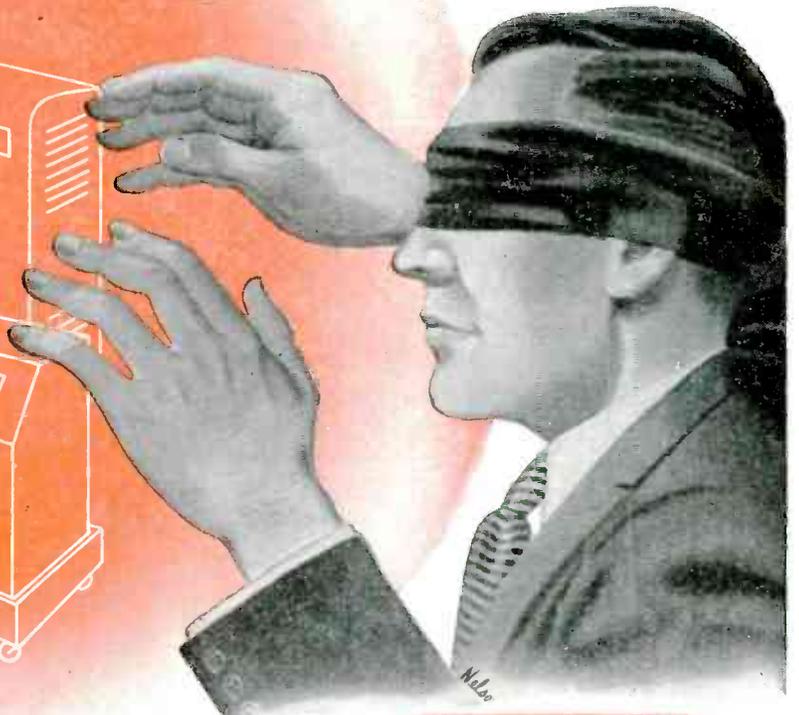
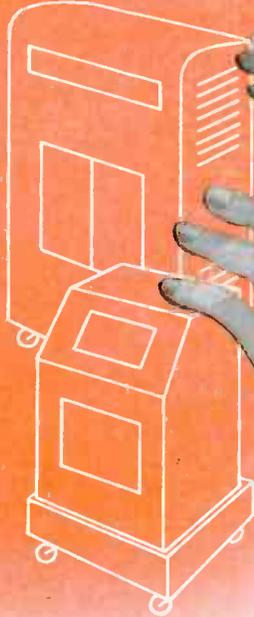
In making measurements, gas is admitted to the waveguide gas cell, which is sealed with plastic tape at its ends. The absorption is shown as a series of vertical deflections on the crt. These lines are compared to those obtained from samples of known gases. Photographic records can be made as shown in Fig. 2.

Selective absorption of electromagnetic radiation at wavelengths between a millimeter and a centi-



FIG. 2—Photographing microwave absorption bands as displayed on cathode-ray tube

Don't buy an electronic heater *blindly*



INVESTIGATE AND INSIST ON PROOF BY TRIAL — WITH AUTOMATIC OR HAND-OPERATED APPARATUS

Have you soldering, brazing, surface-hardening, annealing or other heat-treating operations? Or do you use heat to treat non-metallic substances such as plastics, plywood, rubber, etc.?

It is quite possible that you can use electronic heating apparatus for these operations, profitably replacing older and slower heating methods. The savings and increased efficiency are decidedly worthwhile. The speed-up in production is as great as 700% in some instances. Work that formerly took minutes or hours now requires only SECONDS.

Investigate the possibilities of high frequency heating for your production. But be sure to get plenty of sound experienced advice before you buy. Don't just buy a "machine." Let our engineers prove to you by actual demonstration under your own conditions, how Scientific Electric equipment fits your exact needs. Remember, there is no such thing as an all-purpose electronic heater. Each individual operation and each factory production set-up requires a specific type of installation, with the proper combination of frequency and power output. Consult us without obligation. We will engineer the right installation to your particular requirement. Buy nothing till we've PROVED IT BY TRIAL for you.

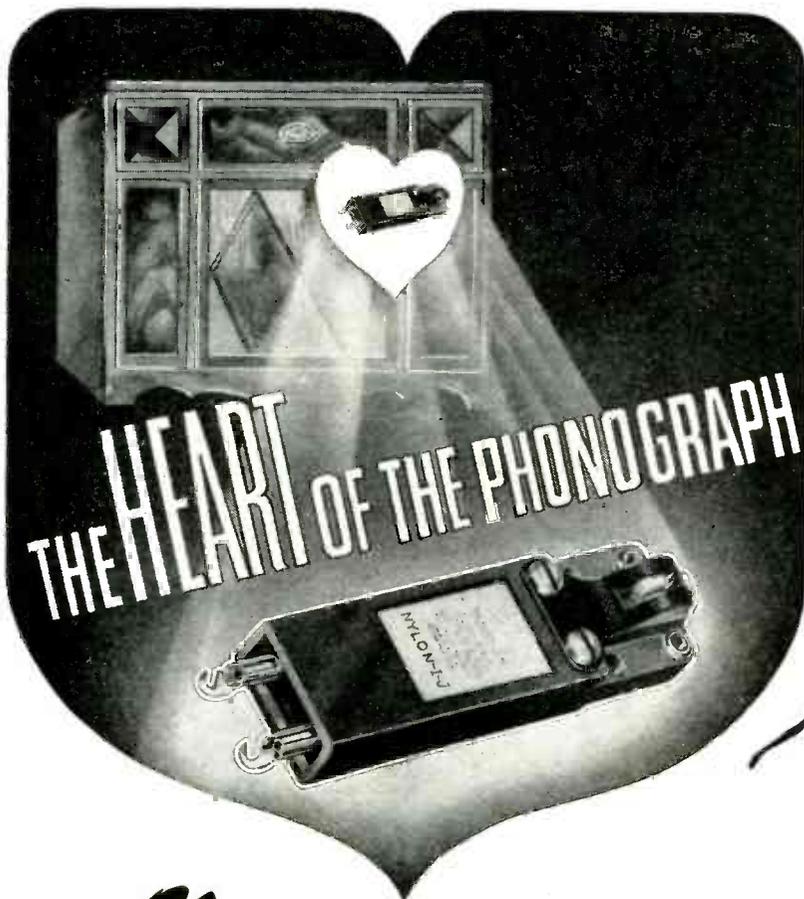
NOW—IMMEDIATE DELIVERY

Scientific Electric

DIVISION OF
"S" Corrugated Quenched Gap Co., 107 Monroe St., Garfield, N. J.



Scientific Electric Electronic Heaters are made in the following range of power: 1—3—5—7½—10—12½—15—18—25—40—60—80—100—250KW. — and range of frequency up to 30 Megacycles depending on power required.



No other part of a modern phonograph is so important as the small crystal cartridge mounted in the pickup or reproducer arm. This cartridge is the pulsating heart of the instrument and upon the degree of efficiency of its operation depends the quality of reproduction.

It is not surprising, therefore, that many radio-phonograph manufacturers and engineers are expressing intense interest in Astatic's new Nylon I-J Phonograph Pickup Cartridge. Designed with Nylon Chuck and MATCHED, sapphire-tipped, knee-action Nylon Needle, this cartridge improves performance with respect to needle life and frequency response, suppresses mechanical resonance, improves tracking at low needle pressure and reduces record wear. Other important advantages and details concerning Astatic's new Nylon Cartridge are given in special literature now available.

THE **Astatic**
ASTATIC CORPORATION
 CONNEAUT, OHIO

IN CANADA: CANADIAN ASTATIC LTD., TORONTO, ONTARIO

Astatic Crystal Devices Manufactured
 under Brush Development Co. patents.

Visit your Radio Parts
 Jobber or Write for New
 Catalog.

meter by water vapor in the atmosphere has been observed with radar (*Trans. A. I. E. E.*, p 209 April 1946). Recently it was shown that the same technique could also be used to measure pressure and rate of diffusion of gases (*Jour Appl Phys*, p 495 June 1946). Atoms can rotate about the intramolecular bonds, as is done in dielectric absorption. However, if the resonant frequency of the bond rotation, determined by the force of the bond and the masses of the atoms, is used in exciting the molecule, the absorption of energy will be very large. Measurements of frequency and absorption at these resonant points indicate the internal construction of molecules. The technique might be extended to use of ultrasonic vibrations as well as to electromagnetic vibrations to further separate phenomena associated with purely mechanical causes from those from electrical causes (*Jour. Aco Soc. Am.*, p 285 Jan 1946). As each gas molecule has its characteristic resonant frequencies and energies of absorption, a study of the absorptions of microwaves serves to identify the gases present in the sample.

Modulation of Concentrated-Arc Lamp

CONCENTRATED-ARC LAMPS¹ have two electrodes sealed into an argon-filled glass bulb. The radiation emitter is a thin film of molten zirconium, a cloud of ionized zirconium vapor, and the excited argon gas. The diameter of the 2-watt lamp is 0.003 in., affording virtually a point source^{2,3} of light. Radiation from the molten, incandescent zirconium has a continuous spectral distribution extending from 2,500 Å in the ultra-violet, through the visible spectrum, reaching a maximum near 10,000 Å, and continuing into the infrared to 5 microns where it is cut off by the glass of the bulb. In addition, the mixed vapor gives all the usual zirconium and argon lines distributed chiefly between 0.7 and 0.9 micron. Radiation from the molten zirconium shows a rapid decrease in modulation percentage with increase in frequency and spectral

A Guide to the "GUIDE"

HAVE YOU RECEIVED YOUR FREE COPY?



A booklet of information on the ELECTRONICS Buyers' Guide is now available. It contains facts about the value and use of the "Guide" . . . gives reasons why the "Guide" is a "must" medium in electronic and allied fields.

MANUFACTURERS: This booklet shows . . . the unique value of the "Guide" in selling both name and product . . . the type of information your advertising should supply . . . why the men who design-in, specify, and buy in electronic fields use the "Guide" as their year-round reference book.

ADVERTISING AGENCIES: This booklet provides basic facts on how the "Guide" influences all the buying factors in electronic fields. It includes the results of a survey among ELECTRONICS subscribers revealing their appraisal of the "Guide" as a source of buying information, their evaluation of the advertising content, and their needs in catalog type presentations. Be sure to send now for this free booklet of information on the facts, value, use, mechanical requirements, rates, etc., of the . . .

Get the
FACTS, VALUE, USE
of the

ONLY

COMPLETE
CATALOG AND
DIRECTORY OF
ELECTRONIC
EQUIPMENT
COMPONENTS

and
ALLIED
PRODUCTS

Published

JUNE 15
1947

electronics

BUYERS' GUIDE ISSUE

ABC • A Bonus Issue To All Subscribers • ABP



A MCGRAW-HILL PUBLICATION • MCGRAW-HILL BUILDING

NEW YORK 18, N. Y.



The Ghost In Rev. 4

And it was such a beautiful tracing when it first left the board — but look at the prints now, after that last revision . . . a nice big “ghost” firmly astride the front elevation. Moral . . . don’t use inferior tracing cloth.

If this tracing had been on Arkwright, Rev. 4 would have produced prints just as sharp as the day a tracer first initialed it . . . because Arkwright’s special mechanical process

prevents “ghosts”. This oil, wax and soap-free method of manufacture builds the translucency *all the way* through. Arkwright cloths *can’t* discolor, grow brittle with age.

See for yourself how much better Arkwright is. Send for free working samples. Arkwright is sold by leading drawing material dealers everywhere. Arkwright Finishing Company, Providence, R. I.

All Arkwright Tracing Cloths have these 6 important advantages

- 1 Erasures re-ink without “feathering”
- 2 Prints are always sharp and clean
- 3 Tracings never discolor or become brittle
- 4 No surface oils, soaps or waxes to dry out
- 5 No pinholes or thick threads
- 6 Mechanical processing creates permanent transparency



Arkwright
TRACING CLOTHS

AMERICA’S STANDARD FOR OVER 25 YEARS

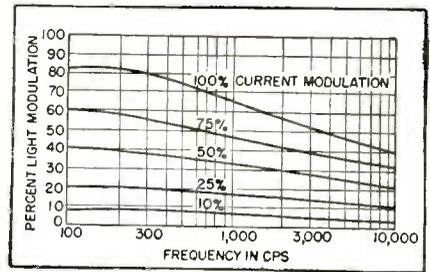


FIG. 1—Modulation response of the 2-watt lamp when used with an antimony phototube

wavelength; radiation from the gas and vapor can be almost completely modulated at all audio frequencies^{4, 5}. The resultant modulation in a special application is shown in Fig. 1.

Frequency characteristics of a system using the concentrated-arc lamp and a phototube depend on the spectral response of the phototube. The blue-sensitive antimony tube is preferable to the red-sensitive caesium type. Although the modulated radiation increases with increasing wattage of the lamp, the percent modulation obtainable decreases. Percentage modulation can be increased by increasing the gas pressure. The dynamic relation between radiation and modulating current not being linear, there is some modulation distortion, chiefly second harmonic.

When operated at 50 percent modulation, all lamps have an inductive impedance, the larger lamps having less impedance. As shown in Fig. 2, there is a frequency at which the lamp has minimum impedance; this frequency decreases as the lamp size increases. The lamps have a negative resistance component (EI curve) at low frequencies. The light always lags the current (IL curve), the lag increasing with frequency. The impedance of the 2-watt lamp is sufficiently high to permit connecting the lamp directly into the plate circuit of a

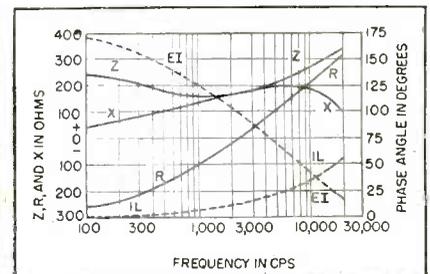


FIG. 2—Modulation impedance characteristics of the 2-watt lamp

Where there is Horsepower...

There is Wire



Coal ... Water ... Oil ... these are our sources of power. Our early use of each of them was crude and localized and wasteful—before the time of electrical wire.

Now, wire harnesses horsepower. Wire traps it at its birth—even bringing about its generation. Wire packages power and brings it into our homes. Wire transforms power into a thousand different characters.

The use of horsepower is a many-sided science, now that wire is here. Each specialized application has its specialized wire counterpart. The development of these wires is in itself a scientific undertaking ... a challenge ... an achievement ... a source of pride for the wiremakers among whom a pioneering leader is Belden Manufacturing Company.

Belden

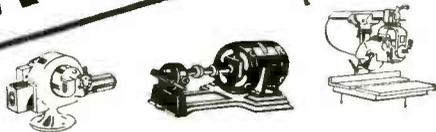


WIREMAKER FOR INDUSTRY

OHIO "Application Proved" MOTORS



PREVENT
Product
FAILURES



Check These Four Advantages of OHIO MOTORS

- ✓ 1 **FREEDOM FROM VIBRATION:** All Ohio AC Motors are of the squirrel cage type, which are inherently in balance. Rotor and shaft assemblies are dynamically balanced.
- ✓ 2 **FREEDOM FROM HEAT:** Better-than-adequate ventilation provides longer life for bearings and windings.
- ✓ 3 **FREEDOM FROM DIRT:** All internal parts are fully protected against falling chips, dirt and dripping liquids.
- ✓ 4 **FREEDOM FROM LUBRICATION WORRIES:** Large oil reservoirs, packed with wool yarn, provide generous lubrication. Ball bearings are of the self-sealing type... do not require lubricating for years.

OHIO ELECTRIC MFG.

CHESTER BLAND, Pres.

5908 Maurice Ave. • Cleveland 4, Ohio

ELECTRON ART

(continued)

6L6. Also, the direct current necessary to maintain the arc (55 ma) is sufficiently low as to be supplied by the modulator tube. A high voltage must be momentarily applied to the lamp to strike the arc.

(1) Concentrated-Arc Lamp, W. D. Buckingham and C. R. Deibert, *Journal of the Optical Society of America*, p 245, May 1946.

(2) A New Point-Source Lamp for the Laboratory, Harry L. Smith, *American Journal of Physics*, p 313, September-October 1946.

(3) Characteristics and Applications of Concentrated-Arc Lamps, W. D. Buckingham and C. R. Deibert, *Photographic Society of America Journal*, p 610, November 1946. (See also: New Concentrated-Arc Lamp, G. S. Oslin, *International Photographer*, p 12, July 1946.)

(4) The Concentrated Arc-Lamp as a Source of Modulated Radiation, W. D. Buckingham and C. R. Deibert; paper presented at the 1946 SMPPE winter convention, to be published in *Journal of the Society of Motion Picture Engineers*. (See also: Characteristics and Applications of Concentrated-Arc Lamps by the same authors, *Journal of the Society of Motion Picture Engineers*, p 376, November 1946.)

(5) Modulation Characteristics of Concentrated-Arc Lamps, W. D. Buckingham and C. R. Deibert, The Western Union Telegraph Co., Electronics Research Laboratories, Water Mill, L. I., N. Y.

Electronics in the Food Industry

RESEARCH is finding the manner in which dielectric heating can be used in dehydrating foods and for thawing frozen foods. With insufficient data on dielectric constants of various foods, the investigation proceeds slowly, but possibilities can be foreseen.

Dehydrating

Determination of moisture content is essential in dehydration processing. Several commercial types of dielectric moisture meters are available. Among the factors that affect measurements of moisture content by the dielectric-constant method are temperature, particle size, and density of compaction of sample. For reproducible moisture measurements these conditions must be duplicated from sample to sample.

Experiments on potatoes revealed that well-compressed blocks could be produced only if the potatoes contained 15 percent moisture. To further dehydrate the compressed blocks to seven-percent moisture, required for proper preservation of the blocks, dielectric heating was found faster than vacuum-oven drying. The initial drying rate was much faster because of the internal heating produced by the dielectric technique. However, once the block



SCA rectifiers of tomorrow

IN DESIGNS OF TODAY!

POWER RECTIFIERS



SCA Selenium Rectifiers are ENGINEERED FOR ENGINEERS. Improved performance at lower costs through ENGINEERED adaptability. Selenium Corporation of America meets exacting specifications of modern electronic developments. Manufacturers of a broad line of Selenium Power and Instrument Rectifiers, Self generating Photo-Electric Cells and allied scientific products.

Selenium Rectifiers are rapidly becoming standard in industry for all rectifier applications. Selenium Corporation of America's engineering experience can be called upon for the development and production of special rectifiers for any application.

CHECK THESE OUTSTANDING FEATURES:

- ✓ Permanent characteristics
- ✓ Adaptability to all types of circuits and loads
- ✓ Unlimited life—no moving parts
- ✓ Immunity to atmospheric changes
- ✓ High efficiency per unit weight
- ✓ From 1 volt to 50,000 volts rms.
- ✓ From 10 micro-amperes to 10,000 amperes
- ✓ Economical—simple to install—no maintenance cost
- ✓ Hermetically sealed units available



SELENIUM CORPORATION OF AMERICA

Affiliate of **VICKERS** Incorporated
1719 WEST PICO BOULEVARD • LOS ANGELES 15, CALIFORNIA

INSTRUMENT RECTIFIERS



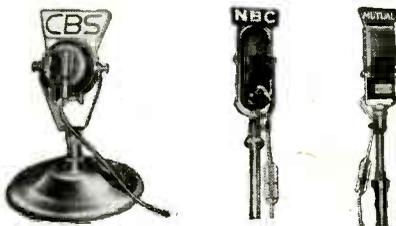
PHOTO-ELECTRIC CELLS



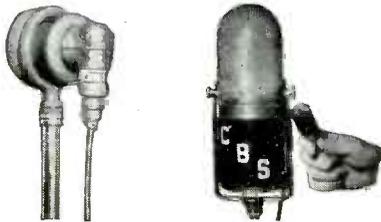
Dependable MICROPHONE PLUGS by CANNON ELECTRIC



Judy Canova, radio star, broadcasting over NBC in Hollywood, with Hal Gerard and Joe Kearns. RCA microphone is equipped with Types "O" or "P". ALL RADIO NETWORKS USE CANNON MICROPHONE PLUGS.

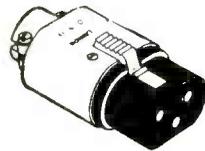
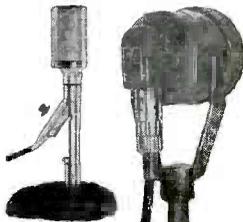


Left: Type "O3-42" Receptacle and "O3-11" Plug on Western Electric table type mike used by Columbia Broadcasting Co. Center and Right: Other large network mikes use type "O" for cable extension. The latchlock device prevents accidental disconnection resulting from jerks or strain on cord.



Left: Microphone with "P-12" Receptacle and P-CG-11 Plug used for platform public address. (Photo courtesy Reiss P. A. Systems, Detroit). Right: Mike used by CBS-Hollywood, with P-CG-12 plug shown in hand. As in the case of the above Type "O", two mating "P" plugs can be used conveniently for cable extension where receptacle is not an integral part of the microphone itself.

The New lightweight Type "XL" is standard equipment on the equally new RCA "Announce" Microphone which has a unique construction in the stem, allowing the plug to swing into the stem with a cover. Relief spring on XL-3-11 plug protects cord from sharp bends. Adapters are available to users of microphones such as the Turner (second to right) for those desiring to convert to Cannon "XL" Plugs.



TYPE "O"

Two plugs and six receptacle styles available in this series. One oval insert arrangement with three 30-amp. contacts for No. 10 B&S stranded wire.



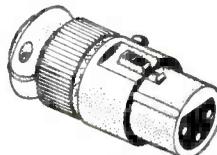
TYPE "P"

Five plugs and nine standard receptacle styles available in six insert arrangements; two to six 30-amp. contacts, one eight 15-amps. for No. 14 B&S stranded wire.



TYPE "XL"

Two small plugs and four receptacles with zinc shells carry three 15-amp. contacts for No. 14 B&S stranded wire. Equipped with compression gland and relief spring.



TYPE "XL"

Two steel shell XL plugs for rough, heavy-duty usage. Same insert arrangement as above. Integral clamp construction and leading XL features.

Write Dept. B-120 for C-46A Condensed Catalog, describing all above connectors and list prices. Available from jobbers everywhere.

had been thoroughly heated, the rate at which the water vapor could diffuse out of the block determined the speed with which drying could proceed.

Potatoes dried by the faster dielectric heating process did not have as good quality as the slower oven-dried ones. Apparently a low temperature is desirable at the beginning of the drying cycle. Modification of the dielectric heating process to meet this condition would counteract its advantage of speed. Where the material to be dried is not subject to damage by heat, dielectric heating would be preferred.

Thawing

Precooked, frozen foods in either small domestic or large processing packages thaw slowly and unevenly if, as is usually done, they are removed from refrigeration and stood at room temperature. Portions of the package to thaw first spoil before the entire package thaws.

Experiments conducted on one-pound packages left in their cardboard wrappers indicated that the rate of temperature rise was practically uniform during the electronic thawing process; in conventional thawing, temperature rises exponentially. The time for thawing by dielectric heating was one-thirtieth that of conventional methods, being minutes instead of hours; thus there is little opportunity for spoilage. (Research in Agricultural Products, by T. L. Swenson, *The Scientific Monthly*, 1946 June 477.)

Edison Effect

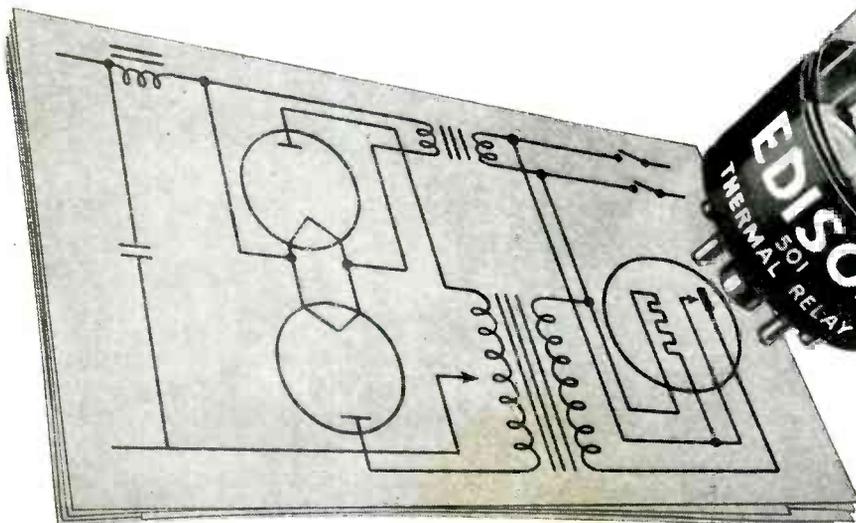
EMISSION OF ELECTRONS from a hot metal, the Edison effect, was studied in the modified lamp shown herewith. This electron emission is now used in the communication and broadcasting industry, in the motion picture industry, and for measurement and control in almost every phase of modern technology from aviation to mining. Thomas A. Edison, born a century ago this February 11th, pioneered in generation of electrical power, incandescent and fluorescent lamps, phonographs, motion picture projectors, and microphones. Not only does mankind benefit from such natural



CANNON ELECTRIC DEVELOPMENT COMPANY

3209 Humboldt Street, Los Angeles 31, California
Canada & British Empire — Cannon Electric Co., Ltd., Toronto, Ontario • World Export
Agents (excepting British Empire) Frazer & Hansen, 301 Clay St., San Francisco 11, Calif.

Why the EDISON thermal relay protects electronic tubes



Here's What It Is

1. **ELECTRICAL HEATER** — (5 watts nominal up to 150 volts AC/DC) deflects bi-metal to actuate contacts.
2. **CONTACTS**—rated at 6 amperes at 250 volts AC or DC for delays less than 1 minute. For delays longer than 1 minute, rating can be increased to 500 volts AC or DC if reduced to 3 amperes. S.P.S.T. normally open or closed.
3. **MOVING CONTACT ARM**—carried by bi-metal, is a preloaded spring, which applies full contact pressure immediately. Action absolutely noiseless and positive in operation.
4. **FACTORY-ADJUSTED SCREW**—sets contact spacing for desired operating time—5 seconds to 8 minutes.
5. **COMPENSATING BI-METAL**—maintains pre-set contact spacing and relay timing, regardless of ambient temperature variations.
6. **"E" SPRINGS**—braced between sturdy ceramic support and glass tube, make assembly shock proof.
- DIMENSIONS**, 1 1/4" diameter, 3 1/4" height (seated).
- WEIGHT**, 0.08 lb.
- HERMETICALLY SEALED** in glass envelope, relay is tamper-proof, fully protected from dust, dirt, corrosion, or contact with outside air, with operation independent of altitude.
- ARC-QUENCHING ATMOSPHERE** guarantees absolute minimum of contact fouling, pitting, or transfer; permits equal AC or DC ratings.
- STANDARD RADIO TUBE BASE** 4-pin or octal.

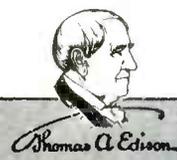
Delays plate voltage application until cathode is properly heated

PROTECTION OF CATHODES in electronic tubes, such as thyratrons and gas filled rectifiers, depends on allowing cathodes to reach operating temperature rather than delaying application of plate voltage for a fixed time. A thermal relay, since its operation also depends on attaining a predetermined temperature, is eminently suitable for cathode protection.

The Edison Thermal Relay is widely used for this purpose because (a) its delay characteristics vary with line voltage as does cathode heating; (b) it is suitable for continuous operation; (c) it offers sustained accuracy; (d) it has a wide range of delay periods; (e) it is silent and positive in operation; (f) it is as independent of ambient temperatures as the cathode it is protecting; (g) it is relatively inexpensive; (h) it is small and lightweight. The slow cooling rate of the Edison Thermal Relay prevents loss of equipment operating time due to momentary power interruptions.

The combination of the foregoing features indicates that this is the best device available for cathode protection.

Edison engineers will help solve your cathode protection problems if you will write and give them the data. Just address Instrument Division, Thomas A. Edison, Incorporated, 24 Lakeside Avenue, West Orange, New Jersey.



AN
EDISON
CONTROL

THOMAS A. EDISON, Incorporated
Instrument Division, 24 Lakeside Avenue
West Orange, New Jersey

GENTLEMEN:

Please send me your Bulletin No. 3007X on the Edison Thermal Relay.

NAME _____

COMPANY _____

ADDRESS _____

CITY _____

ZONE NO. _____

STATE _____

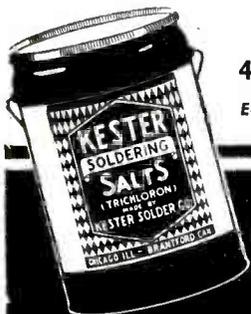


DON'T RISK THE WRONG FLUX

Good soldering jobs depend on the right flux—and Kester has the right flux for you. You can count on Kester for a flux that will properly clean, prevent oxidation, make way for a tight bond that will resist shock, vibration, twisting, bending, and the contraction and expansion of temperature extremes.

Growing out of nearly half a century of practical experience, Kester's hundreds of flux formulas have been time-tested in laboratory and industry, to establish exact specifications for every flux need. Among them is the ideal flux formula for your particular soldering job.

Consult Kester engineers at any time for practical, experienced help with flux problems. They'll gladly suggest the right flux to protect your product. A letter today will bring expert Kester assistance—without obligation.



KESTER SOLDER COMPANY

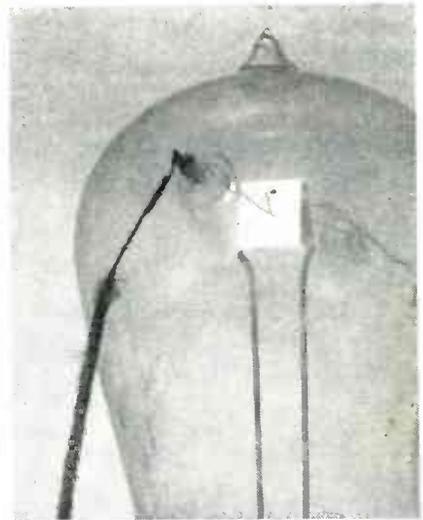
4204 Wrightwood Avenue, Chicago 39, Illinois

Eastern Plant: Newark, N. J. Canadian Plant: Brantford, Ontario

KESTER

Solder Fluxes

STANDARD FOR INDUSTRY



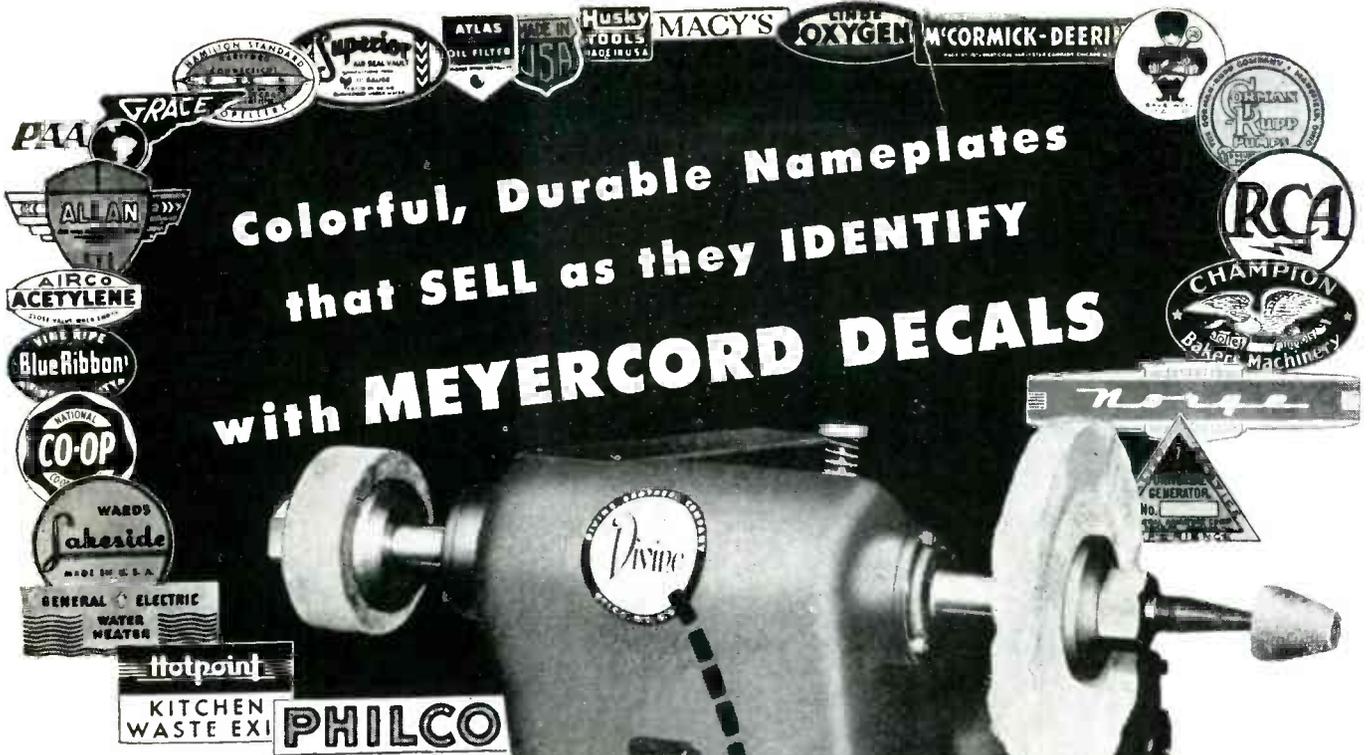
Electron emission from a hot cathode was first studied in this simple diode

resources as fertile soil and sunshine, but also from the inquisitiveness and creativeness of individuals such as Edison. The effect of Edison on our lives indicates the importance of fostering those mental and emotional attributes in individuals that make possible socially beneficial basic and applied research.

Variable Electronic Capacitor

USING THE SPACE CHARGE of a tube, an inertialess electronic capacitor is obtained. Two planar cathodes mutually parallel are mounted on opposite sides of a control grid. As the potential between the grid and the two cathodes is varied, the electron clouds bordering the cathodes move closer to or further from the control grid, thus varying the capacitance between themselves and the control grid. The two variable capacitances appear in series across the two cathodes.

Variation of capacitance is linear with control grid potential over a limited range. At excessively negative potentials, mutual repulsion of the cloud electrons and the fact that the clouds cannot move further from the grid than the faces of the cathodes prevent further capacitance reduction. At excessive positive potentials, the control grid draws current, preventing further increase in capacitance. A high series resistor in the control circuit increases the linear range (U. S. Patent 2,407,424).



**Colorful, Durable Nameplates
that SELL as they IDENTIFY
with MEYERCORD DECALS**

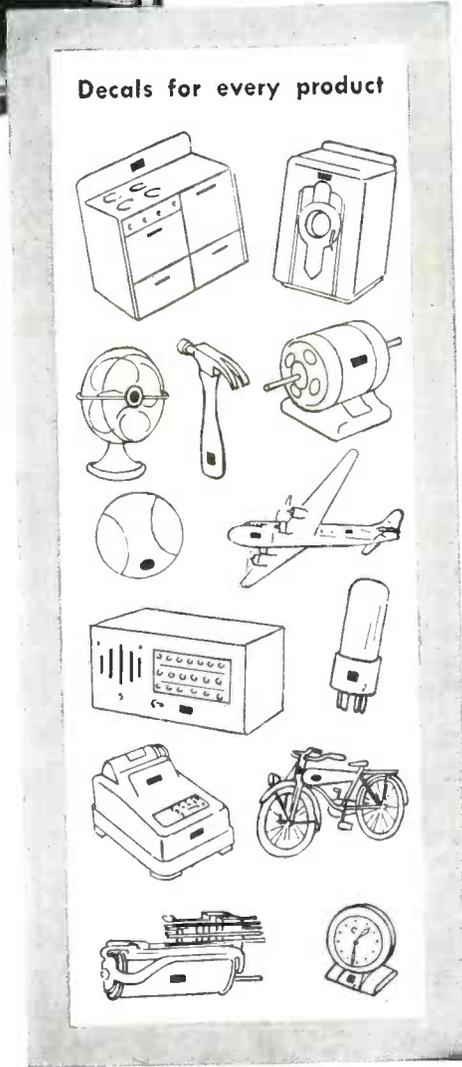
NO RIVETS • NO SCREWS
Simple adhesion methods
assure durable, colorful
product identification



**Conditions under which this
"Divine" buffer operates dem-
onstrate Meyercord quality.**

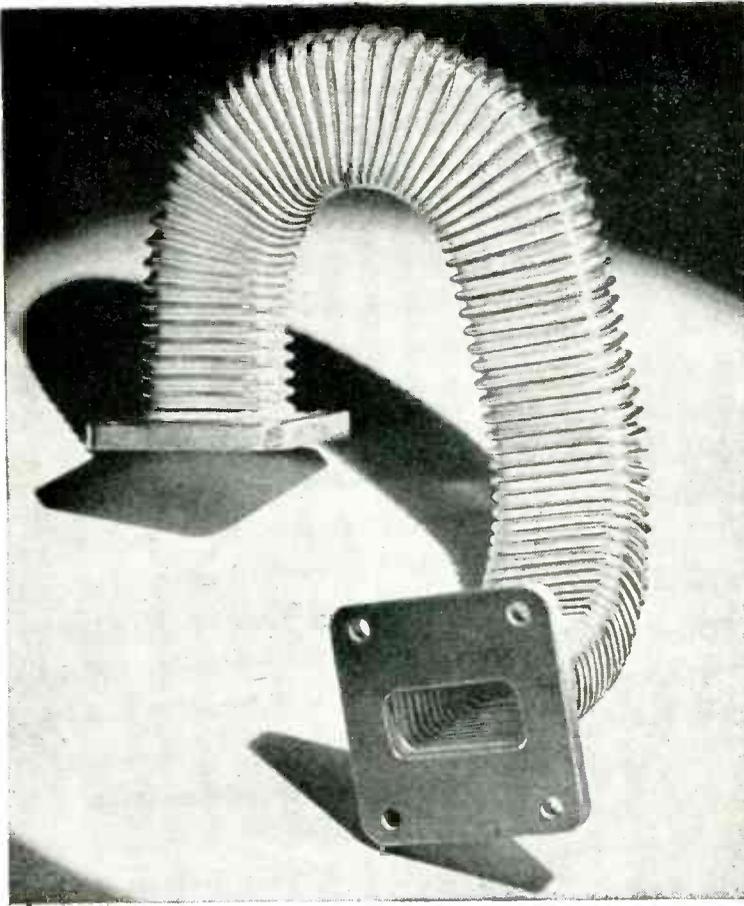
Double-duty, low-cost Meyercord Decal nameplates *advertise* as they *identify*. They offer full color for quick brand recognition! Divine Brothers Co., Utica, N.Y., has used them for years as trademarks of colorful distinction on quality buffing wheels. They resist vibration, fumes, moisture, abrasion, acids, wear and constant use.

Advertise *your* brand-name for the life of *your* products with tough, flexible Meyercord Decals! They can be applied at production-line speeds. No screws, rivets...no sharp edges. Washable, durable! Smooth, lasting adhesion on any commercial surface, curved or flat...even on rubber or crinkle finish. Trademarks, operating or lubrication guides, patent data, etc., can be produced in any size, colors, designs. Learn how Meyercord Decals add more "sell" to nameplates! Write today for free Meyercord Decal Selector...it shows where and how to use Decals. Address Dept. 9-2



Founder-Member Lithographic Technical Foundation

The MEYERCORD Co.
World's Largest Decal Manufacturer
5323 W. LAKE ST. ----- CHICAGO 44, ILL.



This *Flexible* Tubing makes Radio Waves TURN CORNERS...

THIS AMERICAN Seamless Flexible Wave Guide is made from thin-wall rectangular metallic tube... can be extended, compressed or bent in two planes to small radii and withstands a large number of flexures of moderate amplitude.

Other widely used American Flexible Wave Guides are the "Vertebra" type, consisting of a series of choke-plate wafers inserted in a synthetic rubber jacket, and the "Moldlock" type, made of spirally wound strip with fully interlocked joints, with (or without) a synthetic jacket.

These high precision units mate electrically and mechanically with the standard sizes of rigid guide for operation at wave lengths from 20 to less than 3 Cm.

We will be glad to assist in selecting the wave guide best suited to the specific requirements of your installation. Write for our "Electronics Data Book!"

46361



American
METAL HOSE

THE AMERICAN BRASS COMPANY
American Metal Hose Branch

General Offices: Waterbury 88, Conn.
Subsidiary of Anaconda Copper Mining Company



factured for home-recording, public-address, and amateur radio use. It provides flat response from 40 to 6,000 cycles with output level 50 db below 1 volt dyne per square centimeter open circuit. The microphone is supplied with cable, plug, and removable base.

Direct Reading pH Meter (21)

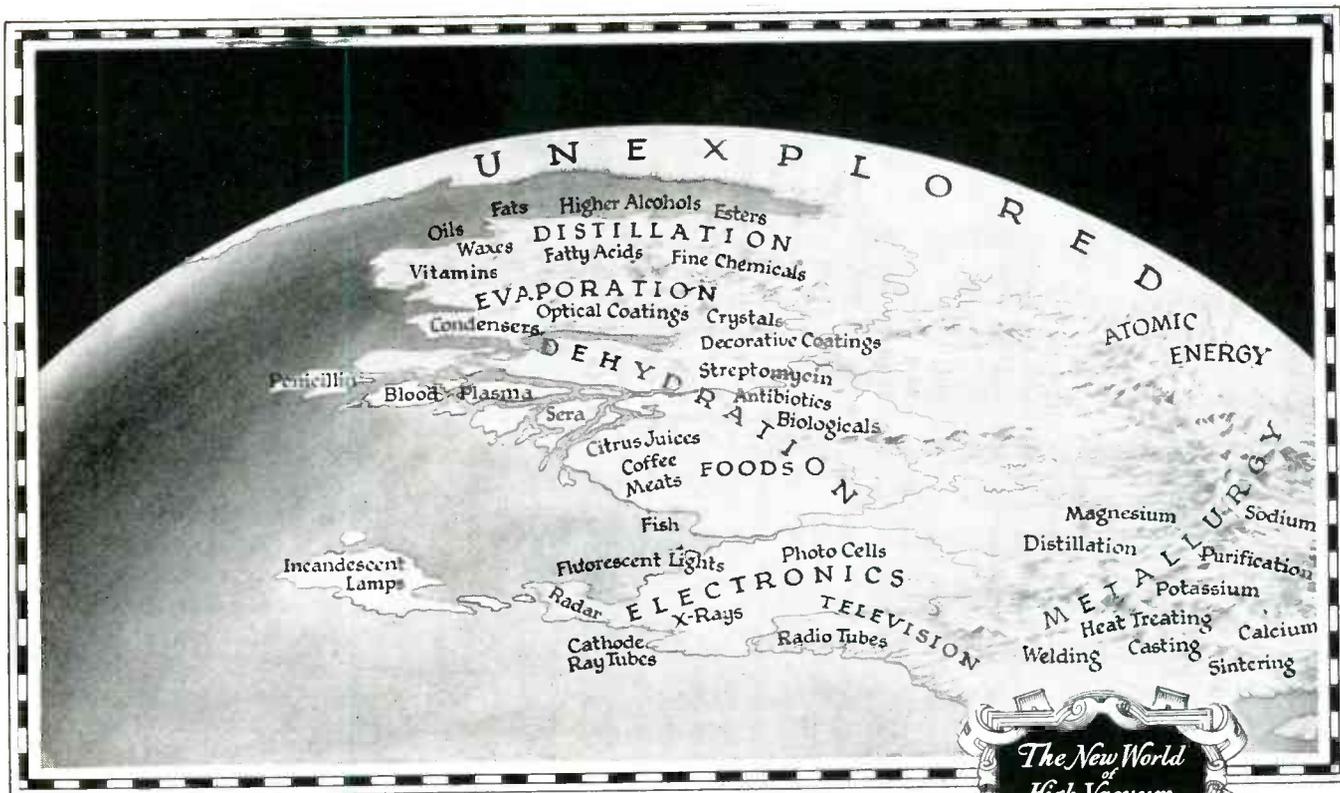
MUIRHEAD AND Co., Ltd., Elmers End, Beckenham, Kent, England. Bulletin B-569-B describes the type D-303-B direct reading meter that has an accuracy of 0.05 pH. The equipment may be used alternatively as a high-impedance millivoltmeter. Operating controls are conveniently located on a sloping panel with the meter. Setting-up



controls are arranged to be covered by a flap after initial adjustments have been made to avoid accidental disturbance.

Improved Recording Turntable (22)

PRESTO RECORDING CORP., 242 West 55th St., New York 19, N. Y. The model 14-B recording turntable represents an improvement over the model 14-A. The skeleton illustration shows the degree of isolation of



THIS IS OUR WORLD

The definition of "High" Vacuum is arbitrary. We choose to consider that the term applies to pressures less than 1 mm. Hg. absolute. The use of this pressure range for industrial processing is a recent development. The organized body of empirical information, built from performance records, which characterizes the conventional branches of engineering, is generally not available to the engineer who undertakes a project in High Vacuum.

The calculation of efficient pipe and manifold sizes, of pumping requirements and capacities, of relative outgassing of construction material, is not easily done with the published data. The effect of very small leaks at very low pressure and the degree of tightness which may be expected with suitably designed and properly built equipment is not generally appreciated. The virtues and the failings of different types of vacuum gauges and the location of these gauges for true control of processing conditions is a small field in itself.

Measurements made during our early experience in building large systems conflicted with existing information on rates of flow at low pressures. An engineer spent twelve months running tests on pipe and tubing from $\frac{3}{8}$ " diameter to 8" diameter in various lengths up to 35', including elbows, bellows connectors and valves. The results of this work are the basis of our present piping and manifold design.

We have found it necessary to develop special pieces of basic equipment to fill specific needs in

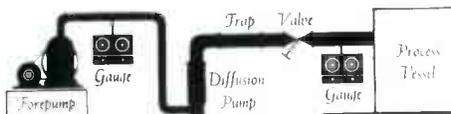
the industrial field. Our Thermocouple Gauge was evolved to meet a condition of severe vibration met in the preparation of magnesium. The Alphasatron Vacuum Gauge removes the guesswork connected with pressure measurement in the presence of water vapor, a serious problem in High Vacuum Dehydration. We have built diffusion pumps with unusual characteristics to overcome problems in other fields.

Installations of our Vacuum Diffusion Process are now handling 1,000,000 CFM of water vapor at 100 microns Hg. pressure. In one plant another process is pumping in two separate operations 275 lbs./hour of water vapor at 100-200 microns Hg., and 6,500 lbs./hour of water vapor at 8 mm. Hg.

The design and construction of High Vacuum systems of all sizes and for all purposes is our business. We have accumulated a substantial body of practical information on which to base design. Our engineers are familiar with the problems of industrial High Vacuum installations. Our production departments have mastered the requisite fabrication techniques. This is our world.

If you are considering the use of High Vacuum, we can relieve your engineers of this portion of responsibility. Your inquiry will receive prompt attention and will place you under no obligation.

VACUUM ENGINEERING DIVISION, National Research Corporation, Boston 15, Massachusetts.



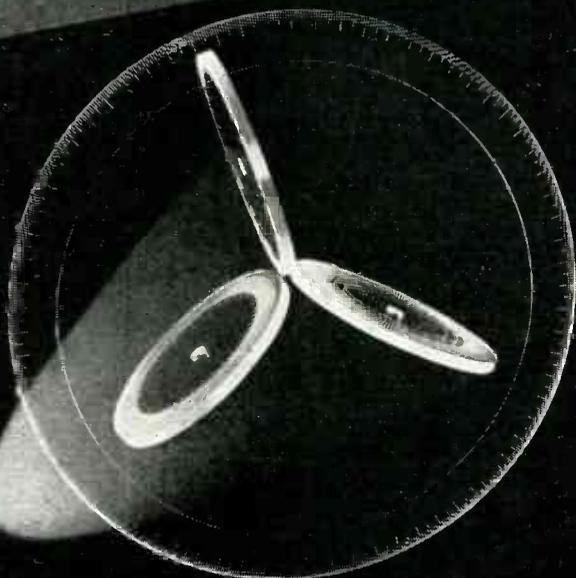
We engineer Plant installations and manufacture High Vacuum Gauges, Valves, Seals, Diffusion Pumps, Stills, Furnaces, Coating Equipment and Dehydration Equipment.

NATIONAL RESEARCH CORPORATION

Vacuum ENGINEERING DIVISION

It's ACCURATE if it's AMPREDIZED

Accuracy of graduation combines with excellent legibility to assure easy, accurate reading when dials, scales, and screens are engraved by the automatic, precision process designated "Ampredizing".



Large Circles

Perfect circles, up to 20 inches in diameter, can be engraved as continuous or interrupted lines.

Anti-parallax Scales

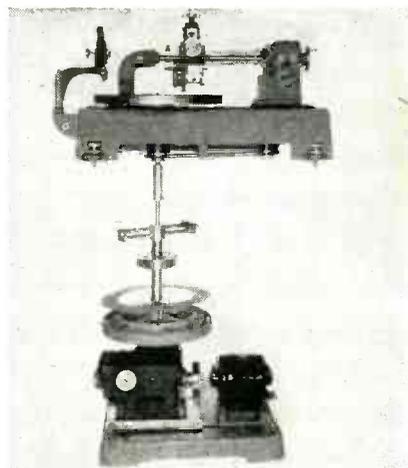
Scales and screens can be accurately matched on both faces of material up to one-half inch thick.

Radial and Linear Scales

A variety of radial scales can be provided as a single dial, with even the closest graduations accurate to 2 minutes in 360 degrees. Straight, linear scales, up to 15 feet long, can be engraved with equal accuracy.

Economical, automatic production makes "Ampredized" scales available at cost generally below that of conventional pantograph engraving. Write for particulars.

American **PRECISION DIAL Co.**
93 MASSACHUSETTS AVENUE BOSTON 16, MASS



the motor-drive mechanism and the turntable cutting-head platform. Speeds of either 33½ or 78 rpm are available. Six different cutting pitches, either inside-out or outside-in can be quickly chosen. The cutting head responds to frequencies between 50 and 8,000 cycles.

Capacitor Analyzer (23)

SOLAR MANUFACTURING CORP., 285 Madison Ave., New York 17, N. Y. The model CBB capacitor analyzer is direct reading between 10 micro-



microfarads and 800 microfarads. A magic-eye tube is used to indicate balance in the Wien bridge, while a simplified neon lamp test circuit is used for insulation resistance. The instrument may also be used as a line frequency resistance bridge covering a range of 50 ohms to 2 megohms. A complete description is given in catalog IN-2.

Millisecond Relay (24)

STEVENS-ARNOLD Co., 22 Elkins St., South Boston, Mass. A new relay housed in a metal-tube container and suitable principally for use on

the New Seeburg "M"

... the three-post, intermix changer



A CHANGER WITH NEW APPEAL FOR MANUFACTURERS, DEALERS, MUSIC LOVERS

Announcing the new Seeburg Model "M" . . . a record changer to add appeal to even the most glamorous radio-phonograph combinations.

Outstanding among the many fine features of the "M" is its exclusive three-post construction which brings these important record playing advantages:

1. INTERMIX playing of 10 and 12-inch recordings.
2. INCREASED RECORD LOAD. The "M" has a capacity of fourteen 10-inch records, twelve 12-inch records or twelve 10-inch and 12-inch records intermixed.
3. LONGER RECORD LIFE. Multiple post construction assures gentle handling, minimum spindle hole wear.

But more than this the Model "M" possesses all the engineering refinements that have made Seeburg changers the favorites of manufacturers, sellers and buyers alike.

FEATURES OF THE NEW SEEBURG MODEL "M"

- **THREE-POST CONSTRUCTION** that lengthens the life of precious discs, increases record load.
- **INTERMIX PLAYING** of both 10 and 12-inch recordings.
- **SIMPLE MECHANISM** that gives long, trouble-free operation.
- **SWIFT, QUIET OPERATION** that means minimum time between changes—assures pleasurable listening.
- **CONSTANT SPEED MOTOR** that brings turntable up to speed quickly—holds it there.

Seeburg
RECORD CHANGERS ★ MUSIC SYSTEMS
J. P. SEEBURG CORPORATION
1500 N. DAYTON ST. • CHICAGO, 22

Designed for



Application



90881

**The No. 90881
RF POWER AMPLIFIER**

This "500" watt, RF power amplifier unit may be used as the basis of a high power amateur band transmitter or as a means for increasing the power output of an existing transmitter. As shipped from the factory, the No. 90881 RF power amplifier is wired for use with the popular RCA or G.E. "812" type tubes, but adequate instructions are furnished for re-adjusting for operation with such other popular amateur style transmitting tubes as Taylor TZ40, Eimac 35T, etc. The amplifier is of unusually sturdy mechanical construction, on a 10 1/2" relay rack panel. The panel contains the grid and plate tank tuning capacitor dials, as well as the grid and plate current milliameters. Plug-in inductors are available for operation on 10, 20, 40 or 80 meter amateur bands, from stock, as well as special coils to order for commercial frequencies. The standard Millen No. 90800 exciter unit is an ideal driver for the new No. 90881 RF power amplifier.

**JAMES MILLEN
MFG. CO., INC.**

MAIN OFFICE AND FACTORY
**MALDEN
MASSACHUSETTS**



NEW PRODUCTS

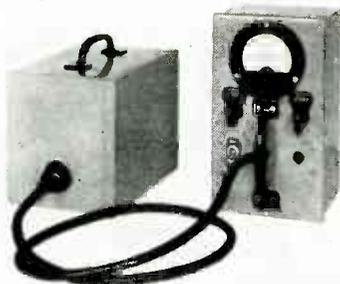
(continued)



resistive loads has an operating time of one millisecond or less. Contact rating is 0.5 ampere at 110 volts. Because of its shock-absorbing mechanism, the relay can be used as a square-wave generator by applying a-c to the coil and d-c to the contacts. Catalog 105A gives complete details.

Light Meter (25)

THE BARTON Co., 968 Farmington Ave., West Hartford, Conn. The model 623 light meter provides a means of measuring relative light intensities of low magnitude in the blue portion of the light spectrum,



and has been designed particularly in checking the operation of photoelectric lighting controls employing blue-sensitive tubes. A calibration chart and auxiliary light tunnel used with the meter allow adjustment of street lighting controls.

Twin Power Supply (26)

FURST ELECTRONICS, 800 W. North Ave., Chicago 22, Ill. The electronically regulated twin power supply,



For extraordinary electrical performance

Use SILVER GRAPHALLOY*



THE SUPER CONTACT MATERIAL



BRUSHES

CONTACTS

in BRUSHES
for high current density • minimum wear • low contact drop • low electrical noise • self-lubrication

in CONTACTS
for low resistance • non-welding character

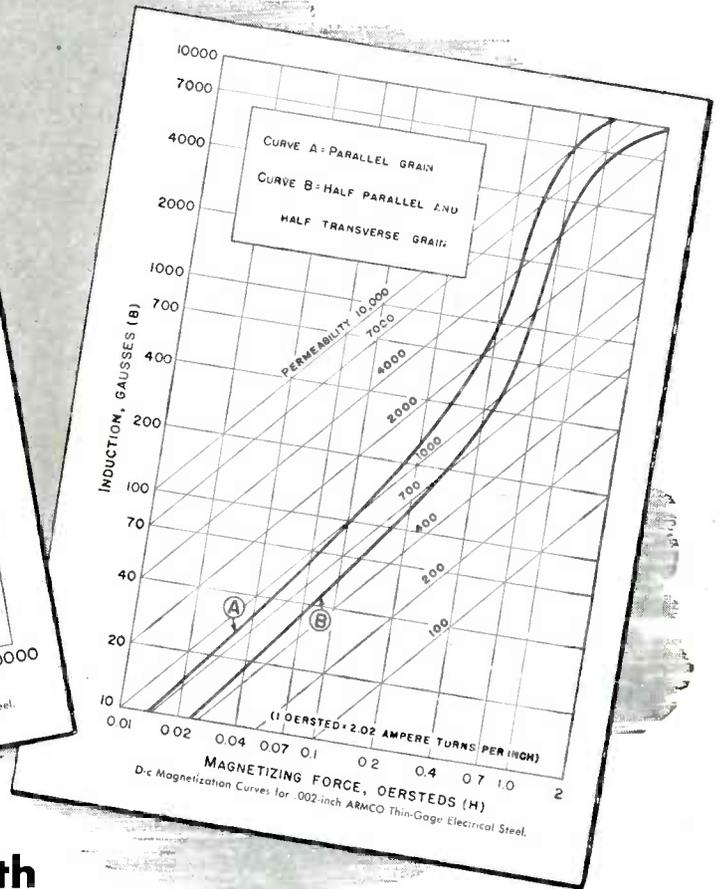
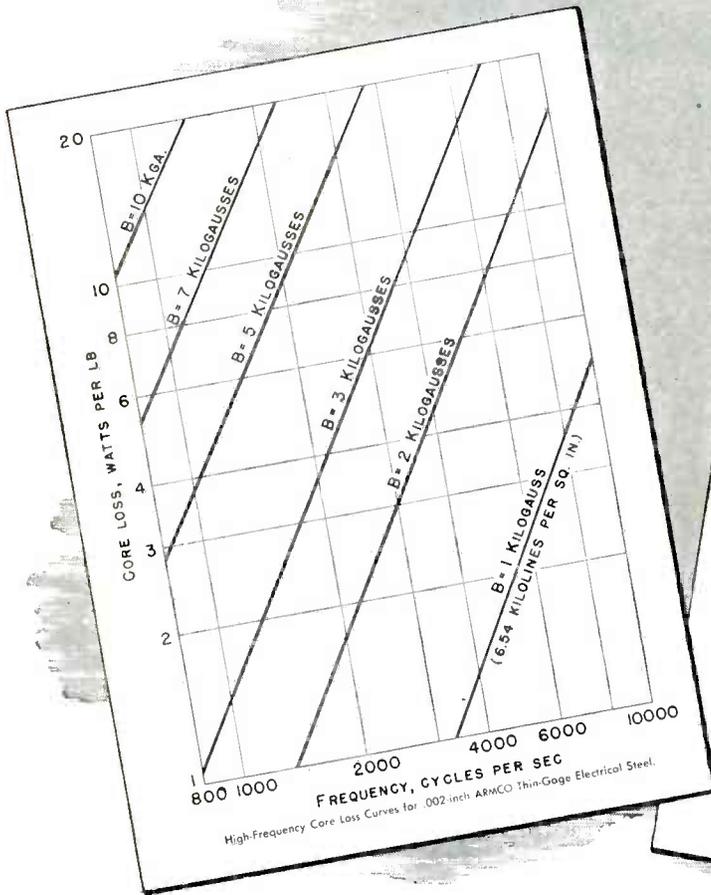
GRAPHALLOY works where others won't! Specify GRAPHALLOY with confidence.

*A special silver-impregnated graphite

GRAPHITE METALLIZING CORPORATION

1055 NEPPERHAN AVENUE, YONKERS 3, NEW YORK

Can you use *tissue thin* electrical steel ?



It Can be Supplied in a Width 12,000 Times Its Thickness!

Now you can get insulated electrical steel thinner than a human hair — steel of exceptional magnetic quality that is rolled to a remarkable gage-uniformity.

This is one of Armco's war-born developments that makes possible many new improvements in electrical equipment of all kinds. Peace-time uses include magnetic cores for television, high-frequency induction heating, radar, sonic detection, air-

borne electrical equipment and many other high-frequency devices.

If you make these or similar products, it may be possible to greatly improve their efficiency by using exceptionally thin insulated laminations in magnetic cores operating at high frequencies.

Low Energy Loss

Low energy loss and small, compact cores are two important advantages. For example, 100 kilowatt modula-

tors for radar systems with cores of .002-inch electrical steel now weigh only one-half pound. Earlier models had cores weighing 20 times as much.

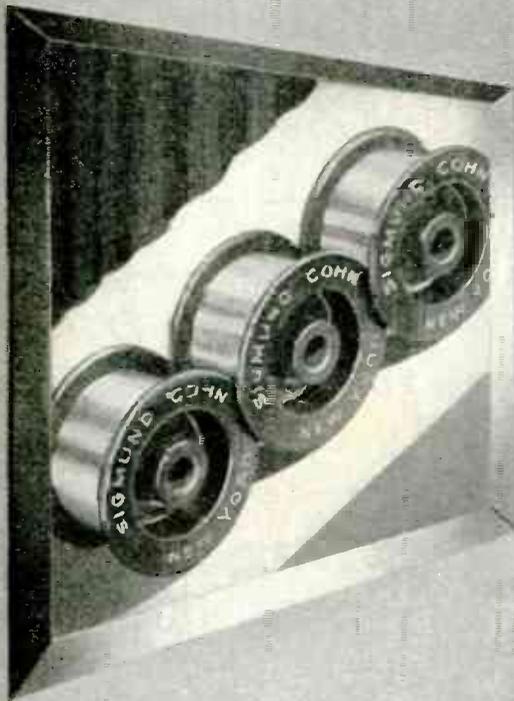
Charts on this page show core loss vs. frequency for .002-inch silicon steel, and a d-c magnetization curve at low induction. Write us for other information pertaining to your specific products. Just address The American Rolling Mill Company, 681 Curtis Street, Middletown, Ohio.

The American Rolling Mill Company



Look first to ARMCO for Special-Purpose Electrical Steels

MICRODIMENSIONAL WIRE & RIBBON FOR VACUUM TUBES



Wires drawn to .0004" diameter.

Ribbon rolled to .0001" thickness.

Special Alloys for individual requirements

WRITE for list of stock alloys.

SIGMUND COHN & CO.

45 GOLD ST. NEW YORK



NEW PRODUCTS

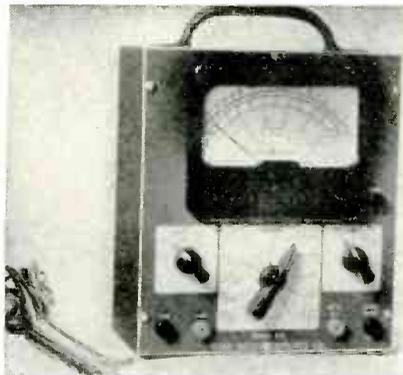
(continued)



model 210 features two independent adjustable output voltages that remain constant regardless of variations in the power line and load connected to each output. A selector switch allows connection of the supplies in series or parallel. An unregulated output of 6.3 volts is also available.

Test Meter (27)

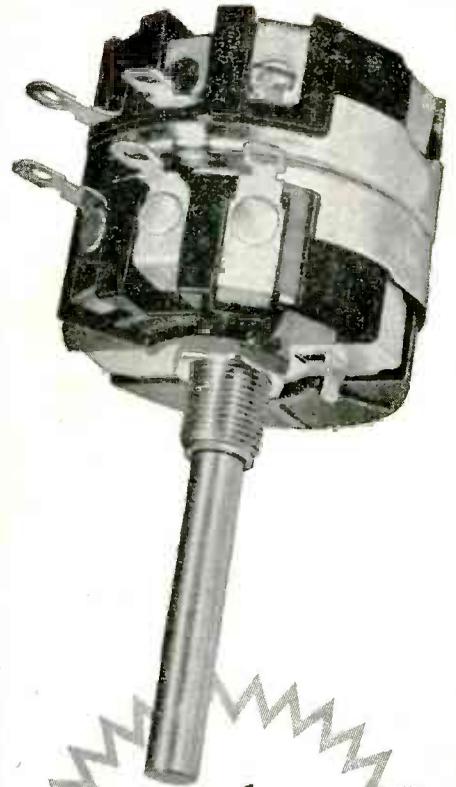
STAR MEASUREMENTS Co., 442 East 166th St., New York 56, N. Y. The model M-11 tester is a volt-ohm-milliammeter with voltage ranges



up to 1,000 volts on both a-c and d-c. Current ranges up to one ampere and resistance ranges up to 5 megohms are also incorporated. In all, twenty-seven separate ranges are available. Batteries are enclosed in the metal cabinet.

Direction Finder (28)

RADIO CORP. OF AMERICA, Camden, N. J. The type AVR-21 automatic direction finder consists of four



Dual Controls

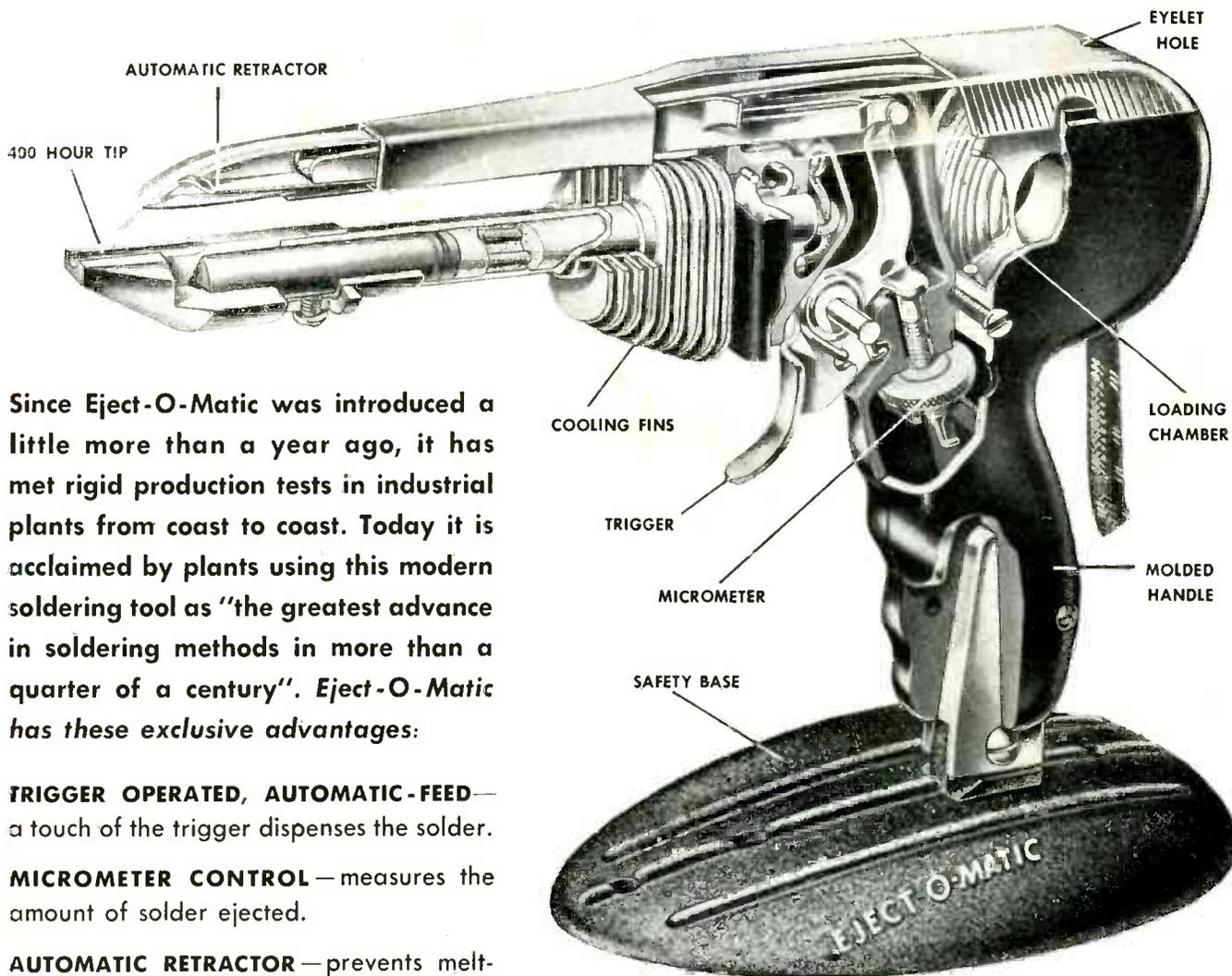
★ The improved, tougher Type 58 Clarostat wire-wound control provides among other notable advantages, a neat, more rugged, still more effective tandem dual assembly as here shown. Available with or without power switch.

Metal locating pin on front unit will not break or tear off. Bushing, keyed into the bakelite case, cannot slip or turn when locking nut is drawn up tightly. 1500 v. breakdown insulation between windings and shaft. Each center rail is in one piece with its terminal. Direct connection between winding and "L" and "R" terminals. Thus a real good dual control is made still better with these improved Type 58 units.



CLAROSTAT MFG. CO., Inc. - 285-7 N. 6th St., Brooklyn, N. Y.

the inside story OF AMERICA'S MOST EFFICIENT SOLDERING IRON



Since Eject-O-Matic was introduced a little more than a year ago, it has met rigid production tests in industrial plants from coast to coast. Today it is acclaimed by plants using this modern soldering tool as "the greatest advance in soldering methods in more than a quarter of a century". Eject-O-Matic has these exclusive advantages:

TRIGGER OPERATED, AUTOMATIC-FEED—a touch of the trigger dispenses the solder.

MICROMETER CONTROL—measures the amount of solder ejected.

AUTOMATIC RETRACTOR—prevents melting of excess solder on tip.

400-HOUR TIP, MULTI-CLAD—non-corroding, never needs filing or tinning.

COOLING FINS—keep tip at proper working temperature—no thermostat required.

LOADING CHAMBER—easily accessible, holds 4 oz. reel of solder.

EYELET HOLE—permits automatic feeding of solder from large rolls mounted on, or under, bench.

MOLDED HANDLE—made of heat-resistant plastic.

SAFETY-UTILITY BASE—provides resting place for idle or cooling iron.

WEIGHS ONLY 18 OZS.

Write for descriptive literature or, if you wish, we shall be glad to arrange for a demonstration.

Available in 50, 75, 100 and 150 watt models. Tips in 6 different sizes and shapes.

Individually packed. Shipping weight per carton of 12 units, approximately 35 lbs.

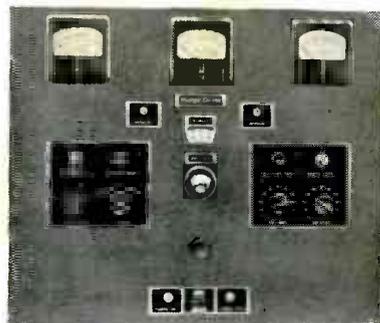


AUTOMATIC-FEED SOLDERING TOOL
EJECT-O-MATIC
HOUSES · MEASURES · EJECTS THE SOLDER

MULTI-PRODUCTS TOOL COMPANY, 123 SUSSEX AVENUE, NEWARK 4, NEW JERSEY



SIT BACK
AND RELAX
WITH ASSURANCE



... install a

Western Electric 2A PHASE MONITOR

You just can't beat the 2A Phase Monitor as an aid for quick, accurate adjustment and monitoring of directional antenna arrays.

No matter what your antenna control or coupling problems, you'll find that Western Electric has the units to solve them efficiently. For details, write Graybar Electric Co., 420 Lexington Avenue, New York 17, N. Y., or ...

ASK YOUR LOCAL

Graybar

BROADCAST REPRESENTATIVE

NEW PRODUCTS

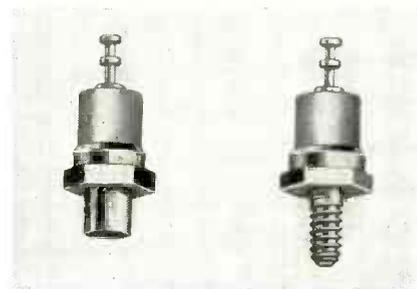
(continued)

components for airline use. The receiver contains its own power supply and can be mounted in any convenient location. The azimuth indicator shows the position of the enclosed loop. The pilot's control box contains the station indicator and the necessary switches for remote control.

Terminal Lugs

(29)

CAMBRIDGE THERMIONIC CORP., 445 Concord Ave., Cambridge 38, Mass. New insulated midget terminal lugs are furnished in both rivet and stud type with 6,000-volt a-c breakdown. The primary uses of the insulated



lugs cover such applications as tie-points where potential is high or where r-f exists. Further information is contained in a catalog available through Dept. 4.

Tube Tester

(30)

PRECISION APPARATUS CO., Inc., 92-27 Horace Harding Blvd., Elmhurst, L. I., N. Y. The type 954-P tube, battery, and set tester includes a mutual-conductance vacuum tube checker and a 37-range a-c and d-c meter. Voltages



POTENTIOMETERS
JACKS
RESISTORS
PHONE PLUGS
RHEOSTATS
SWITCHES
SWITCH STACK ASSEMBLIES
"T" AND "L"
PAD ATTENUATORS

CARTER

RADIO DIVISION

"Twenty-five years of service to industry"

CARTER RADIO DIVISION
PRECISION PARTS CO.

213 Institute Place
Chicago 10, Illinois

Write for full details
and catalogue today

electronics READER SERVICE . . .

TO BRING YOUR LIBRARY UP TO DATE ON LITERATURE and NEW PRODUCTS

Manufacturers' literature as well as further information on New Products described in this issue are important "working tools" for design and production departments. To make it easy to keep up to date, ELECTRONICS will request manufacturers to send readers the literature in which they are interested. Just fill out card as shown in the filled-in sample (right), being particularly careful to write out in full all the information called for in each section of each card that is used.

Write in circle number of item describing one item wanted → (14) Your Company Name <i>Jones Mfg. Co.</i> Address <i>3217 Lewis Ave. Chicago 13, Ill.</i> Your Name <i>Geo. Smith</i> Your Title <i>Chief Engineer</i> ELECTRONICS, 330 W. 42nd St., N. Y. 18	Write in circle number of item describing one item wanted → (23) Your Company Name <i>Jones Mfg. Co.</i> Address <i>3217 Lewis Ave. Chicago 13, Ill.</i> Your Name <i>Geo. Smith</i> Your Title <i>Chief Engineer</i> ELECTRONICS, 330 W. 42nd St., N. Y. 18
Write in circle number of item describing one item wanted → (37) Your Company Name <i>Jones Mfg. Co.</i> Address <i>3217 Lewis Ave. Chicago 13, Ill.</i> Your Name <i>Geo. Smith</i> Your Title <i>Chief Engineer</i> ELECTRONICS, 330 W. 42nd St., N. Y. 18	Write in circle number of item describing one item wanted → (49) Your Company Name <i>Jones Mfg. Co.</i> Address <i>3217 Lewis Ave. Chicago 13, Ill.</i> Your Name <i>H. S. Towne</i> Your Title <i>Adv. Mgr.</i> ELECTRONICS, 330 W. 42nd St., N. Y. 18

SAMPLE CARD SHOWING CORRECT FILL-IN



PLACE 1¢ STAMP ON CARD • DO NOT USE AFTER MAY 1

HOW TO ORDER:

- There are two postcards, each divided into four parts. Each of the four parts contains a box. You must write in this box the number that appears in this issue over the literature or new product item in which you are interested. Place one number only in each box.
- Fill out completely (name, address, etc.) for each piece of literature or new product information you desire.
Do not say "same" in lieu of writing out full information called for when requesting more than one item.
- This service applies only to literature and new product items in this issue. It does not apply to advertisements. Write directly to the company for information on its advertisements.

Careful and complete filling in of each portion of the card on which information is requested gives your request authority, and allows the manufacturer to whom we send your original request, the opportunity to address your copy correctly.

PLEASE NOTE:

In the event this copy of ELECTRONICS is passed along to other members of your company, please leave this sheet in for their convenience. This assures everyone in your plant the opportunity to fill in their requests. When the round is completed, cards can then be detached along perforated lines and dropped in the mail. Each individual request will be mailed by us to the company offering the information and for that reason must be completely filled out.

Write in circle number of item describing one item wanted →

Your Company Name.....

Address.....

Your Name.....

Your Title.....

ELECTRONICS, 330 W. 42nd St., New York 18, N. Y.

Write in circle number of item describing one item wanted →

Your Company Name.....

Address.....

Your Name.....

Your Title.....

ELECTRONICS, 330 W. 42nd St., New York 18, N. Y.

Write in circle number of item describing one item wanted →

Your Company Name.....

Address.....

Your Name.....

Your Title.....

ELECTRONICS, 330 W. 42nd St., New York 18, N. Y.

Write in circle number of item describing one item wanted →

Your Company Name.....

Address.....

Your Name.....

Your Title.....

ELECTRONICS, 330 W. 42nd St., New York 18, N. Y.

Write in circle number of item describing one item wanted →

Your Company Name.....

Address.....

Your Name.....

Your Title.....

ELECTRONICS, 330 W. 42nd St., New York 18, N. Y.

Write in circle number of item describing one item wanted →

Your Company Name.....

Address.....

Your Name.....

Your Title.....

ELECTRONICS, 330 W. 42nd St., New York 18, N. Y.

Write in circle number of item describing one item wanted →

Your Company Name.....

Address.....

Your Name.....

Your Title.....

ELECTRONICS, 330 W. 42nd St., New York 18, N. Y.

Write in circle number of item describing one item wanted →

Your Company Name.....

Address.....

Your Name.....

Your Title.....

ELECTRONICS, 330 W. 42nd St., New York 18, N. Y.

An electronics service designed for READERS *and* MANUFACTURERS

FOR THE READER...

ELECTRONICS fundamental policy has always been to supply its readers with all the pertinent and timely industry news. The ELECTRONICS Reader Service supplements this policy by offering the reader an easy and effective means of obtaining complete, up to the minute data on new products and of maintaining at his fingertips comprehensive, practicable information on "who's doing what" in the industry.

In every issue of ELECTRONICS there's complete coverage of the month by month development by manufacturers of new materials, components and equipment, as well as brief mention of all the important, new, manufacturers' technical pamphlets and catalogs. Some of these items will be of particular interest to specific design and plant engineers, buyers, executives and others of our readers. They will want to make further inquiry concerning the new products described or they will want to read and make a permanent part of their industrial library some of the manufacturers' literature and catalogs. ELECTRONICS Reader Service makes it easy for them to obtain in readily accessible and usable form the information they desire.

PLACE 1¢ STAMP ON CARD • DO NOT USE AFTER MAY 1

Place
1¢
Stamp
Here

ELECTRONICS

330 WEST 42nd STREET

NEW YORK 18, N. Y.

2-1-47

FOR THE MANUFACTURER...

ELECTRONICS Reader Service will also be welcomed by manufacturers who are desirous of placing the complete news of their product developments as well as their technical bulletins and catalogs in the hand of those members of the electronic industry... including design, electrical, and production engineers, researchers, physicists, executives, and buyers—who have a particular interest in, or represent a potential buying power for, their products.

Place
1¢
Stamp
Here

ELECTRONICS

330 WEST 42nd STREET

NEW YORK 18, N. Y.

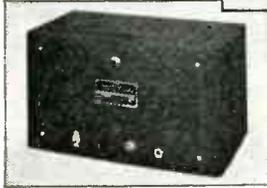
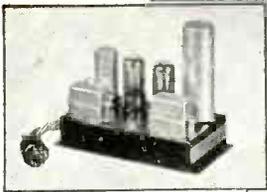
SUGGESTIONS FOR THE IMPROVEMENT OF OUR READERS' SERVICE ARE INVITED

ELECTRONICS is constantly seeking new and improved ways of providing its readers with the news and information they want and need, and of assisting the manufacturer in effectively delivering his message to electronic markets. If you have any ideas for us, send them along. They'll receive prompt and grateful consideration.

2-1-47

LOW FREQUENCIES ACCURACY TO 1/1,000th of 1%

Actual Size



TOP
FREQUENCY STANDARD
(60 cycle) for use with external power supply

CENTER
CHRONOGRAPH
Records time intervals with resolution to .001 second

BOTTOM
FREQUENCY STANDARD
(120 cycles) with self-contained power supply

These tuning forks which include new engineering principles, provide frequencies from 120 to 1,000 cycles directly with an unqualified guarantee of accuracy to 1 part in 100,000 over a wide temperature range. (Better than 1 second in 24 hours). Closer tolerances are obtainable on special order.

These tuning fork assemblies are available only in single or multi-frequency instruments of our own manufacture which are de-

signed to test, measure or control other precision equipment by mechanical, electrical, acoustical or optical means.

The dependability of these frequency standards is being demonstrated for myriad purposes in all climates and under all working conditions.

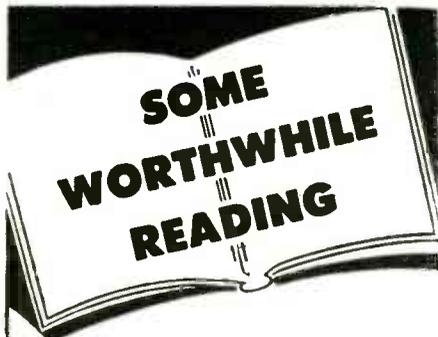
If you have need for low frequency standards of exceptional accuracy, your inquiries are invited.

American Time Products, Inc.

580 Fifth Ave.

New York, N. Y.

Dist. of Western Electric & *Watch Master* Watch-rate Recorders



HARVEY has been appointed authorized dealer for the new Collins line of transmitters and receivers. These units are precision built to the highest standards. We are now taking orders on the whole line for quick delivery.

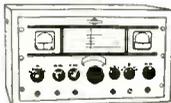
The Model 30K-1 Transmitter, complete with the 310A-1 Exciter and all tubes, is a complete transmitter ready to operate. Input is 500 watts on cw, 375 watts on phone. Operating controls in Exciter unit.



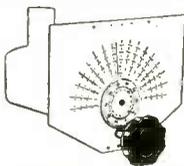
\$1250

32V-1 150-watt transmitter (120 watts on phone) complete with tubes. Uses the highly stabilized and accurate Collins VFO. \$475

70E-8 VFO. It is new, versatile and extremely accurate. Overall accuracy and stability are within 0.015%.

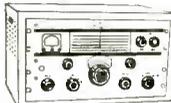


Can be used for all bands up to 2/3 meter with doublers. Complete with calibrated dial. You can build a good band-switching exciter unit with the 70E-8 that will make multi-band operation a pleasure.



\$40.00

Collins 75A Receiver. The receiver to end all receivers! 80-40-20-15-11-10 meter bands. Straight line tuning. Dial calibrated in frequency. 50db image rejection on all bands, uses double conversion. Permability tuned, extremely high stability, uses separate oscillator for mixers. Complete with tubes, crystals and speaker.



\$375

Send your order in now for earliest delivery. All prices quoted are Net. F.O.B. New York and are subject to change without notice.

Telephone: **hrc** LOngacre 3-1800

HARVEY
RADIO COMPANY INC.
103 West 43rd St., New York 18, N. Y.

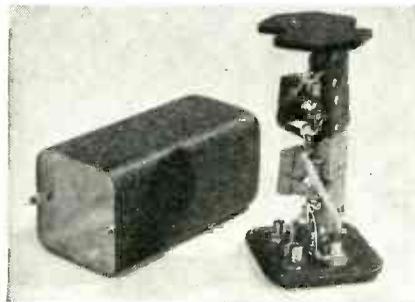
NEW PRODUCTS

(continued)

up to 6,000 can be measured. Among other features, resistance up to 60 megohms and db ranges up to plus 70 can be accommodated on the instrument.

Wien Bridge Filter (31)

KALBFELL LABORATORIES, 1076 Morena Boulevard, San Diego 10, Calif. A Wien bridge filter designed to cancel 60 and 120 cycle hum when using an oscillograph or vacuum-tube voltmeter consists of



two bridges in cascade. Terminals are brought out so that either or both can be used. Only fixed mica capacitors and low temperature coefficient resistors are used, the whole assembly being sealed in polystyrene.

Counter and Control (32)

POTTER INSTRUMENT CO., 136-56 Roosevelt Ave., Flushing, N. Y. The new model 140 single-channel predetermined counter used for high-speed counting, batching, and

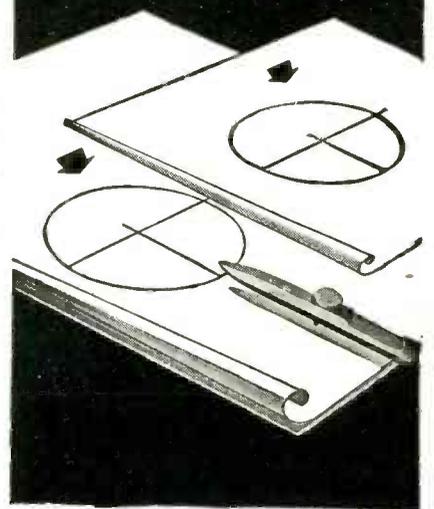


packaging control will function at rates of 15,000 per minute or higher if required. The unit utilizes four standard four-tube counter decades arranged to permit use of any predetermined number from 0 to 10,000.

Booster Amplifiers (33)

DAVID BOGEN Co., Inc., 663 Broadway, New York 12, N. Y. Two new

Tracing cloth that defies time



The renown of Imperial as the finest in Tracing Cloth goes back well over half a century. Draftsmen all over the world prefer it for the uniformity of its high transparency and ink-taking surface and the superb quality of its cloth foundation.

Imperial takes erasures readily, without damage. It gives sharp contrasting prints of even the finest lines. Drawings made on Imperial over fifty years ago are still as good as ever, neither brittle nor opaque.

If you like a duller surface, for clear, hard pencil lines, try Imperial Pencil Tracing Cloth. It is good for ink as well.

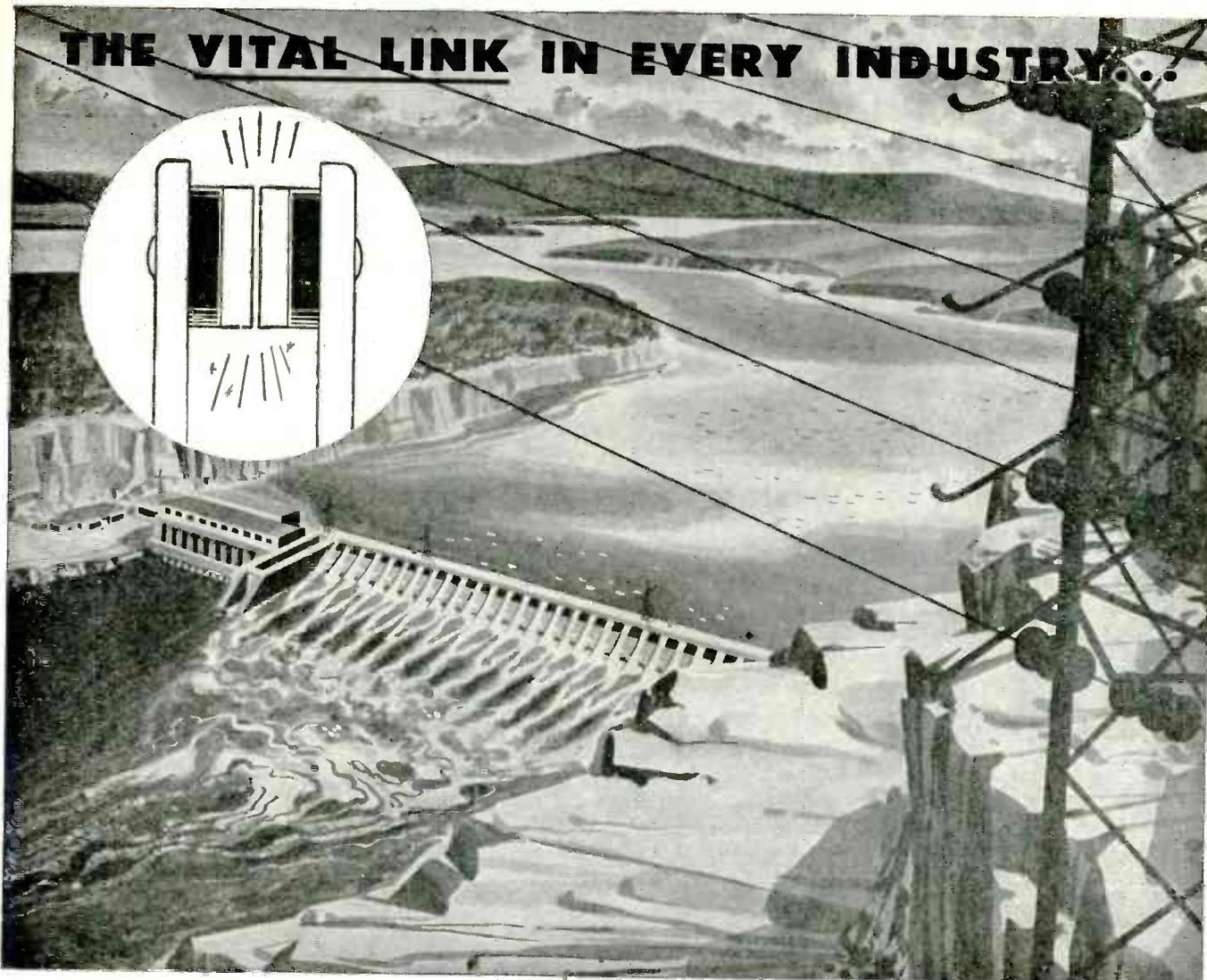


IMPERIAL TRACING CLOTH



SOLD BY LEADING STATIONERY AND DRAWING MATERIAL DEALERS EVERYWHERE

THE VITAL LINK IN EVERY INDUSTRY...



WILCO CONTACTS

They keep the power flowing!

WILCO PRODUCTS INCLUDE:

CONTACTS

Silver - Platinum - Tungsten - Alloys
Sintered Powder Metal

THERMOSTATIC BIMETAL

All temperature ranges, deflection
rates and electrical resistivities.

SILVER CLAD STEEL

JACKETED WIRE

Silver on Steel, Copper, Invar or
other combinations requested.

ROLLED GOLD PLATE AND WIRE

NI-SPAN C*

New Constant Modulus Alloy

SPECIAL MATERIALS

*Reg. Trade Mark, The International Nickel Co., Inc.



Modern industry utilizes WILCO CONTACTS in frequency operations of every range both because of their longer service life and because they assure maximum ductility, hardness, density, freedom from sticking, low metal transfer, high conductivity and arc-resistance.

These same peerless WILCO qualities of stamina and precision performance—assured by exclusive WILCO processes—will keep the power flowing in your products. WILCO engineers will gladly help you select from a great variety of available WILCO contact materials the particular contacts suited to your needs—or develop new alloys for special purposes.

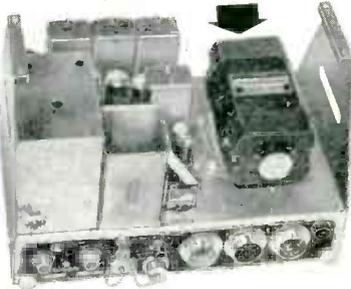
THE H. A. WILSON COMPANY

105 Chestnut Street, Newark 5, N. J. • Branch Offices: Chicago, Detroit, Los Angeles, Providence

SPECIALISTS FOR 30 YEARS IN THE MANUFACTURE OF THERMOMETALS • ELECTRICAL CONTACTS • PRECIOUS METAL BIMETALLIC PRODUCTS

NO.
2
OF A SERIES

Carter
powers the
MOTOROLA 162 MC
F.M. Transmitter



Reliable power assures the reliable operation of the new Motorola FM Mobile 162 megacycle Transmitter... instantaneous power from the CARTER Genemotor shown on the chassis above. The **ONLY** Dynamotor that delivers full power in 3/10 second and over 100,000 service-free transmissions. Write for latest catalog.

Carter Motor Co.
Chicago, Illinois

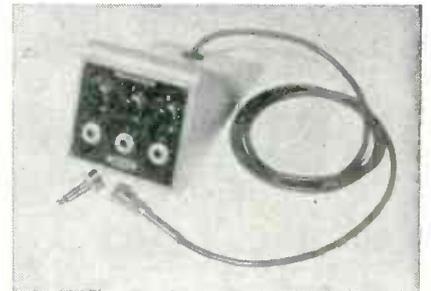
2648 N. MAPLEWOOD AVENUE • CABLE: GENEMOTOR



booster amplifiers, types G050 and G0125, capable of delivering 50 and 125 watts respectively use multi-stage inverse feedback to attain a flat response within 1 db from 20 to 20,000 cycles. Input impedance is 500,000 ohms with provision for balanced-line zero-level input for use on telephone lines. The self-contained power pack provides a regulated screen supply.

Mike Input (34)

SPECIAL PRODUCTS Co., Silver Spring, Md. The Max-Mixer is a device to enable owners of public address amplifiers to use three additional microphones and control each one at the proper level. The



unit is equipped with six feet of shielded cable for connection to the amplifier.

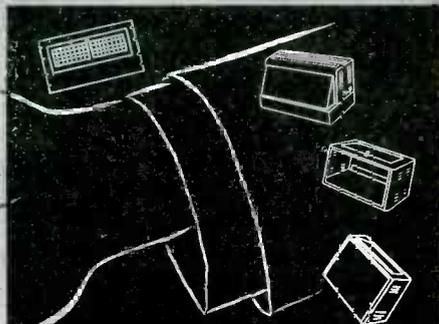
Antenna Rotator (35)

THE WORKSHOP ASSOCIATES, Inc., 66 Needham St., Newton Highlands 61, Mass. Designed primarily for amateur transmitting antenna arrays, the new rotator can be used for other service such as f-m and television reception. Mechanically rugged, the device simplifies the electrical-connection problem by using only a 360-degree rotation that obviates the need for slip rings. The feed line can be matched without difficulty to the antenna structure. Motion of the antenna

SPECIALIZED Skill in METAL

PANELS • CHASSIS • RACKS
with Beautiful Chrome Trim

CABINETS



The time-tested Par-Metal line presents superior features of styling, design, and construction. True to policy, Par-Metal continues to specialize in Electronic Housings exclusively... and is therefore able to offer leadership in value. Compare! Write for Catalogue.

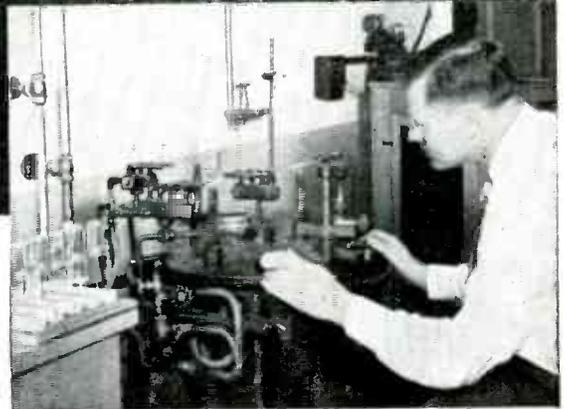
PAR-METAL
PRODUCTS CORPORATION
32-62 - 49th STREET
LONG ISLAND CITY 3, NEW YORK
Export Dept.: Rocky International Corp.
13 East 40 Street, New York 16

**Practical Research
DEDICATED TO
Superior
Electronic Tubing**



Superior's Electronic Laboratory opens the doors to far reaching research and development of electronic tubing, through the study of materials, processes and controls.

The Emission Microscope, shown above, makes it possible to test the material in electronic tubes, under actual operating conditions, for emissive qualities. Material control standards, otherwise unattainable, are now realities. The way is open to important development of new tubing materials and uses.



Sealing-in Machine in the process of sealing experimental electronic tubes preparatory to emission testing.



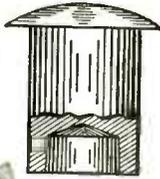
Comparator measuring dimensions to 10 thousandths of an inch, for inspecting the quality of work going into electronic tube cathodes and parts. This is just one of many tests conducted by the "Quality Control Group" of the Superior Laboratories.

THE **BIGGER NAME IN SMALL TUBING**
Superior



**SUPERIOR TUBE COMPANY
NORRISTOWN • PENNSYLVANIA**

**EVER
SEE
THESE?**



Milford SEMI-TUBULAR Rivets —

SOLID where solidity is required for strength.

SEMI-TUBULAR to save time in setting.

**MILFORD
FASTENING
EQUIPMENT**

A pin on Milford Rivet Setters engages the semi-tubular end of the rivet, guides it home accurately and instantly to make an unbreakable assembly. Costs cut. Time saved. Production speeded. Milford designs and manufactures rivets in endless variety and makes 15 standard models of bench and floor type rivet setters (special models, to order).

MILFORD BENCH TYPE RIVET SETTER

**SETS 60 RIVETS
A MINUTE**

**in Metal, Wood, Fabric, Plastic
or any combination of the four.**

Send blue prints or actual sample for more information, or write for a Milford representative to call.

**THE MILFORD RIVET
& MACHINE CO.**

**859 Bridgeport Ave.
MILFORD, CONN.**

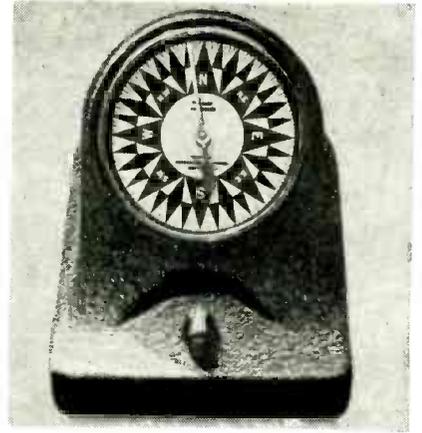
1002 West River St., Elyria, Ohio

*Inquiries may also be addressed to our subsidiary:
THE PENN RIVET & MACHINE CO. PHILADELPHIA 33, PENNA.*



NEW PRODUCTS

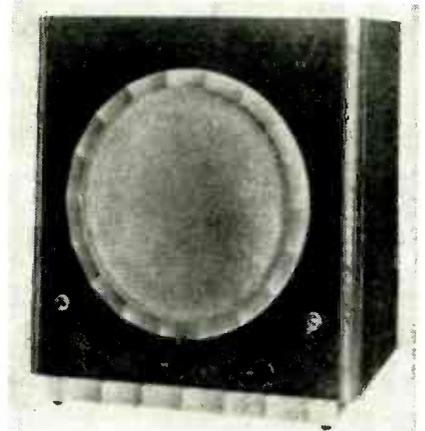
(continued)



stops automatically at north. A three-position switch control is shown on the indicator base casting.

Sound Reproducer (36)

ALLEN D. CARDWELL MFG. CORP.,
97 Whiting St., Plainville, Conn.
The model CE-26 sound reproducer is a combined amplifier and loud-



speaker designed for general use with microphone, phonograph pick-up, or guitar reinforcing system. Eight watts undistorted output is available with a frequency response flat within 2 db from 60 to 8,000 cycles.

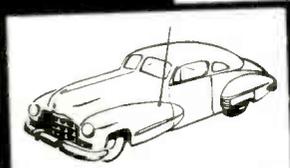
Capacitance Meter (37)

MAIDA DEVELOPMENT CO., Box 588,
Erie, Pa. The model 201 direct-reading capacitance meter operates on the principle of measuring the current through a capacitor when a known voltage at 100 kilocycles is impressed across it. Ten overlapping ranges make possible measurements from 0.1 to 10,000 microfarads. Each instrument is adjusted to within 1 percent of full-scale

ANTENNA SYSTEMS
for **USERS**
of **PRIVATE BRANDS**



ESTABLISHED 1906



We manufacture the following, under private labels and trademarks:

AUTOMOBILE ANTENNAS . . . every variety, including types that can be raised and lowered from inside the car.

RESIDENTIAL ANTENNAS . . . AM and FM, for homes, stores and multi-family buildings. Complete lines of noise-reducing systems incorporating latest patented developments of coupling transformers.

FM, AM and TELEVISION . . . Dipoles with or without reflectors, folded dipoles, turnstile, radiating types and other combinations for roof, sidewall and other mountings.

MARINE ANTENNAS . . . Collapsible and transmitting types for every purpose.

For POLICE and other mobile units . . . roof-top antennas for ultra-high frequencies.



WE INVITE INQUIRIES AND CONSULTATIONS.

L. S. BRACH MFG. CORP.

200 CENTRAL AVENUE NEWARK, 4 N. J.



WORLD'S OLDEST AND LARGEST MANUFACTURERS OF RADIO ANTENNAS AND ACCESSORIES

METAL PLATES that serve a steady diet of sound



The FATHOMETER†—the first practical application of "Sonar"—utilizes the magnetostriction of Nickel

One of the most practical uses of sonar is the Fathometer, manufactured by the Submarine Signal Co., Boston, Mass.

The Fathometer generates sonic vibrations, throws them at the bottom, and then listens for their echoes. With a Fathometer you can map the ocean floor . . . locate fish . . . safeguard navigation.

Like many other adaptations of sonar, the Fathometer depends upon Nickel to send and receive the sonic vibrations. Heart of each oscillator is a stack of thin Nickel plates, laced together with a winding of wire.

HOW THE FATHOMETER WORKS

When current is passed through these windings, a magnetic field is created. *That's when the magnetostrictive property of Nickel goes to work!*

For under the influence of magnetic force, Nickel contracts, returning to its original length when the field goes dead. In a fluctuating field, the resulting vibrations are powerful enough to produce an echo from the ocean floor.

When the sonic waves bounce back to the Fathometer, a second oscillator (acting as a receiver) goes through the same cycle in reverse to convert sound into electrical impulses. Other components then time the lag between transmission and echo, registering the depth on an indicator.

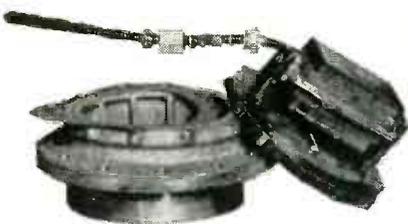
WHY NICKEL WAS CHOSEN

Nickel is used in sonar because it contracts more than other magnetostrictive metal, contracting 32 units of length for every 1,000,000.

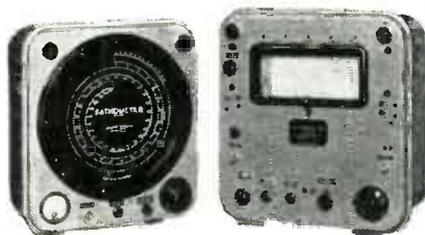
Magnetostriction is just one of the specialized properties obtainable with Nickel. When specifying metals for electronic or electrical use always consider Nickel and the INCO Nickel Alloys. They are strong, tough, rustless, corrosion-resistant and thermally durable.

†Trademark registered by Submarine Signal Company

THE INTERNATIONAL NICKEL COMPANY, INC.
67 WALL STREET, NEW YORK 5, N. Y.



One of the two oscillators that are the key parts of every Fathometer. Here, the oscillating unit has been tipped back out of its casing to show where the stack of Nickel lamination plates is mounted.



Both an indicating dial and recorder can be used with the Fathometer. Other components include an amplifier and a driver.

Nickel

NICKEL  ALLOYS
TRADE MARK

MONEL* • "K"*MONEL • "S"*MONEL • "R"*MONEL • "KR"*MONEL • INCONEL* • NICKEL • "L"*NICKEL • "Z"*NICKEL
*Reg. U. S. Pat. Off.

• PHONOGRAPH-TURNTABLE UNITS

• FRACTIONAL HORSEPOWER MOTORS

PRECISION WIRE WOUND RESISTORS

RADIO AND ELECTRONIC TEST EQUIPMENT

Eastern Electronics Corp.



PHONOGRAPH TURNTABLE UNIT

Engineers will find this compact turntable meeting all of their requirements.

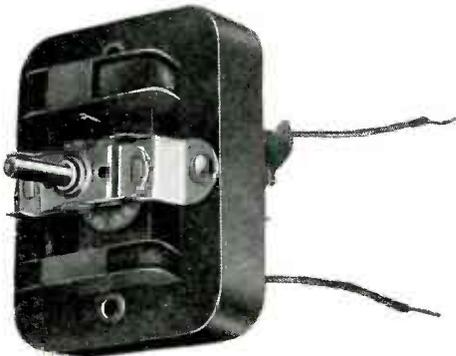
PERFORMANCE:—Correct and uniform speed is secured through the use of a motor of ample capacity, preloaded to operate on the flattest portion of the torque-speed characteristic.

QUIETNESS:—Is assured by full-floating rubber motor mountings and rubber cushioned drive. Permanent freedom from turntable wobble is guaranteed by an extra rigid turntable, an extra long bearing and precision machining of these parts.

Unit can be supplied for 110 volt and 220 volt 50 or 60 cycle operation.

Deliveries prompt.

FRACTIONAL HORSEPOWER MOTORS



Sturdy motors, precision built for long life and rugged requirements.

Single phase shaded pole induction type suitable for many applications. Constant speed is maintained through the use of new shading design making this motor ideal for use where good starting torque requirements are needed.

Dual motor coils of ample turns impregnated against moisture will operate continuously with an exceptionally low temperature rise.

Bearings are of ample size and are self-aligning with self-lubricating features.

Production starts soon and we invite inquiries now as to your 1947 motor requirements.

ROTARY SELECTOR SWITCHES

FOR THE CRITICAL ENGINEER



TYPE XC—Single or multiple decks. Instrument type. Contact Resistance less than .001 ohm. Ideal for shunt ammeter, thermo couple type measuring equipment and Wheatstone Bridges.

SERIES EE-14—Single or multiple decks. One to six. 14 circuits each deck. Shorting or non-shorting contacts. Recommended for use in quality test equipment or accurate switching of multi-circuits with low contact loss.



SERIES EE-20—Similar to Series EE-14 but with 20 circuits each deck. Contacts and moving parts heavy coin silver plated to meet 200 hour salt spray test. Low leakage laminated plastic decks selected for maximum mechanical and dielectric strength.

Write for catalogue

Eastern Electronics Corp.

41 CHESTNUT STREET, NEW HAVEN, CONN.

BRADLEY COPPER OXIDE RECTIFIERS

IDEAL FOR AUTOMATIC CURRENT CONTROL

"Coprox" rectifiers may be your answer to more efficient current control. Their varistor characteristics make them ideal for automatic current valving, current limiting, current blocking, as well as current measurement.

Bradley rectifiers are designed to give you trouble-free service. Their electrical characteristics remain stable indefinitely. When operated within normal rating, their life is unlimited.

Send for curves showing current, voltage, resistance and temperature characteristics of Bradley copper oxide rectifiers.

Illustrated literature, available on request, shows more models of copper oxide rectifiers, plus a line of selenium rectifiers and photocells. Write for "The Bradley Line."

BRADLEY LABORATORIES, INC.

82 Meadow St. New Haven 10, Conn.

NEW PRODUCTS

(continued)

erings. A noncontaminating jacket covers the shield. Characteristic impedance of the cable is 95 ohms. Attenuation per 100 feet is 1.7 db at 30 megacycles, 3.6 at 100 mc and 10.0 db at 400 mc.

High Voltage Tester (40)

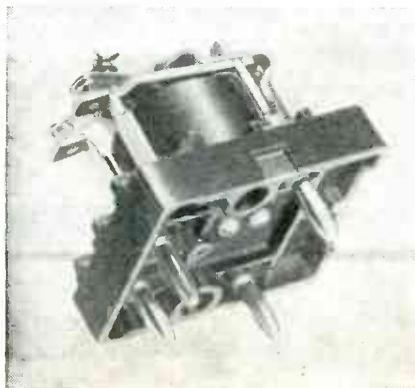
ROWE RADIO RESEARCH LABORATORY Co., 2422 North Pulaski Road, Chicago 39, Ill. The type SP22 electronic spark plug analyzer uses an oscillographic technique that is easily interpreted by inexperienced



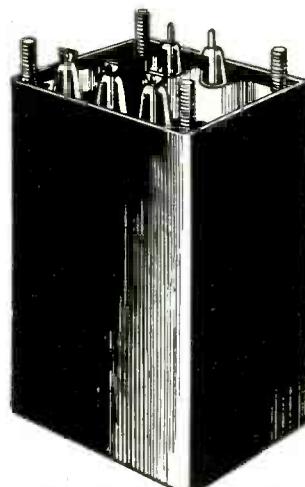
personnel. Tests at peak voltages between 1,000 and 21,000 volts can be rapidly determined. The instrument can be modified for testing high tension cable or for other resistance, corona and breakdown testing. The unit measures 20x20x22 inches.

Plug-In Relays (41)

WARD LEONARD ELECTRIC Co., 31 South St., Mount Vernon, N. Y. Bulletin 106 magnetic relays feature pin-plug connections. They are suitable for a-c or d-c operation on standard frequencies and voltages up to 125 volts. Single-break rat-



From out of
the west...
America's
finest
transformers



Thermador is a name remembered when the utmost in transformer quality is desired, and when exceptional engineering skill is required.



"Seven Leagues Ahead"

THERMADOR

THERMADOR ELECTRICAL MFG. CO.
5119 District Blvd., Los Angeles 22, California

Number, Please... Big Numbers!



When America switched to the monophone telephone in 1925, millions were needed—quick. The job called for complex molds—presses to handle heavy pieces—ample production. Kurz-Kasch did it first.

Many firms and individuals have contributed to the amazing advances of the plastics industry. As this series of ads testifies, Kurz-Kasch and its engineers have played their parts since the very earliest days.

We mention it only because yesterday's achievements are your promise of added competence today—because by choosing Kurz-Kasch as your molder now, your production will benefit *ahead of time* from many of the improvements of tomorrow. And that pays off.

Investigate our complete molding service. Write for your free copy of "A Businessman's Guide to the Molding of Plastics"—or ask for an engineer.



Kurz-Kasch

*For Over 29 Years
Planners and Molders in Plastics*

Kurz-Kasch, Inc., 1425 S. Broadway, Dayton 1, Ohio. *Export Offices:* 89 Broad Street, New York, N. Y.
Branch Sales Offices: New York • Chicago • Detroit • Los Angeles • Dallas • St. Louis • Toronto, Canada.

NEW! ELECTRONIC DEVELOPMENT 5" OSCILLOSCOPE



STOCK NO. 84-376
ONLY
\$ **99.50**

For PRECISION OBSERVATION of Radio, Sound, Television and other Electronic Phenomena...

This new 5" Cathode Ray Oscilloscope is a precision instrument at an attractively low price, designed for practical application in laboratory research and production work. Sturdily built to stand up under continuous use, and ably engineered for accuracy, versatility and easy operation. Has wide frequency range, 10 cycles to 300 Kc. Deflection sensitivity, 1 volt RMS per inch. Sweep range, 10 cycles to 60 Kc. in four steps. For 110-120 volt, 50-60 cycle operation. In welded steel cabinet, with baked black wrinkle-finish; 8½" wide, 14½" high, 18½" deep. Instrument panel in black, with white designations; has removable calibrated plastic scale. Complete with tubes. No. 84-376. Net Only. \$99.50

Order from the Central Source for Everything in Radio and Electronics

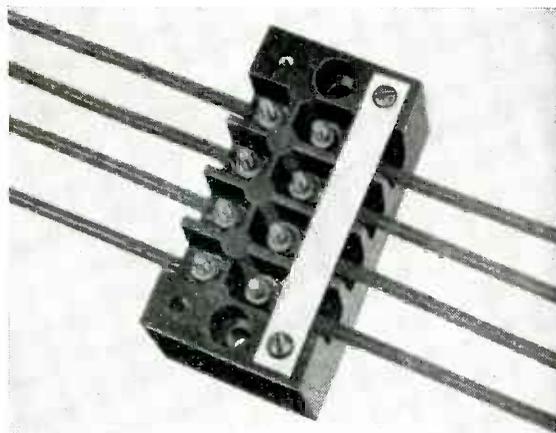
ALLIED RADIO CORP.

833 W. Jackson Blvd., Dept. 24-B-7, Chicago 7, Illinois

Send for
ALLIED
Catalog
No. 111

IMPERVIOUS to MOISTURE

BURKE Bakelite blocks are uniformly dense due to high pressure in hardened steel moulds in electrically heated and operated moulding presses. They feature high resistance to moisture and electricity.



SERIES 3000 features a center barrier moulded-in construction for extra mechanical strength. Center barrier off center to permit the use of terminal lugs on one side.

★ Write for New Booklet

to 1172 West 12th St., Erie, Pa.



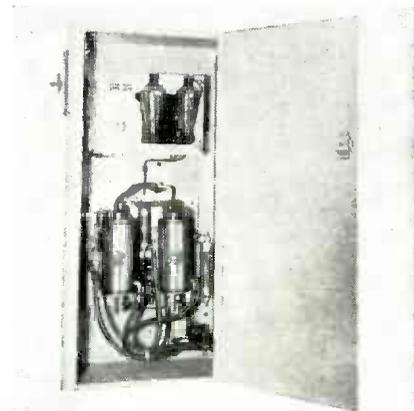
AC AND DC MOTORS AND GENERATORS

BURKE Terminal BLOCKS
BURKE ELECTRIC COMPANY • ERIE, PENNSYLVANIA

ings are 4 amperes, 125 volts, 60 cycles on noninductive loads.

Resistance Welding Control (42)

GENERAL ELECTRIC Co., Schenectady, N. Y. A new line of non-synchronous electronic resistance welding control combinations designed to meet new NEMA stand-



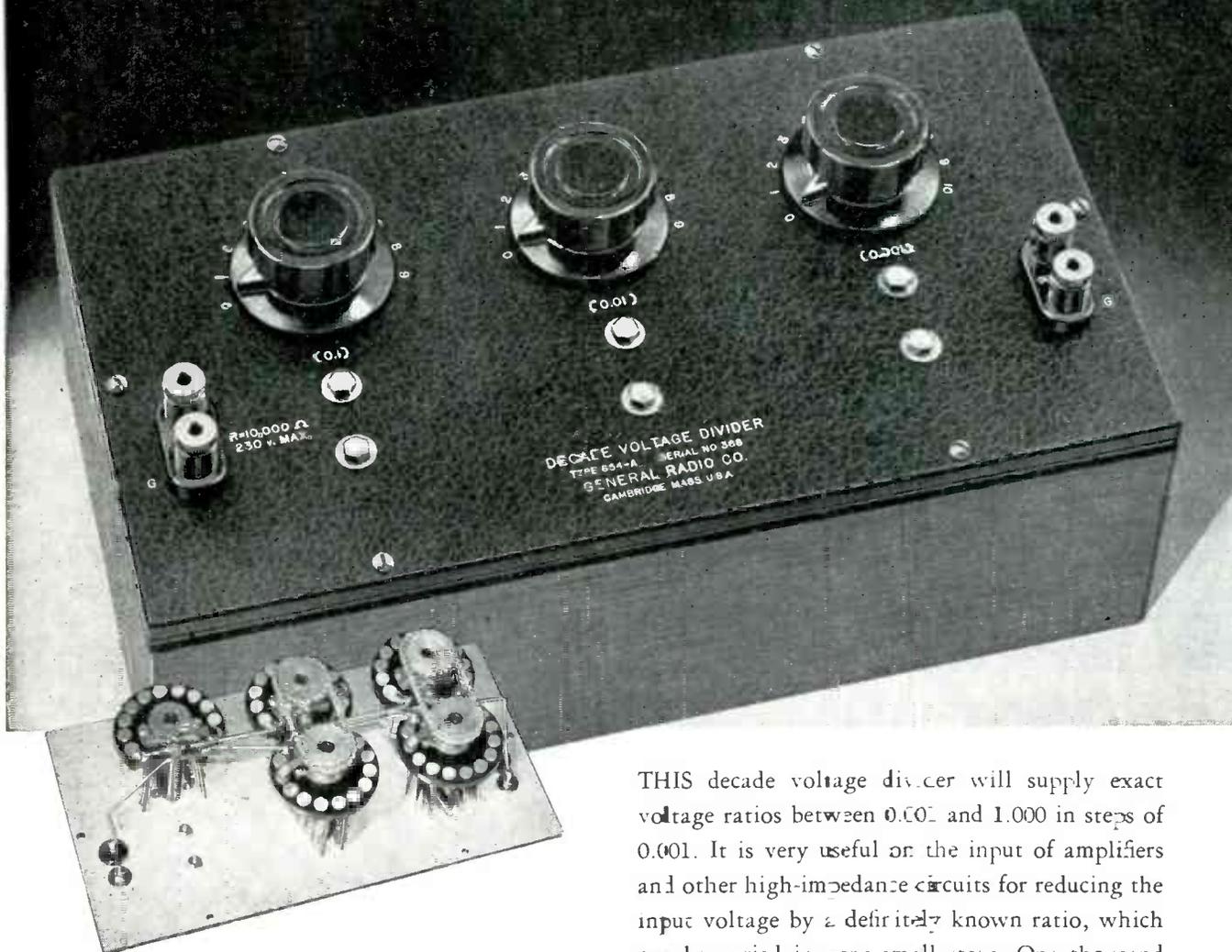
ards includes ignitron contactors and sequence-weld timers. The control cabinet illustrated can be mounted on a welder and requires only the connection of air and water lines in addition to power.

Interval Counter (43)

RADIO CORP. of America, Camden, N. J. The type WF-99B time interval counter gives direct visual indication of the time elapsed between two impulses each of extremely short duration. Maximum time that can be accommodated is one second, in microsecond increments. The equipment can be initiated by simple mechanical switches or triggers by inertialess means such as phototube equipment. Op-



1,000 DIFFERENT VOLTAGE RATIOS!



ABRIDGED SPECIFICATIONS

ACCURACY: each resistor is adjusted within $\pm 0.1\%$, error in voltage never exceeds $\pm 0.2\%$

INPUT IMPEDANCE: constant: resistance of 10,000 ohms regardless of ratio setting

OUTPUT IMPEDANCE: varies from 10 to 10,000 ohms, depending upon settings

FREQUENCY CHARACTERISTIC: if external capacitance across output terminals is less than 20 micromicrofarads, frequency error is less than 0.1% below 10,000 cycles

TEMPERATURE COEFFICIENT of resistors is less than $\pm 0.002\%$ per deg. C at normal room temperature

AT THE MOMENT WE HAVE A FEW IN STOCK

WRITE FOR COMPLETE DATA

THIS decade voltage divider will supply exact voltage ratios between 0.001 and 1.000 in steps of 0.001. It is very useful on the input of amplifiers and other high-impedance circuits for reducing the input voltage by a definitely known ratio, which can be varied in very small steps. One thousand different ratios can be obtained.

The input resistance remains constant regardless of dial settings, consequently reaction on the input voltage is eliminated.

The instrument is equivalent to a pair of our type 602 Decade-Resistance Boxes connected in series and so arranged mechanically that as resistance is taken out of one box it is added to the other to maintain the total resistance constant at 10,000 ohms.

All resistors are wound with an alloy wire of such characteristics that no difficulty from thermal emf will be encountered in direct-current measurements.

TYPE 654-A DECADE VOLTAGE DIVIDER... \$100



GENERAL RADIO COMPANY

Cambridge 39,
Massachusetts

90 West St., New York 6

920 S. Michigan Ave., Chicago 5

950 N. Highland Ave., Los Angeles 38



HOLLOWELL

"SOCKET SCREW" KIT
with interchangeable bits

For men who like to have a complete supply of tools, yet dislike bulk and confusion, the Hollowell "Socket Screw" Kits are the answer. Their hollow, durable plastic handles hold interchangeable *steel* bits for most all purposes . . . Phillips, Hex and Flat. They each have a swivel bit-chuck, which locks securely in five positions.

The "Socket Screw" Kit comes in 2 sizes: small #25 Kit; and the large #50 Kit.

Other Hollowell Kits: "Socket Wrench"; "Auto"; "Home".

Obtainable at Dealers throughout the country. If none near you, or he is sold out, send his name to us, along with yours, and you will be taken care of promptly.

Kits: Patents Pending

An ideal gift or prize

Over 43 Years in Business

STANDARD PRESSED STEEL CO.

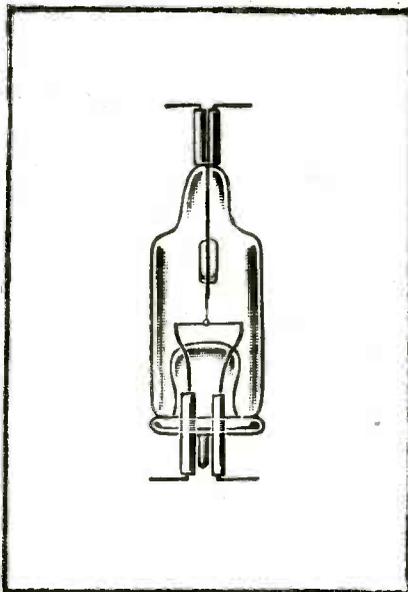
JENKINTOWN, PENNA., BOX 596

Boston • Chicago • Detroit • Indianapolis
St. Louis • San Francisco

erations can be automatically started and stopped on the basis of a predetermined number of items or counting impulses.

Vacuum Thermocouple (44)

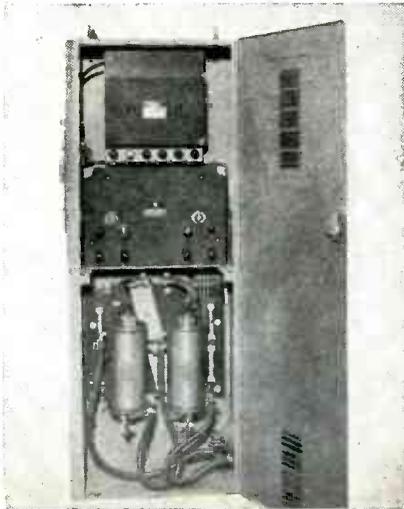
FIELD ELECTRICAL INSTRUMENT CO., 109 East 184th St., New York 53, N. Y. The type U vacuum thermocouple illustrated represents an im-



provement over the former unit designed for measurement of current, voltage, power at ultrahigh frequencies. Chief difference is reduction in size owing to a different conformation of the glass bulb.

Welding Controls (45)

GENERAL ELECTRIC CO., Schenectady, N. Y. The complete line of synchronous precision controls for resistance welding machines has



REQUIRE
Relays?



SIGMA

SENSITIVE RELAYS

have proven themselves in countless applications:

- ✓ Temperature Control
 - ✓ Vacuum Tube Circuits
 - ✓ Fire and Burglar Alarms
 - ✓ Telephone Dialing
 - ✓ Aircraft Controls
 - ✓ High Speed Keying
- ... and many others.

Specify
SIGMA!

SIGMA'S specialty is the combination of a fine relay and an unusually thorough approach to your specific application problem.

SIGMA standard relays are available with various enclosures including fixed mountings, 5-pin, and octal male plug bases.

New relays are being developed for special purposes. Send your requirements to SIGMA for dependable relay recommendations.



Sigma Instruments, Inc.

Sensitive RELAYS

62 Ceylon St., Boston 21, Mass.

VARFLEX CORPORATION, manufacturer of electrical insulation,

invites you to—

Test these Free Samples



See for yourself how new developments can give you better electrical insulation

● Varflex Corporation wants every manufacturer of electrical equipment to have one of these new folders. Each one contains actual working samples of 20 different types of sleeving and tubing, including *Varglas Silicone*, which was developed during the war to meet temperature variations from -85° F. to 500° F.

Write for this folder containing test samples today.



Varflex Corporation, 308 N. Jay St., Rome, N. Y.

Please send me your FREE folder containing 20 different types of electrical insulation. I am particularly interested in samples suitable for.....

Name.....

Company.....

Street.....

City..... State.....



With Two DI-ACRO BENDERS

A difficult production problem of forming two bends in a long length of tubing was solved by "teaming up" two DI-ACRO Benders as illustrated. This dual-forming arrangement saved installation of special machinery. Two accurately formed bends are obtained in one operation — without distortion of the tube and at a cost competitive to power operated equipment. More than 300

pieces are completed per hour—600 individual bends.

"DIE-LESS DUPLICATING" Often Does it Quicker WITHOUT DIES

This is but one example of how DI-ACRO precision machines—Benders, Brakes and Shears—can accurately and economically duplicate a great variety of parts, pieces and shapes, without die expense.

Write for Catalog—"DIE-LESS DUPLICATING"

← DI-ACRO is pronounced "DIE-ACK-RO".



O'NEIL-IRWIN MFG. CO.

321 EIGHTH AVENUE

LAKE CITY, MINNESOTA



been redesigned. The representative system illustrated comprises ignitron contactors, sequence controls for electrodes, and a synchronous weld timer, all components meeting new NEMA standards.

Counting-Rate Meter (46)

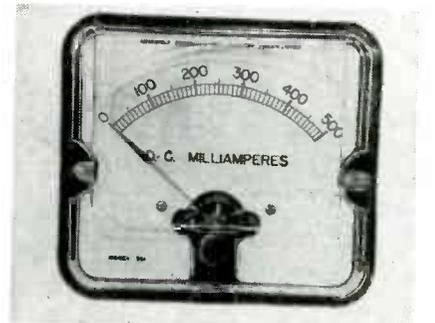
GENERAL RADIO Co., 275 Massachusetts Ave., Cambridge 39, Mass. A counting-rate meter and Geiger counter are available for both qualitative and quantitative observation



of radioactive materials and cosmic radiation. A loudspeaker is provided for the former and either a meter or an ink recorder can be used to count rates from 5 to 20,000 a minute.

Plastic Case Meter (47)

ASSEMBLY PRODUCTS INC., Main and Bell St., Chagrin Falls, Ohio. A line of panel meters in clear plastic cases is now available. Advantages claimed for the instruments are better illumination of the



dial and an unbreakable front cover. The scale can be illuminated by conduction of light from the rear along the edge of the plastic.

Antenna Arrays (48)

TECHNICAL APPLIANCE CORP., 41-06 DeLong St., Flushing, N. Y. The



U.H.F. STANDARD SIGNAL GENERATOR MODEL 84

SPECIFICATIONS

CARRIER FREQUENCY: 300 to 1000 megacycles.

OUTPUT VOLTAGE: 0.1 to 100,000 microvolts.

OUTPUT IMPEDANCE: 50 ohms.

MODULATION: SINEWAVE: 0—30%, 400, 1000 or 2500 cycles. PULSE: Repetition—60 to 100,000 cycles. Width—1 to 50 microseconds. Delay—0 to 50 microseconds. Sync. input—amplifier and control. Sync. output—either polarity.

DIMENSIONS: Width 26", Height 12", Depth 10".

WEIGHT: 125 pounds including external line voltage regulator.

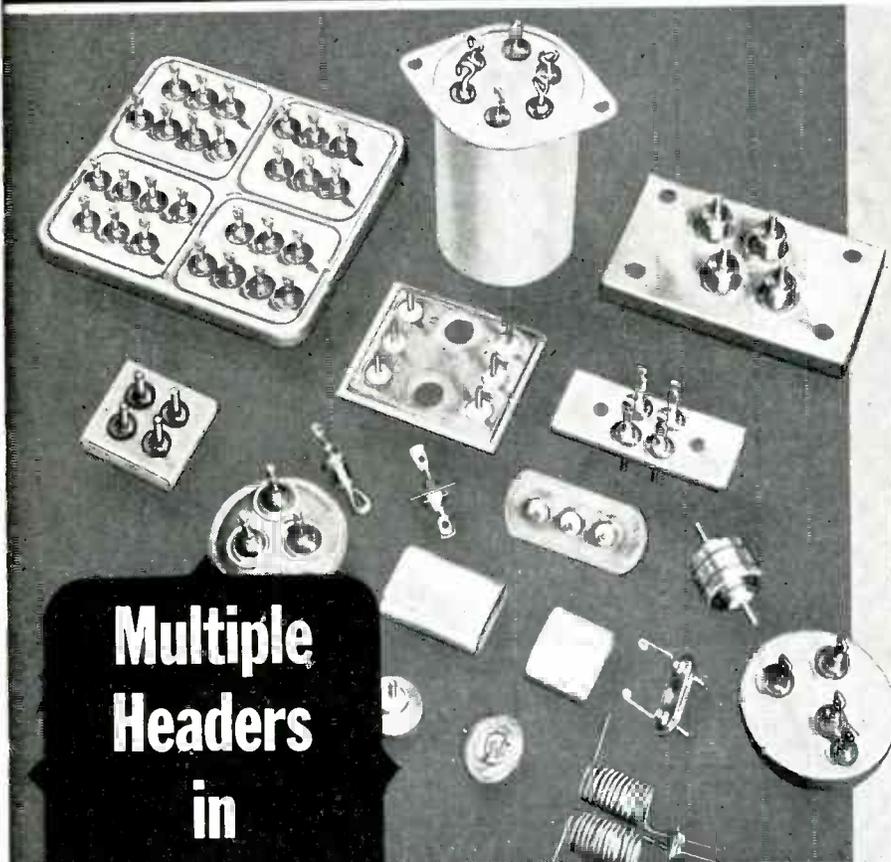


Laboratory Standards

MEASUREMENTS CORPORATION

BOONTON • NEW JERSEY

A Major Development in Hermetic Sealing!



**Multiple
Headers
in
All Shapes**

**Hermico-Glass
Multiple Headers
and Seals in
Unlimited Shapes
for Unrestricted Use
at 75% Material
Cost Savings**

.... in a **COMBINATION OF NEW METAL AND GLASS FOR HERMETIC SEALING** with matched coefficient of expansion

By their exclusive method of production, HERMETIC can provide an unlimited variety of shapes in multiple headers, with as many terminals as desired molded into a cover unit. No matter what your specifications are for shape, size and weight, single terminals or multiple headers, your requirements can be taken care of at once . . . samples within 48 hours . . . production runs, either long or short, immediately thereafter. Hermico-Glass Headers are unhampered by any restrictions whatsoever in their use.

Hermico-Glass Headers are vacuum-tight . . . have re-

sistance of over 10,000 megohms between body and terminals or between terminals . . . have a permanent chemical bond between metal and glass . . . are capable of withstanding shock of hot tin dipping to facilitate soldering.

Terminals may be arranged with a minimum spacing in any pattern or combination of voltage ratings. Illustrated are only a few variations. The range is unlimited, offering you the kind of latitude that will enable you to distinguish your products from those of competition.

Submit details of your requirements for samples and estimates of amazingly low cost multiple headers that are guaranteed impervious to every element. Your inquiry will receive immediate attention.



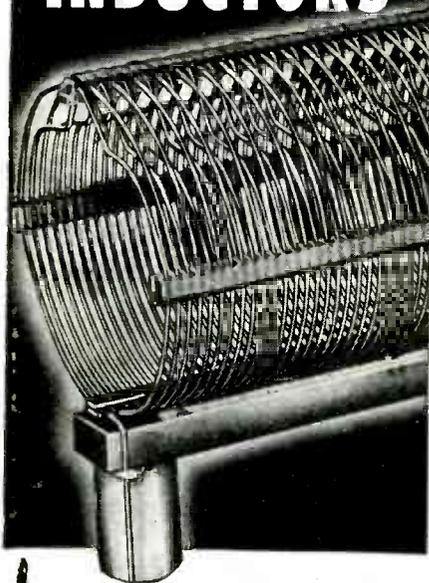
HERMETIC SEAL PRODUCTS COMPANY

414-418 MORRIS AVENUE • NEWARK 3, NEW JERSEY

Specify

B&W

AIR-WOUND INDUCTORS



for

- LOWER DIELECTRIC LOSS
- GREATER ADAPTABILITY IN MOUNTING
- LIGHTER WEIGHT
- EASIER TAPPING
- LESS CHANCE OF BREAKAGE

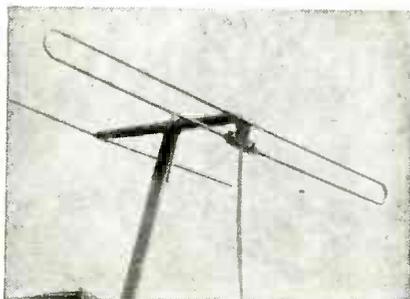
All types, shapes and sizes including turrets for modern Radio-Electronic needs.

BARKER & WILLIAMSON

DEPT. E-27237 FAIRFIELD AVE., UPPER DARBY, PA.

NEW PRODUCTS

(continued)



type 620 combination folded dipole and reflector antenna for f-m reception is illustrated. Dipole and reflector rods are aluminum, but the mast is wood to permit attaching the 300-ohm ribbon type transmission line directly to it for mechanical support. Other types of f-m, television, and a-m arrays are described in catalog 27A.

Null Detector (49)

GENERAL RADIO Co., 275 Massachusetts Ave., Cambridge 39, Mass. The type 707-A cathode-ray null detector is not new, but has only recently been put back into produc-



tion. It is useful at power-line and audio frequencies and can be used for the comparison of frequencies by means of Lissajous figures. Indication is by means of a one-inch cathode-ray tube.

Literature

(50)

Audio Amplifier. Brook Electronics, Inc., Box 430, Elizabeth, N. J. A high quality audio amplifier with optional bass and treble controls is described in a four-page leaflet. The equipment is suitable for broadcast station or home use.

(51)

Electrical Insulation. James G. Biddle Co., 1211 Arch St., Philadelphia 7, Pa. Technical publica-

Soundcraft and QUALITY CONTROL

The Soundcraft name symbolizes quality control in the manufacture of recording discs. It is the recordists guarantee that every Soundcraft disc offers an identical potential for the utmost in high fidelity reproduction.

One factor in the success of Soundcraft's exacting quality control is the disc prover. Capable of measuring minute differences in surface noise, frequency response, distortion, playback life, and thread behavior, this multi-channel test set also makes and compares recordings made under typical studio conditions.

Soundcraft discs need not be stamped with serial numbers. Disc prover quality - control plus triple inspection insures that every disc is up to the Soundcraft high quality standard.

'Broadcaster'
8" 10" 12" 16"
'Audition'
6 1/2" 8" 10" 12" 16"
'Playback'
6 1/2" 8" 10" 12" 16"
'Maestro'
12" 13 1/4" 17 1/4"



A Disc for Every Application

REEVES SOUNDCRAFT CORP.

10 EAST 52 ST., NEW YORK 22, N. Y.
PROGRESS ALONG SOUND LINES

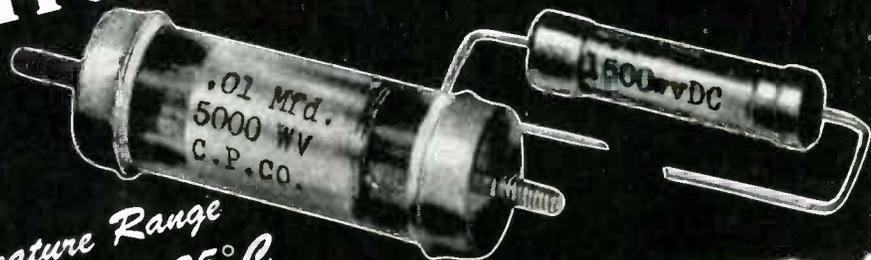
PLASTICON* ASG Silicone-Filled GLASSMIKES



1-3/8 x 3-1/2

FOR HIGHER VOLTAGES

*Extreme Temperature Range
from Minus 60° C to Plus 125° C*



Modern functionally designed capacitors. Metal ferrules are soldered to silver bands fused to each end of heavy-walled glass tubes. This vacuum tight assembly is fungus-proof and passes Signal Corps, Air Corps and Navy thermal cycle and immersion tests.

From 600 to over 30,000 Volts

Announcing an illustrated technical booklet on uses of
PLASTICON* GLASSMIKES

Contains the following subjects:—

- Glassmike characteristics and design data
- Comparison of Glassmike and Mica Capacitors
- Uses of Glassmikes for improved RF and Audio bypassing
- Use in Audio and RF coupling
- Glassmike in television power supplies
- Video coupling
- Vibrator buffer applications
- Geiger Counter Capacitors
- Instrument capacitors
- And many other applications

Come in and visit
our exhibit at the
I.R.E. show,
March 3-7, incl.

WRITE for above free booklet
on your firm letterhead.

* PLASTICONS: Plastic-Film Dielectric Capacitors

Order from your jobber: if he cannot supply you, order direct



Condenser Products Company

1375 NORTH BRANCH STREET • CHICAGO 22, ILLINOIS



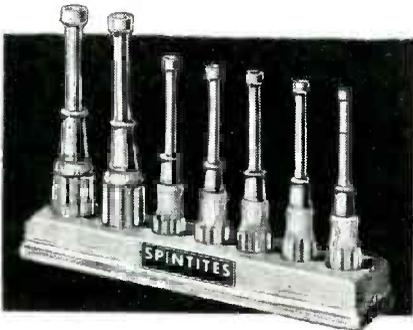
PARTNERS IN TIME!

Today, time saved means more than minutes—it means markets. There's no surer way to speed production than by the use of time-saving tools. That Spintite wrenches achieve this, is proved by their acceptance on the assembly lines of the radio industry.

A few simple twists of the screwdriver type Spintite speed parts into place with a minimum of waste motion.

Ranging in size from 3/16" to 5/8". Spintites are available to fit square, hex, or knurled nuts.

When time is of the essence, there's no substitute for Spintites.



T-73 Set, has 7 sizes of hex heads. Shock-proof handles, and cold forged sockets assure safety and strength.



STEVENS • WALDEN
INCORPORATED
Worcester • Massachusetts

NEW PRODUCTS

(continued)

tion 21T4 entitled "Temperature-Resistance Characteristics of Electrical Insulation" summarizes the composite nature of electrical insulation and the wide variations in insulation resistance owing to temperature changes. Simplified curves of temperature correction factors are presented.

(52)

House Organ. Tracerlab Inc., 55 Oliver St., Boston 10, Mass. The first issue of "Tracerlog" announces its purpose to publish technical information on laboratory, medical and industrial uses of radioactivity as well as descriptions of Tracerlab products and services. The monthly publication will be mailed free to interested physicists, chemists, physicians and engineers.

(53)

Stand-By Antenna. Andrew Co., 363 East 75th St., Chicago 19, Ill. The type 1200 folded quadrupole antenna, approved by FCC, is immediately available for f-m transmitters. Bulletin 46 offers full details.

(54)

Microwave Components. Sperry Gyroscope Co., Inc., Great Neck, N. Y. A six-page folder describes a cross-section of products available. Although most of the space is given over to microwave equipment, industrial and navigation equipment is also described.

(55)

Speech Equipment. Collins Radio Co., Cedar Rapids, Iowa. A new catalog just published includes information on all essential speech equipment and accessories for broadcast use.

(56)

Ceramics Wall Chart. American Lava Corp., Chattanooga 5, Tenn. A two-color wall chart has been prepared for free distribution to engineers desiring complete information on the more widely used types of AlSiMag compositions. While the chart does not attempt to cover the many special types of

Higher Output

OF "UNIVERSAL"
(LATTICE-WOUND) COILS

Up to four lattice-type coils of like specifications are produced at the same time on the No. 84 Universal Coil Winding Machine. Two machines can often be assigned to a single operator.

The higher rate of production . . . plus other advantages listed below . . . makes the No. 84 ideal for a great variety of cross-wound coils.

ACCURACY. Quickly-adjustable "gainer" mechanism accurately places wire turns (spaced or close-wound). "Veeder" Pre-Determining Counter.

CONVENIENCE. Strap-type tensions facilitate handling. In-built calibration. Quick-adjusting wire guide holders.

PRODUCTION. Winding speed, 400-750 rpm. Wires as fine as No. 46 unrolled without breakage.

DURABILITY. Many No. 84 machines now operating have been in service 20 years or longer.

Write for Bulletin 84.
Universal Winding
Co., P. O. Box 1605,
Providence 1, R. I.

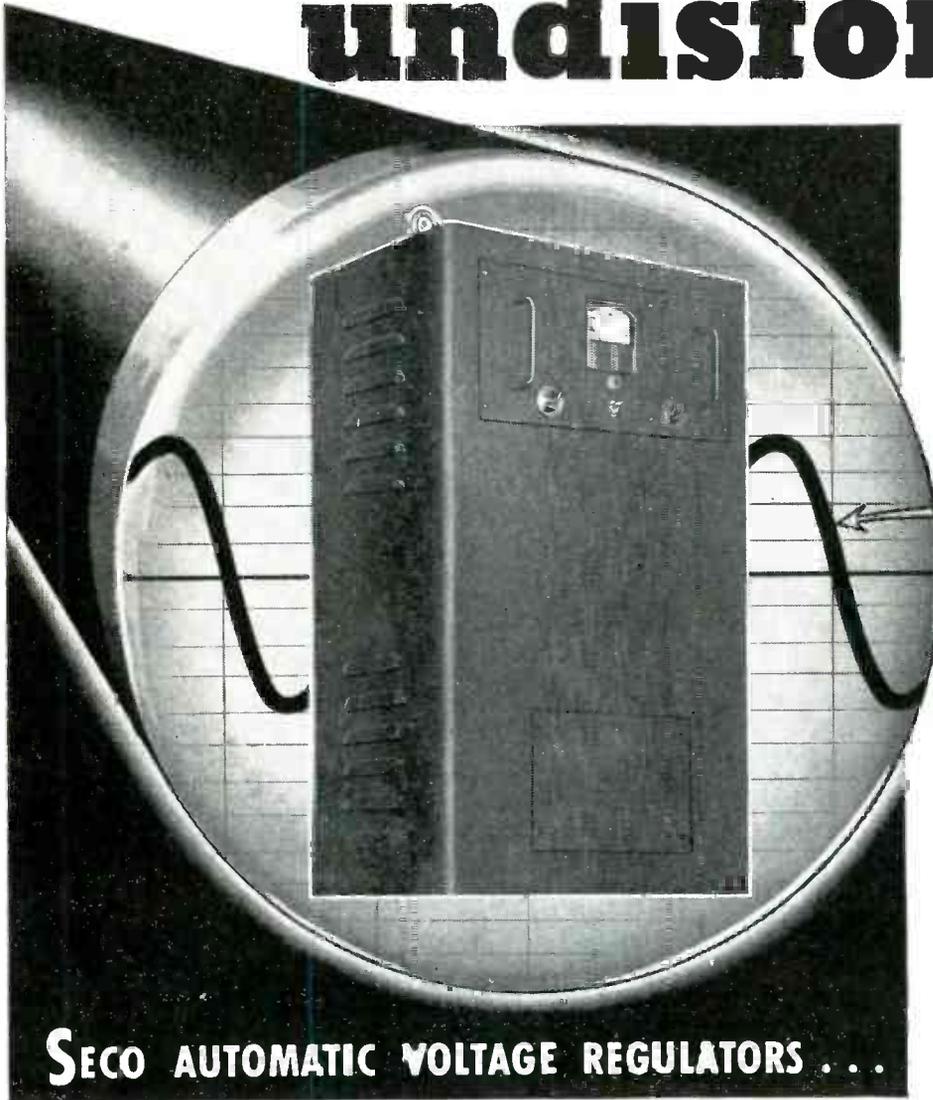


*For Winding Coils
in Quantity Automatically,
Accurately—Use . . .*

23B-6-1

**UNIVERSAL
WINDING MACHINES**

POWER undistorted



● ZERO WAVEFORM DISTORTION...a characteristic of all SECO Automatic Voltage Regulators... is not the most important but certainly a highly desirable feature in voltage regulating equipment. Please keep in mind —

Seco Automatic Voltage Regulators produce zero waveform distortion

But...zero waveform distortion is just one of the many decided advantages of SECO Automatic Voltage Regulators. A few others are listed and a more comprehensive investigation would reveal such factors as low cost per KVA — easy installation — rugged mechanical construction.

Consider these combined advantages when in need of equipment to maintain CONSTANT VOLTAGE to electrical apparatus.

SECO Automatic Voltage Regulators offer more per dollar value whether the requirement involves 1 or 100 KVA.

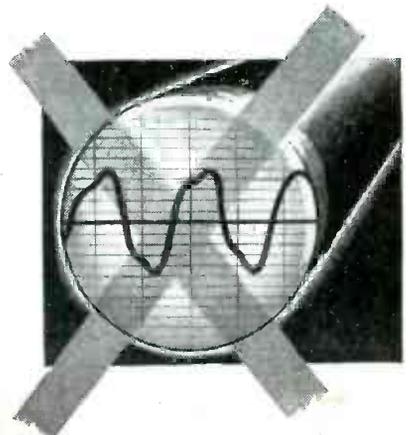
SECO AUTOMATIC VOLTAGE REGULATORS . . .

- RAPID CORRECTION OF LINE VOLTAGE VARIATIONS
- NO CRITICAL MECHANICAL ADJUSTMENTS
- DOES NOT AFFECT POWER FACTOR of the SYSTEM
- NOT AFFECTED BY CHANGES in the POWER FACTOR OR MAGNITUDE of the LOAD

Send for Bulletin 150 LE

The **Superior**  **Electric** Company

882 LAUREL STREET • BRISTOL, CONNECTICUT, U.S.A.



Announcement

In order to unify the handling of all foreign business and to provide the best possible service to our customers, we are pleased to announce the appointment of:

RCA INTERNATIONAL DIVISION

745 Fifth Avenue, New York 22, N. Y., U. S. A.

Radiogram Address: RADIOINTER

as exclusive distributors for our product in all countries outside the United States

BOONTON RADIO Corporation 
BOONTON · N · J · U · S · A ·

Designers and Manufacturers of

The Q-Meter . . . QX-Checker . . . Signal Generators . . . And
Other Direct Reading Instruments

BURNDY



HYLUGS

BURNDY ... New York 54, N. Y. In Canada: Canadian Line Materials, Ltd., Toronto 13. Foreign: Philips Export Corp., New York 17, N. Y.

ceramics available, electronic, electrical and mechanical engineers will find it of great use.

(57)

Frequency Shift Converter. H. O. Boehme, Inc., 915 Broadway, New York, N. Y. The type 5-C frequency shift converter accepts the output of two diversity receivers, combines the signals and converts them into polar or neutral-keyed direct current. A four-page folder.

(58)

Power Rheostats. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. Bulletin E-1 covers the characteristics and specifications of the type PRT (AN 3155) power rheostats. Temperature rise curves and dimensions are clearly pictured.

(59)

Regulated Power Supplies. Furst Electronics, 800 W. North Ave., Chicago 22, Ill. New catalog sheets describe the models 310-A and 310-B electronically regulated power supplies. The type 310-A also provides a source of variable a-c.

(60)

Radar Brochure. Radiomarine Corp. of America, 75 Varick St., New York 13, N. Y. A six-page, two-color booklet has been issued to give information on the CR-101 navigation radar equipment that operates on the 3.2 centimeter band.

(61)

Magnetic Recorder. Magnecord, Inc., 304 West 63rd St., Chicago 21, Ill. Specifications and a complete resume of the features of the type SD-1 magnetic wire recorder are given in a four-page brochure.

(62)

Plastics Molding Service. G. Felsenthal and Sons, 4100 W. Grand Ave., Chicago 51, Ill. A multicolor 24-page book arranged as a file folder shows in detail the work done by the company in making plastic computers, industrial parts,

NOW... A NEW GRAPHITE FOR ELECTRONIC TUBES

HERE is a new grade of graphite that makes possible the design of greatly improved and more economical power tubes.

This graphite, developed as a result of war-time needs, is *stronger than ever before*. It has *finer grain structure*. And it is the *purest graphite* ever produced for this purpose.

Sylvania Electric Products, Inc., is taking advantage of this "National" graphite in new tubes soon to be announced.

This new "National" graphite offers you many advantages. It has no melting point and does

not distort at highest temperatures. It has high *thermal emissivity*, thus permitting heavy overloads of the anode and providing a welcome reserve of plate dissipation. Also it has unmatched thermal conductivity.

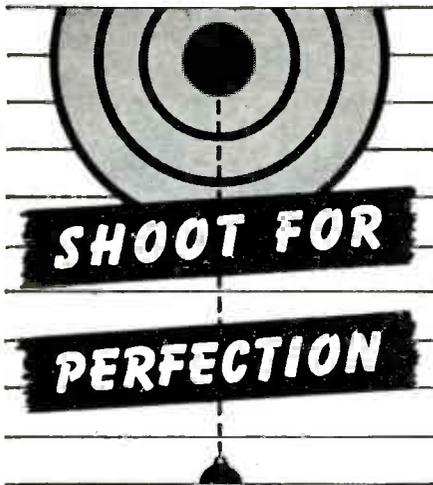
Write for complete details. Address National Carbon Company, Inc., Department E.

The word "National" is a registered trade-mark of
NATIONAL CARBON COMPANY, INC.
30 East 42nd Street, New York 17, N. Y.
Unit of Union Carbide and Carbon Corporation



Division Sales Offices: Atlanta, Chicago, Dallas, Kansas City,
New York, Pittsburgh, San Francisco

“There is a design trend toward the use of graphite for some tube applications where the greatest economy is desirable and at the same time allowing greater capability of tubes both mechanically and electrically.”... H. W. Parker, of Sylvania Electric Products, Inc., in *Radio News*, October, 1946.



In amateur radio today perfection is an absolute necessity. The old days of hit-or-miss operation are gone forever. A good example of the need for perfection is the ever-present menace of the PINK TICKET. Today with frequency multipliers in practically all transmitters, it is easy to hit the wrong Harmonic. The positive way to tell which band you are on, is by using the BUD WM-78 wavemeter.

The BUD WM-78 covers all amateur bands from 160 to 5 meters . . . accomplishing this by bandswitching. Due to its sensitivity the BUD WM-78 can also be used as a neutralizing indicator.



\$8.25

your cost at your radio parts dealer

**LET BUD SUPPLY
ALL YOUR NEEDS**

with the latest types of radio equipment, including variable condensers, coils, chokes, dials, switches and a complete line of sheet-metalware.



NEW PRODUCTS

(continued)

nameplates, scales and crystals. Tables showing characteristics of some plastics, decimal equivalents and a temperature conversion table are included.

(63)

Flexible Shaft Index. S. S. White Dental Mfg. Co., 10 E. 40th St., New York 16, N. Y. An index has been prepared and is available for those owning a flexible-shaft hand-book.

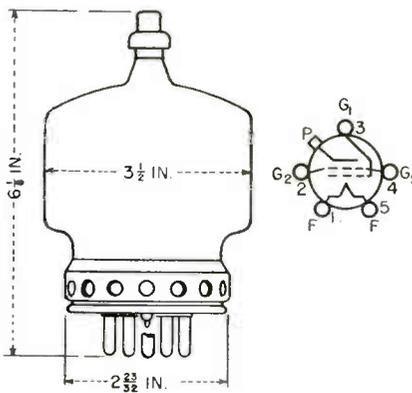
(64)

Wire Stripper. The Williams Products Co., 515 Main St., Middletown, Conn. A machine that cuts, strips and slits covered wire at high speed can be adjusted to any wire up to 1/2 inch diameter. It has been designed for production use. Further information is available from the manufacturer.

Tube Registry

Tube Types Registered by RMA (Starting Oct. 1946)

Type 5D22



$E_f = 5.0$ v
 $I_f = 14.5$ amp
 $E_b = 1,000$ v (max)
 $I_b = 350$ ma
 $\phi_m = 4,000$ μ mhos

$W_p = 250$ watts
 $C_{in} = 12.7$ μ mf
 $C_{out} = 4.5$ μ mf
 $\mu C_p = 0.06$ μ mf

Tetrode power amplifier/oscillator, filament type.

Type 6BL6

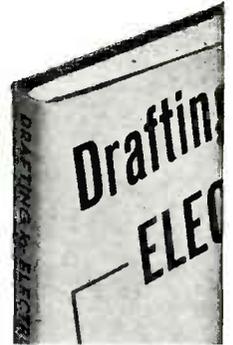
Velocity modulation reflex oscillator, heater type, pee-wee 4-pin base, metal glass envelope, maximum

This new guide brings you the

special drafting know-how

you need to succeed in ELECTRONICS

YOU can speed up your advancement considerably in electronics work with a better knowledge of diagrammatic drawing as it applies to the recent technical developments in this field. To assist you in this achievement here is a practical and up-to-the-minute drafting guidebook, written particularly for all in radio, television, industrial electronics, and communications engineering. It brings you the information you need for a clear understanding of principles and procedures which are fundamental to today's best practices in electronics drafting.



Just Out

Drafting for ELECTRONICS

By

L. F. B. Carini, Formerly United States Coast Guard Reserve, Communications Engineering Division, Coast Guard Headquarters, Washington. 211 pages, 6 x 9, 186 illustrations, \$2.50.

THIS practical guide and reference manual clearly explains and illustrates the principles of schematic development as applied to diagrammatic drafting for the electronics field. From the practical viewpoint of the draftsman it reviews drafting fundamentals and fully covers the planning, development and reproduction of specialized drawings. Based on approved standards of the American Standards Association and the Institute of Radio Engineers, the book is in accord with the most widely accepted practices. Special attention is devoted to the correct technique as applied in the projection of diagrammatic drawing and full consideration is given to progress in technical developments in electronics.

See these 14 chapters for practical help:

- | | |
|---|--------------------------------|
| 1. Schematic Drafting | 8. Schematic Patent Drawing |
| 2. Fundamentals of Instrumental Drawing | 9. Industrial Electronics |
| 3. Essential of Lettering | 10. Technical Outline Drawings |
| 4. Abbreviations and Letter Symbols | 11. Graphic Integration |
| 5. Symmetry and Balance | 12. Checking of Drawings |
| 6. Schematic Definition | 13. Preparing Drawing Prints |
| 7. Schematic Circuit Projection | 14. Drawings for Reproduction |

Examine this book 10 days free-mail coupon

McGraw-Hill Book Co., 330 W. 42nd St., N.Y.C. 18. Send me Carini—Drafting for Electronics, for 10 days' examination on approval. In 10 days I will send \$2.50, plus few cents postage, or return book postpaid. (Postage paid on cash orders.)

Name

Address

City and State

Company

Position

For Canadian price write Embassy Book Co., 12 Richmond Street E., Toronto 1.

More and More Users of Extruded Vinyl Tubing are STANDARDIZING on NATVAR #400

Here's Why:-

Most users, to make sure that they get the right tubing for a particular job, run tests on the various extruded tubings available to find out whether they are suitable. For some applications, heat resistance is of primary importance. For others, it may be tensile strength, high dielectric, oil resistance, low moisture absorption, or a combination.

Before Natvar #400 was available, it was often the practice to stock several different types of special purpose tubings. This is no longer necessary. Test reports show that Natvar #400 is able to hold its own on practically every count for which a special purpose tubing might be considered.

One of the largest electrical manufacturers reports:

This tubing has been used in radio transformer construction here at ----- for some time, and it has been found satisfactory ... A comparison of our results with those of the supplier is very favorable ... One peculiar characteristic of this material is the manner in which it behaves after immersion in hot transformer oil. A sample before immersion gave a tensile strength of 4140 psi, and after immersion a tensile strength of 6890 psi. ... The sag test which was conducted in this investigation was more severe than is usually conducted on materials of this type. Nevertheless, this tubing performed remarkably well under these conditions ... A copy of this report is being sent to the various division engineers for review.

Another large electrical manufacturer reports:

MATERIAL TESTED: #400 Natvar Tubing, Flexible Extruded Vinyl.

Effect of Heat: Like any other plastic, this material softens upon heating, but at 125° C. it does not flow or sag. It remains unaltered, except for darkening, after a week in the drying oven.

Effect of Oil: In oil at 100° C., the tubing does not swell, soften, dissolve or harden. It remains unchanged except for a change in color.

Effect of Compound Treatment: The tubing flattened out due to heat, but was still pliable when removed. It is satisfactory for this application.

Dielectric Strength: Dielectric Puncture Tests, using a metal rod as inner electrode, and copper ribbon as outer electrode, gave the following results (tested in oil at room temperature):

	Short Time	Step-by-Step
As received	19,000 v=725 v/mil	17,600 v=691 v/mil
Dried 2 days @ 125°C	19,000 v=744 v/mil	16,800 v=667 v/mil
Dried 3 days @ 125°C plus 24 d. in oil : 100°C	26,000 v=1023 v/mil	19,400 v=723 v/mil

Underwriters' Laboratories limitations permit wide use. Natvar #400 is now available for immediate shipment in most sizes, either from your wholesaler's stock or from our own. Write, wire or phone us your requirements.

Excerpts from the E.T.L. report covering tests made on Natvar No. 400 in accordance with A.S.T.M. Standards.

DIELECTRIC STRENGTH—A.S.T.M. D350-43
Average volts per mil: At 28°C—1090
At 85°C—700
Wall thickness: .0235"

DIELECTRIC CONSTANT AND POWER FACTOR
Dielectric constant at 29°C and relative humidity 60%
At 60 cycles: 8.15
At 1 megacycle: 4.35
Power Factor: At 60 cycles: .056
At 1 megacycle: .064

ARC RESISTANCE—A.S.T.M. D495-42
Average—135 seconds

OIL RESISTANCE—A.S.T.M. D295-43T
"Turbol 10" at 105°C was used. After 15 minutes immersion there was no apparent change in the tubing. After 24 and 48 hours there was no sign of change in the tubing. Three separate tests were made.

HEAT ENDURANCE—A.S.T.M. D350-43
After 7 days at 125°C the tubing did not crack or otherwise fail when bent 180° around a 5/16" mandrel.

TENSILE STRENGTH AND ELONGATION
At 200% elongation: Average 1980 lbs. per sq. in.
At Maximum: Average 2870 lbs. per sq. in.
Total elongation: 350%

LOW TEMPERATURE FLEXIBILITY
After 3 hrs. at minus 30°F specimens were bent around a mandrel 5/16" in diameter. There was no sign of cracking or other failure.

FLAME RESISTANCE—D350-43
Burned about 1/4 in. in 10 to 15 seconds and then went out. Three tests were made.

EFFECT OF CHEMICALS
Effect of 7 days immersion in solvents at room temperature; average of 3 tests in each solvent:

Solvent	Change in weight Per cent of weight of speci- men as received	Change in dimensions Per cent of specimen as received		
		Length	Outside diameter	Thickness
5 per cent sulfuric acid	+ 0.41	none	none	none
1 per cent potassium hydroxide	+ 0.83	none	none	none
Petroleum	+ 6.62	+2.6	none	none
Ethyl Alcohol	+ 1.66	none	none	none
Benzol	+21.9	+6.6	+10.9	-24.0

WATER ABSORPTION
Average of 5 tests

Water absorption, per cent by weight of dry specimen	0.63
Soluble matter, per cent by weight of dry specimen	0.01
Total water absorption, per cent by weight of dry specimen	0.64
Change in dimensions:	
in length	none
in outside diameter	none
in thickness	none

THE NATIONAL VARNISHED PRODUCTS Corporation

TELEPHONE
RAHWAY 7-2171

CABLE ADDRESS
NATVAR: RAHWAY, N. J.

201 RANDOLPH AVENUE * WOODBRIDGE NEW JERSEY



PICK-UP

...AS QUICK AS A WINK... WITH...

Smooth Power

Not a word or a note need be missed when your record players, record-changers or recorders are equipped with *Smooth Power* motors. That's because these units are built for split-second pick-up to full constant speed.

Their quietness and freedom from vibration give smooth performance that will delight your customers. From our complete line of *Smooth Power* phonomotors, recorders and combination record-changer recorders, you can select exactly the right units to match your own fine products.



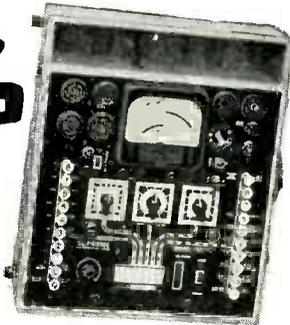
Model GI-RM4 Smooth Power Recording Motor

THE GENERAL INDUSTRIES CO.

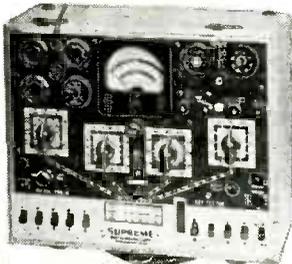
DEPT. ME • ELYRIA • OHIO

HAVE YOU RECEIVED YOUR SUPREME?

While our production has not yet caught up with the heavy demand for SUPREME Testers, it is steadily increasing.



If you have not received your SUPREME Tube Tester, Set Tester, Oscillator, Oscilloscope, Multi-Meter, check with your Authorized SUPREME Distributor.



Big new catalogue now ready. For complete description of all SUPREME Testers, and Panel Meters, write today.



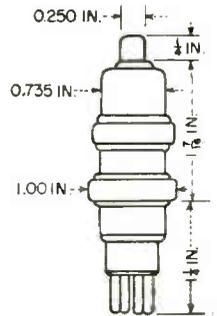
EXPORT DEPT. THE AMERICAN STEEL EXPORT CO., INC.
374 MADISON AVE., NEW YORK 17, N. Y.

SUPREME INSTRUMENTS CORP., GREENWOOD, MISS., U.S.A.

NEW PRODUCTS

(continued)

$E_A = 6.3 \text{ v}$
 $I_A = 0.65 \text{ amp}$
 $E_{c1} = 0 \text{ v}$
 $E_{c2} = 325 \text{ v}$
 $E_{c3} = 325 \text{ v}$
 $I_b = 25 \text{ ma}$
repeller = -40 v

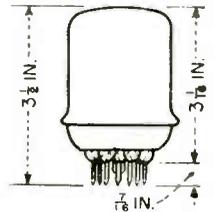


operating frequency (3 $\frac{3}{4}$ mode)
2,200 mc.

Type 3C33

Double triode power amplifier/oscil-

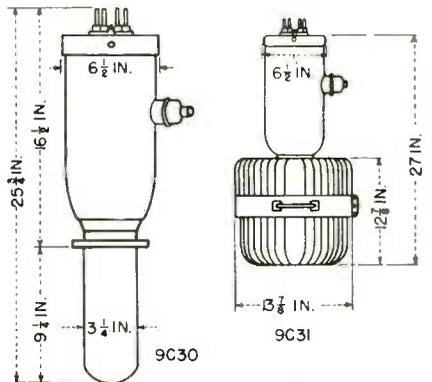
$E_f = 12.6 \text{ v}$
 $I_f = 1.125 \text{ amp}$
 $\mu = 11$
 $E_b = 1,000 \text{ v (max)}$
 $I_b = 120 \text{ ma}$
 $W_p = 15 \text{ watts}$
 $C_{in} = 8.5 \mu\text{f}$
 $C_{out} = 4.0 \mu\text{f}$
 $gC_p = 5.2 \mu\text{f}$



lator, heater type, integral glass envelope-base.

Types 9C30 and 9C31

Triode power amplifier/oscillator,



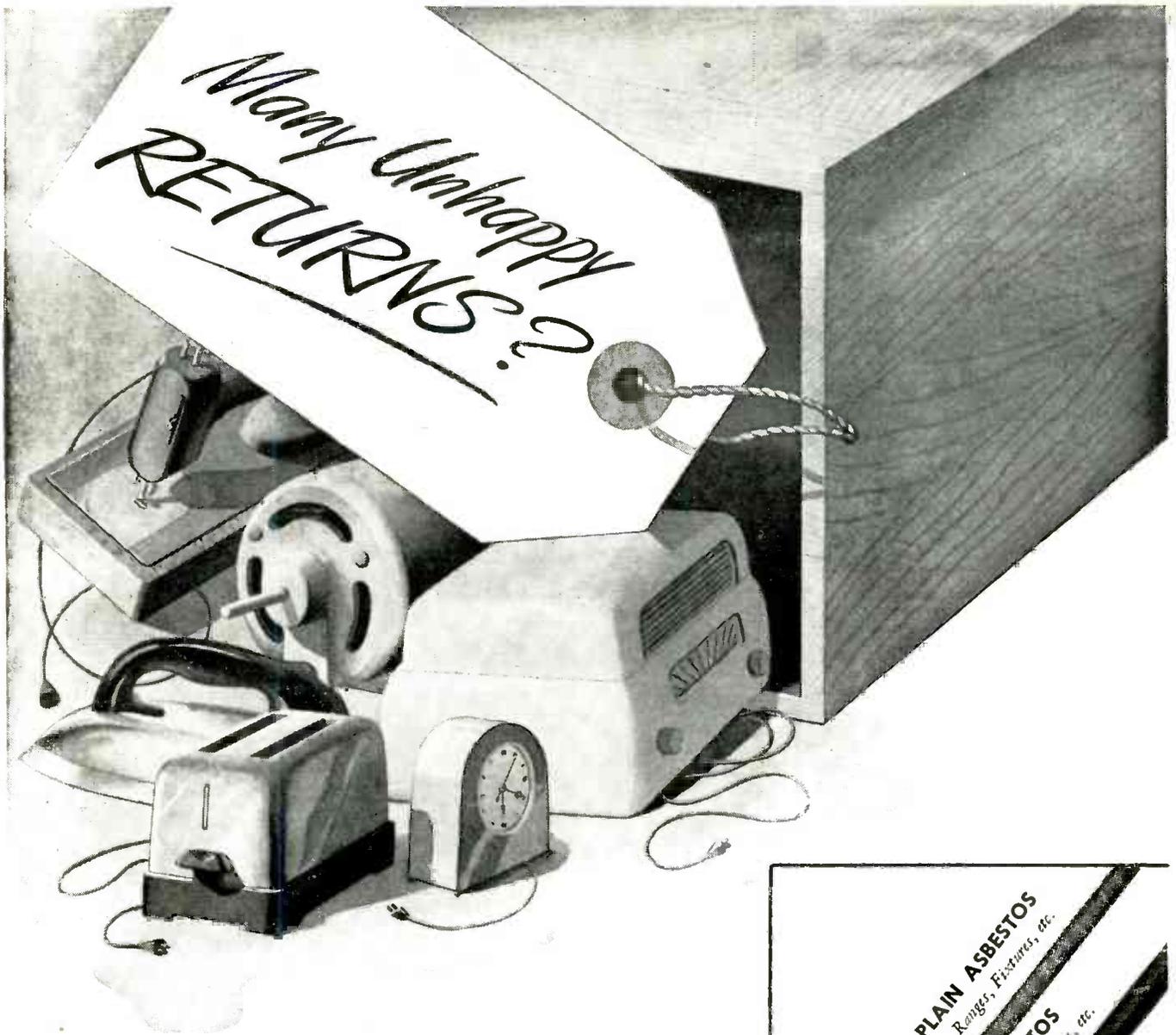
$E_f = 15 \text{ v}$
 $I_f = 135 \text{ amp}$
 $\mu = 42$
 $g_m = 14,000 \mu\text{hos}$
 $E_b = 15,000 \text{ v (max)}$
 $I_b = 8 \text{ amp}$
 $E_c = -3,000 \text{ v}$
 $I_c = 1 \text{ amp}$

$W_p = 40,000 \text{ w}$
(9C30), 20,000 w (9C31)
 $C_{in} = 46 \mu\text{f}$
 $C_{out} = 5.6 \mu\text{f}$
 $gC_p = 9C30 = 35 \mu\text{f}$
9C31 = 40 μf

filament type (9C30 water cooled, 9C31 forced air).

Type 7C27

Triode power-amplifier/oscillator, forced air cooled, thoriated tungsten filament type, metal glass en-



**Use ROCKBESTOS Wires, Cables and Cords
to Keep Your Products in Active Service**

Makers of all sorts of products ranging from airplanes to electronic devices, who spend a lot of time and money trying to make them failure-proof, can appreciably reduce electrical failures by turning their wiring problems over to Rockbestos.

Build customer-satisfaction into your products with wires, cables and cords designed to give them wide safety margins for long-range operation under the most severe conditions. Reduce profit-eating returns for repairs or replacement and expensive service calls with Rockbestos constructions that have been time-tested under heat and moisture, oil, grease or corrosive fumes in everything from airborne radio equipment to hot metal cranes.

For information, samples, recommendations or engineering assistance write to the nearest district office or:

ROCKBESTOS PRODUCTS CORPORATION
444 Nicoll St., New Haven 4, Conn.

ROCKBESTOS The Wire with Permanent Insulation

NEW YORK BUFFALO CLEVELAND DETROIT CHICAGO PITTSBURGH ST. LOUIS LOS ANGELES SAN FRANCISCO SEATTLE

ELECTRONICS — February, 1947

ROCKBESTOS PLAIN ASBESTOS
For Appliances, Radios, Ranges, Fixtures, etc.

ROCKBESTOS ALL-ASBESTOS
For Rheostats, Furnaces, Power Leads, Dryers, etc.

ROCKBESTOS A.V.C.
For Motor Leads, Power Circuits, Switchboards, etc.

From these three basic Rockbestos constructions 125 different permanently insulated wires, cables and cords have been developed to give better service under severe or unusual operating conditions.

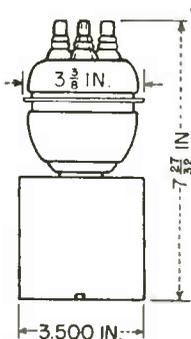
PORTLAND, ORE.



NEW PRODUCTS

(continued)

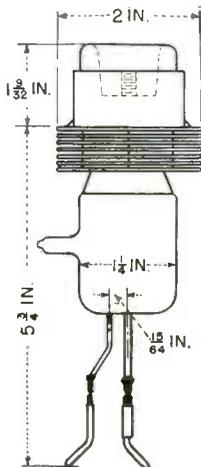
- $E_f = 16.0 \text{ v}$
- $I_f = 28.5 \text{ amp}$
- $\mu = 27$
- $E_b = 4,000 \text{ v}$
- $I_b = 2.0 \text{ amp}$
- $E_{c1} = -1,000 \text{ v}$
- $I_c = 0.2 \text{ amp}$
- $W_p = 3,000 \text{ w}$
- $C_{in} = 14 \mu\text{f}$
- $C_{out} = 0.4 \mu\text{f}$
- $\rho C_p = 14 \mu\text{f}$



velope, maximum ratings up to 110 mc.

Type 4C27

Triode power amplifier, forced air cooled, heater type, metal glass envelope. Typical operation at 215

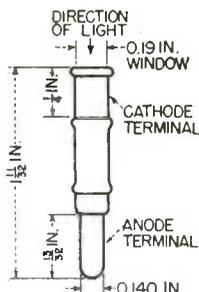


- $E_f = 6 \text{ v}$
- $I_f = 6.5 \text{ amp}$
- $\mu = 23$
- $E_b = 8,000 \text{ v (max)}$
- $E_{c1} = 1,000 \text{ v}$
- $W_p = 150 \text{ watts}$
- $C_{in} = 11 \mu\text{f}$
- $C_{out} = 2.25 \mu\text{f}$
- $\rho C_p = 8 \mu\text{f}$

mc using 2 μsec pulses at 400 pps gives peak power output of 50,000 watts.

Type 1P42

Phototube, high-vacuum, spectral response S-4, wavelength of maximum response 4,200 Angstrom, capacitance 1.2 μf . Sensitivity at



- $E_b = 150 \text{ v (max)}$
- $I_b = 0.4 \mu\text{amp (average)}$

maximum response, 0.020 μamp per μwatt ; luminous sensitivity, 25 μamp per lumen. Temperature 75 C (maximum).

WHAT TYPE OF Jewel Assembly DO YOU NEED?

No matter what type or size of Jewel Light Assembly you need, chances are we can produce it for you quickly, more satisfactorily, and at lower cost! Here, every facility is available for high speed quantity production . . . speedy, efficient, economical service. Drake patented features add greatly to the value and dependability of our products.

You'll like the friendly, intelligent cooperation of our engineers. Let them help you with signals or illumination problems. Suggestions, sketches, cost estimates or asking for our newest catalog incur no obligation.



DRAKE MANUFACTURING CO.
1713 W. HUBBARD ST., CHICAGO 22, ILL.

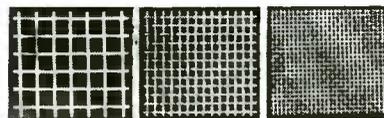
Fine Resistance

WIRE

- ALLOY "A"**
Nickel-Chromium alloy, resists oxidation at elevated temperatures; up to 2100° F. Also used for fixed non-magnetic resistors. Resists chemical corrosion by many media. Specific resistance 650 Ohms/C.M.F.
- ALLOY "C"**
Nominally 60% Nickel, 15% Chromium, balance iron. High resistance to oxidation and corrosion. Widely used for resistors for radio, electronics, industrial equipment and domestic appliances. Operating temperatures up to 1700° F. Specific resistance 675 Ohms/C.M.F.
- ALLOY "45"**
Copper-Nickel alloy with constant resistance over wide range of temperatures. Specific resistance 294 Ohms/C.M.F.; temperature coefficient 0.00002 Ohms per deg. F.; 32-212 deg. Used in winding of precision resistors, rheostats, and electrical measuring devices.
- KANTHAL**
Exclusive manufacturers and distributors of KANTHAL wire, ribbon, and strip. An alloy containing Iron, Chromium, Aluminum and Cobalt . . . for operating temperatures up to 2462° F. Three grades, A-1, AS, DS; resistivity 872, 837, 812 Ohms/C.M.F., respectively, at 68° F.

As fine as .0006" for alloys "A", "C", "45."

and Fine Wire Screen



IN TUNGSTEN and OTHER METALS AND SPECIAL ALLOYS; ALL MESHES IN STANDARD WIDTHS, OR WIRE-MESH PARTS FABRICATED TO ORDER.

Write for Catalogs.

THE C. O. JELLIFF
MFG. CORP.
123 PEQUOT ROAD,
SOUTHPORT, CONNECTICUT
WIRE CLOTH
DIPPING BASKETS
LEKTROMESH



At Your Service

to help you with your

SHEET METAL FABRICATION REQUIREMENTS

SHEET METAL PRODUCTS—*such as:*
INSTRUMENT PANELS, RADIO COMMUNICATION CASES and ENCLOSURES, OSCILLATOR BOXES, CHASSIS and CABINET ASSEMBLIES, RACKS and SPARE PARTS BOXES, WATERPROOF CABINETS and BOXES, METAL STAMPINGS, FORMING and WELDING of FERROUS and NON-FERROUS METALS.

We specialize in RADAR and RADIO COMMUNICATION METAL PRODUCTS. "Whistler and Wiedermann Setups" used for economic and speedy production.

We can assure you of excellent workmanship and prompt deliveries. Send us your blueprints and specifications. We shall quote you immediately.

Our additional facilities enable us to solicit your inquiries regarding SCREW MACHINE ITEMS and GENERAL MACHINE SHOP PRODUCTS.

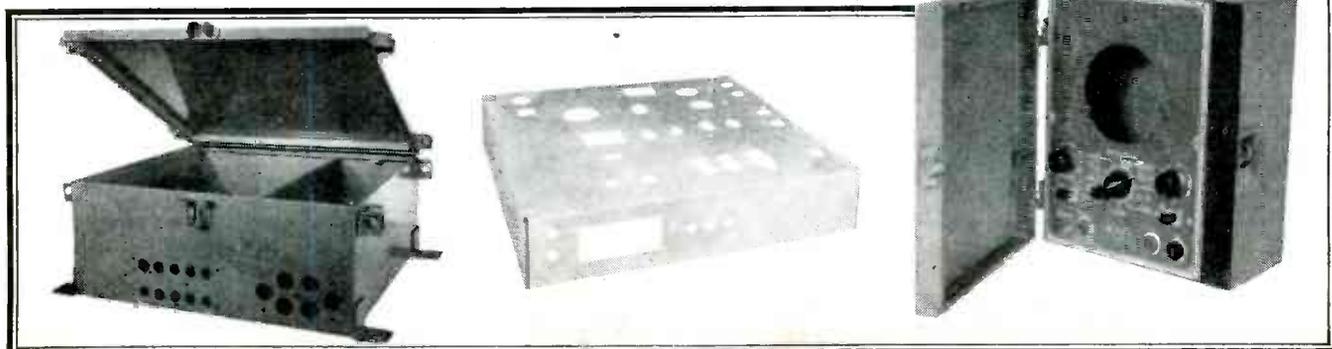
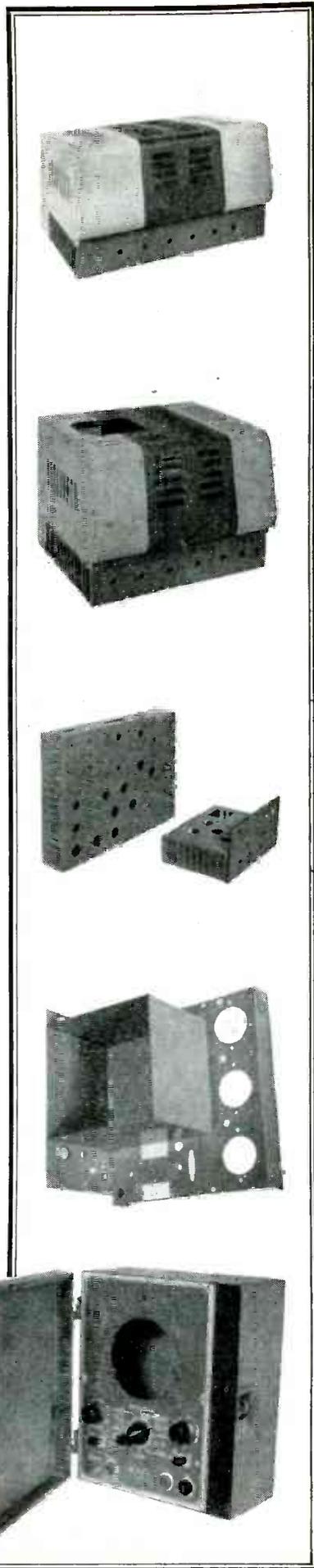
S. WALTER CO.

PRECISION SHEET METAL PRODUCTS

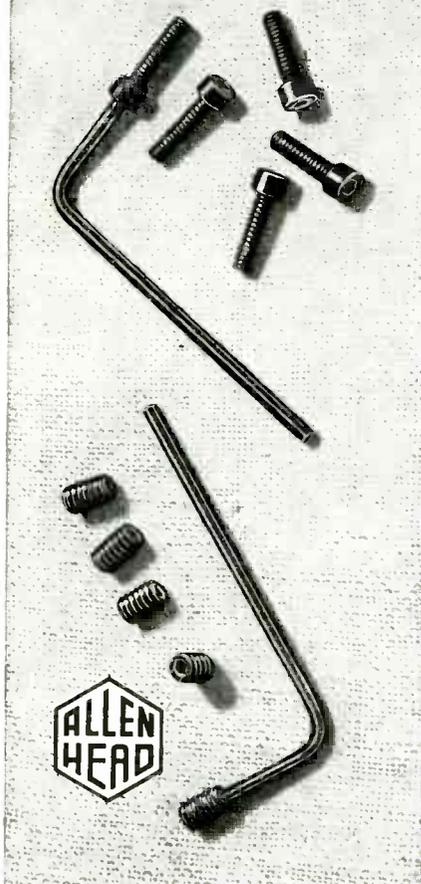
144-146 CENTRE STREET

BROOKLYN 31, N. Y.

Telephone, MAin 4-7395



ALLEN



Small screws for electronic devices

Tiny hex-socket Cap Screws and Set Screws steeled to stand amazingly tight set-ups. Cap Screws in the numbered sizes from 1 to 10 inclusive; Set Screws from No. 2 to 10.

The Cap Screws are Allen "pressur-formd" for maximum strength of head and socket. Threads also formed by pressure-process to a high Class 3 fit.

The Set Screws have die-cut threads accurate to a high Class 3 fit, with perfectly-formed hex sockets. The screws can be held on either end of the handy hex keys and turned into the tapped hole without fingering. Allen Hand Drivers are available to facilitate fast assembling.

In radio and television sets, radio telephones, radar equipment, electronic controls, these screws **HOLD** fine adjustments and intricate assemblies.

Order of your local Industrial Distributor

**THE ALLEN MFG. CO.,
HARTFORD 1, CONN., U. S. A.**

NEWS OF THE INDUSTRY (continued from p 150)

and KOPY-FM elected as president; Everett L. Dillard is vice-president, Frank A. Gunther is secretary, Arthur Freed is treasurer, and J. N. Bailey is executive director. The temporary address of FMA is 810 International Bldg., Washington, 4, D. C. The new group was organized in Chicago during the NAB convention after a majority of the members of its predecessor, FMBI, voted to dissolve that organization.

Latin American Television

IN MEXICO, Cuba, Puerto Rico, Brazil, and other South American countries hundreds of thousands of people are seeing themselves on television screens for the first time as a result of two television shows. The Havana show used Du Mont equipment and was sponsored by



Waveguide and reflector of RCA microwave radio relay transmitter, set up near ring of Mexico City's 60,000-seat bullring for beaming first televised bullfights to a hotel six miles away

Compania Importadora de Lubricantes, S. A., which is installing a complete Du Mont-equipped television station in that city. The other show, staged by RCA, appeared first at Mexico City and is scheduled to make the rounds of Latin American cities. Both were black-and-white television.

Production Figures

TELEVISION set manufacturers produced 1,844 sets in November to double their figure of 827 sets for October and completely outshadow September production of 19 sets, according to RMA reports. A previous RMA report of 3,242 tele-

BRADLEY

PHOTO ELECTRIC CELLS



Unmounted Cells

The shapes of Luxtron photocells vary from circles to squares, with every in-between shape desired. Their sizes range from very small to the largest required.

In addition to the unmounted cells shown here, Bradley also offers cells in a variety of standard mountings, including plug-in and pigtail types.

For direct conversion of light into electric energy, specify Bradley's photocells. They are rugged, lightweight and true-to-rating.

Illustrated literature, available on request, shows more models of Bradley photocells, plus a line of copper oxide and selenium rectifiers. Write for "The Bradley Line."

BRADLEY

LABORATORIES, INC.

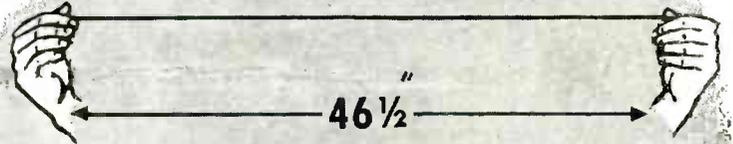
82 Meadow St. New Haven 10, Conn.

This new type potentiometer-rheostat...

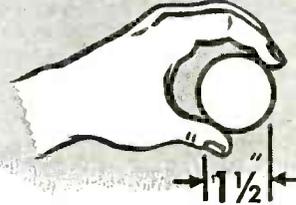


Cutaway
View of
Helipot

puts this much slide wire



into this much panel space



It's the BECKMAN

Helipot

(Trade mark for the HELical POTentiometer)

No matter what type quality electronic instrument you may be manufacturing or preparing to manufacture, be sure to investigate the **multiple advantages** you can build into your product by using Beckman Helipots for resistance control. War-perfected on such ultra-precision electronic equipment as radar, flight control instruments, depth sounding devices, etc., the Beckman Helipot makes possible entirely new standards of accuracy, convenience and compactness in resistance controls.

Unlike conventional potentiometers which consist of a single turn of slide wire, the Helipot has many turns of slide wire helically coiled into a compact case that occupies no more panel space than a conventional single-turn potentiometer. The slider contact is rotated by a knob in the usual manner and a simple device guides the slider contact as the knob is rotated so that the entire helical length of resistance winding can be contacted.

Its advantages are many. Heretofore circuits requiring precise control coupled with wide range have generally required at least two potentiometer units—one for coarse adjustment and the other for fine adjustment. This means two knobs to operate... two controls to waste panel space... two units to complicate installation and wiring. In the

Beckman Helipot both wide range and fine adjustment are combined in the one unit. There is only one knob to operate... one unit to take up panel space... one control to install and wire. You not only save

valuable panel space and assembly time, but you greatly increase the convenience, utility, simplicity and operating efficiency of your electronic instruments. Note these outstanding Helipot features...

High Linearity—As a result of fulfilling wartime requirements for ultra-precision circuit controls, Helipots are mass-produced with linearity tolerances of one tenth of one per cent—and even less!

Precise Settings—Because of the many times longer slide wire, settings can be made with an accuracy impossible with single turn units.

Wide Range—By coiling a long potentiometer slide wire into a helix, the Helipot provides many times the range possible with a single turn unit of comparable diameter and panel space.

Low Torque—Of special interest for power-driven applications—the Helipot has unusually low torque characteristics. The 1 1/2" Helipot—for example—has a torque of only one inch/ounce.

Helipots are Available in 3 Standard Sizes

TYPE A—5 watts, incorporating 10 helical turns and a slide wire length of 46 1/2", coil diameter 1 1/2", is available with resistance values from 25 ohms to 30,000 ohms.

TYPE B—10 watts, with 15 helical turns and 140" slide wire, coil diameter 3", is available with resistance values from 100 ohms to 100,000 ohms.

TYPE C—2 watts, with 3 helical turns and 13 1/2" slide wire, coil diameter 1 1/2", available in resistances from 5 ohms to 10,000 ohms.

The Type B is also available in special sizes of 25 and 40 helical turns, with resistances ranging from 500 ohms to 300,000 ohms, and containing more than 100,000 change of resistance steps.

Data in heading are for the standard Type A unit.

SEND US YOUR POTENTIOMETER PROBLEM and our engineering staff will be glad to work with you in applying Helipot advantages to increase the efficiency, accuracy and convenience of your quality electronic instruments.

THE HELIPOT CORPORATION, 1011 MISSION STREET, SOUTH PASADENA 2, CALIFORNIA

IN-RES-CO RESISTORS

**Close tolerance units for
precision performance**

IN-RES-CO resistors are engineered to meet all important electronic application needs. They are wire wound for permanent, exact resistance value and both inductive and non-inductive types are standard. Standard tolerances are 1 and 2%—closer tolerances on special order. Rigid quality control assures a uniform standard of excellence and modern manufacturing facilities result in low unit cost and prompt delivery. Manufacturers of electrical and electronic instruments and equipment should investigate the advantages of designating IN-RES-CO as their exclusive wire wound resistor source.

.....
 TYPES RN AND SN Tropic-proof resistors—
 RN: 3/4" long x 5/8" dia., Max. Res. 1/2 Megohm, 1/2 watt; SN: 1-3/16" long x 5/8" dia., Max. Res. 1 Megohm, 1 watt



**INSTRUMENT
RESISTORS CO.**

1036 COMMERCE AVE. UNION, N. J.

vision sets for September was in error, according to RMA, because one manufacturer had listed 3,223 phonographs in the television column by mistake.

Total for all sets by RMA companies in November was 1,496,482, of which a new high of 27,330 had f-m bands. The decrease over October is due to fewer working days.

New Synchro-Cyclotron

A NEW electron accelerator with magnet poles 110 inches in diameter is in the planning stage at Carnegie Institute of Technology, Pittsburgh, as a result of a grant of \$300,000 for this purpose by The Buhl Foundation. The machine will be exceeded in size among existing machines only by the giant 184-inch cyclotron at the Radiation Laboratory of the University of California. The grant is conditioned upon at least \$250,000 being subscribed by others for the same purpose.

1947 Broadcast Engineering Conference is Cancelled

PLANS FOR holding the 1947 Broadcast Engineering Conference, sponsored annually by the Departments of Electrical Engineering at the University of Illinois and Ohio State University, have been cancelled due to crowded conditions and lack of sufficient personnel at both universities. The 1947 conference originally was scheduled to be held at the University of Illinois. Some 400 persons attended the sixth annual conference last March 18-23 at Ohio State.

Spectroscopic Research

THE SPECTROSCOPY Laboratory of MIT, devoted during the war almost entirely to work for the Manhattan District, will now operate as an independent entity under the office of the Dean of Science to make its facilities more directly available to research workers in all principal fields of spectroscopy. Specific research programs are

FIBRE FABRICATION
TECHNICAL DATA FREE

WRITE FOR
BULLETIN 120

Baer
 PHENOL AND VULCANIZED
FIBRE
 FABRICATIONS
 FOR
 INDUSTRY

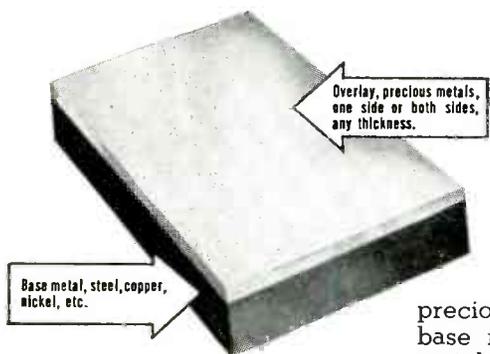
*Design short-cuts—cutting
engineering and assembling time*

Time saved in preliminary planning is directly proportionate to efficiencies effected in the blueprint stage. By designing-in BAER fibre fabrications—whether your product is instrument, machine, appliance or equipment—the utmost in production stream-lining is assured. Further, the inherent advantages of the material—accurately machined, stamped, punched, drilled, milled or sawed by BAER craftsmen—adds a full measure of dependability under varying service conditions.

N. S. BAER COMPANY, 9-11 MONTGOMERY ST., HILLSIDE, N. J.



**"Speaking of Cutting Costs,
GENERAL PLATE LAMINATED METALS
Save Money
and Improve Performance, too!"**



Overlay, precious metals,
one side or both sides,
any thickness.

Base metal, steel, copper,
nickel, etc.

High silver costs are raising the fabrication costs of many products. Yet you can *beat these* high silver costs by using General Plate Laminated Metals.

By permanently bonding a thin layer of silver or other precious metal to thicker inexpensive base metal, you get solid precious metal performance at a fraction of the cost of solid precious metal. This means your costs come down while performance stays up top. General Plate Laminated Metals give you these additional advantages . . . better electrical conductivity, high corrosion resistance, better spring properties, easier fabrication, more strength and longer wearing properties.

Investigate versatile General Plate Laminated Metals. Write for information and engineering assistance.

SHEET . . . Available with precious metal on one side, both sides or wholly covered, inlaid and edge laid in practically any combination of precious to base metal. Base to base metal combinations also available.

TUBE . . . Solid precious metal; laminated precious to base metal, lined, or covered one side or both in a wide range of diameters and odd shapes.

WIRE . . . Shaped, solder filled, channel, solder flushed, squares, flats, ovals and irregular shaped.

GENERAL PLATE DIVISION

of Metals & Controls Corporation

ATTLEBORO, MASSACHUSETTS

50 Church Street, New York, N. Y. • 205 W. Wacker Drive, Chicago, Ill. • 2635 Page Drive, Altadena, California • Grant Bldg., Pittsburgh, Pa.

DESIGNED FOR DISCRIMINATING MANUFACTURERS



Leakproof

ENAMELED
MAGNET
WIRE

A product, resulting from many years of research in the field of fine wire manufacture, that meets the most rigid requirements of radio and ignition coils.

A new coating method gives a smooth, permanently-adherent enameling, and mercury-process tests guarantee perfect uniformity. Great flexibility and tensile strength assure perfect laying, even at high winding speeds. If you want reduction in coil dimensions without sacrificing electrical values, or seek a uniform, leakproof wire that will deliver extra years of service, this Hudson Wire product is the answer.

QUALITY

UNIFORMITY

SERVICE

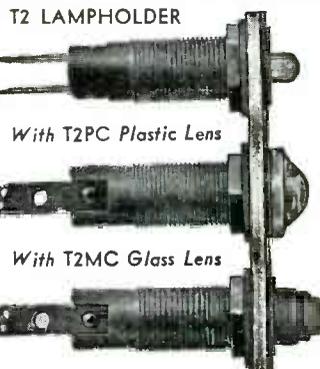
Also manufacturers of high grade cotton and silk covered wires, cotton and silk coverings over enamel coated wires, and all constructions of Litz wires. A variety of coverings made to customers' specifications, or to requirements determined by our engineers. Complete design and engineering facilities are at your disposal; details and quotations on request.

Winsted
HUDSON WIRE CO.
Division

WINSTED • CONNECTICUT

KIRKLAND Pioneer
INDICATING LAMPS

TYPE T2 UNITS



T2 LAMPHOLDER
With T2PC Plastic Lens

With T2MC Glass Lens

T2 lampholder, molded of bakelite, holding lip, dia. 11/16". Tip of lamp bulb protrudes sufficiently to be removed from front of panel without use of special tool.

Very low current consumption bulb (0.038 max. amp. on 24 volts). Series resistor of small size on 120-220-440 volts, etc.

T2PC Lens-cap, molded in plastic. T2MC Lens-cap, metal with glass lens.

WRITE TODAY FOR CATALOGUE

THE H. R. KIRKLAND COMPANY
8 King Street Morristown, N. J.

TOROIDAL COIL FILTERS

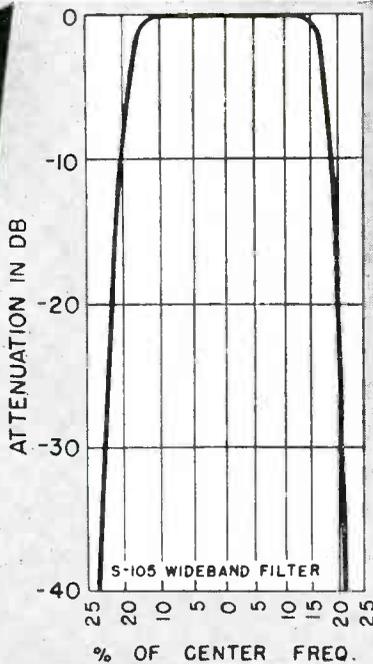
... are the answer to any network problem

- SHARP CUT-OFF
- LOW INSERTION LOSS
- HUM PROOF
- COMPACT
- HIGH STABILITY

Toroidal Coils

Inductance—1 MHY to 3 HYS
Frequency—300 cy. to 30,000 cy.
"Q"—55 at 1000 cy.; 150 at 3000 cy.

Ask to be put on mailing list for complete catalogue of coils and filters.



Actual measurements taken on Toroidal Coil Filter manufactured by Burnell & Co.

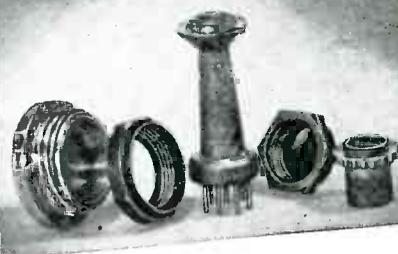
Burnell & Co.

Designers and Manufacturers of Electronic Products

10-12 VAN CORTLANDT AVE. EAST, BRONX 58, N. Y., SEdwick 3-1593

★ STAR

Specialists in Internal and External Perfect Threaded Die Cast Units



Intricate parts of 100% rust-proof Zinc alloy.

Accurate to specification Held to tolerances of .005.

Threads require no machining. Ideal for instrument, small machine and minute electronic parts.

- Producers of the Two Vital Aids to Manufacturers of Miniature Tube Radios.
- JE-10 STAR MINIATURE SOCKET WIRING PLUGS.
 - JE-13 STAR MINIATURE TUBE PIN STRAIGHTENERS.

Write for complete information.

STAR EXPANSION PRODUCTS CO.
(INCORPORATED)

147 Cedar St. New York 6, N. Y.

planned in fields of wavelength and intensity measurements, ultraviolet, visible, and infrared absorption spectrophotometry, and the Raman and Zeeman effects.

Three-Tube Sets for India

PRODUCTION is now under way in Bombay, India on a three-tube pretuned radio receiver that costs about \$45 to produce and is selling for the equivalent of \$28.50. Costs are expected to drop to \$19.50 as output goes up, however. Estimated demand is 1,000,000 sets even under present conditions.

Of the approximately 40 components employed, only tubes, loud-speaker, and volume control are imported. Tubes come from the United States and cost 35¢ each, as contrasted to a quotation of 72¢ by Philips of Eindhoven. The cabinet is solid teak.

Fixed-price merchandising is in effect, with a ten-percent gross margin for the distributor. If dealers prove cool to the proposition, the manufacturer, National Radio & Engineering Co., Ltd., plans to set up retail merchandising facilities. The cheapest imported set in India now costs about \$75 and does not always meet domestic requirements.

British Television

AFTER SEVEN YEARS of picture-free ether over Britain, the BBC has picked up television where it left off in 1939, using 405-line definition. BBC has promised manufacturers that there will be no technical improvements in the next three years that might make present receivers obsolete.

MEETINGS TO COME

JAN. 27-31; ELECTRICAL ENGINEERING EXPOSITION held concurrently with AIEE winter convention; 71st Regiment Armory, New York City.

FEB. 13-14; INSTITUTE OF NAVIGATION; Eastern Regional Meeting; Hotel Pennsylvania; technical pa-

*Just
Out!*

CONCORD

Bargain Catalog of RADIO Equipment

FOR
Immediate Shipment

Just off the press—48 exciting pages of radio parts, equipment, and supplies for dealers, servicemen, amateurs, maintenance, testing, building and experimenting—Thousands of items NOW IN STOCK and ready for IMMEDIATE SHIPMENT! Big feature sections of Radio Sets, Communication Receivers, Amplifiers, Ham Gear, Record Players and Portables, Record Changers and complete Sound Systems. Page after page of bargains and special values in top-quality standard-make radio and electronic parts.

Mail Coupon NOW for FREE COPY

Mail coupon below TODAY for your FREE COPY of this latest Concord Buying Guide and Bargain Catalog of Radio and Electronic needs you can order for SAME DAY SHIPMENT from complete stocks in Chicago and Atlanta.

CONCORD
RADIO CORPORATION
LAFAYETTE RADIO CORPORATION
CHICAGO 7, ILL. ATLANTA 3, GA.
901 W. Jackson Blvd. 265 Peachtree St.

CONCORD RADIO CORP., Dept. G-27
901 W. Jackson Blvd., Chicago 7, Ill.
Yes, rush FREE COPY of the new
Concord Bargain Catalog:

Name.....
Address.....
City..... State.....

for Delicate Soldering Tasks

VULCAN

Pygmy ELECTRIC SOLDERING TOOLS



Finds its way in where there is little clearance or cramped space.

Particularly useful for meters, electrical instruments, small radios and similar articles.



STANDARD 1/4 INCH
Also Available 3/16 Inch

VULCAN ELECTRIC COMPANY

DANVERS, 10, MASS.

Makers of a wide variety of Heating Elements for assembly into manufacturer's own products and of Heating Specialities that use electricity.

PREMAX

RADIO ANTENNA

FOR MOBILE UNITS

High-tempered steel Antennas and specially designed mountings that will meet every need for mobile installations in police, fire and other municipal and governmental services. Get the new Premax Antenna Catalog from your radio jobber.



Premax Products

Division Chisholm-Ryder Co., Inc.

4711 Highland Ave. Niagara Falls, N. Y.

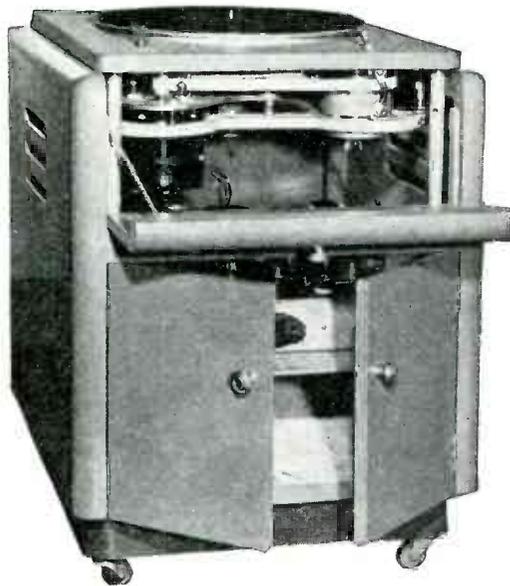
Robinson "PRECISION" Turntables Now Available

★ No "Wow" or vibration whether it's Brahms, boogie or voice.

★ "Right angle" belt drive and patented "seismic" sub base motor mounting.

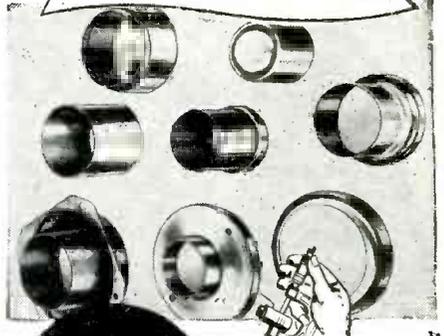
★ Instant, fool-proof lever shift from 78 to 33 1/3 R.P.M.

★ New micrometer speed adjustment and patented planetary ball bearing transmission.



Console \$90 Chassis \$295
Duplex Console \$150

for dimensional accuracy!



METAL
STAMPINGS

DKE

DKE stamped metal parts can now be supplied in any quantity on short notice. Twenty years experience in producing all types of cups, sleeves, flanged shapes, and fabrications to specification. Tools, jigs, fixtures produced on premises for precision and economy.

INQUIRIES INVITED

THE ENGINEERING CO.

DANIEL KONDAKJIAN
27 WRIGHT ST., NEWARK, N. J.

ROBINSON RECORDING LABORATORIES
35 SO. NINTH ST., PHILADELPHIA 7, PA.

pers; Paul Rosenberg, chairman, Woolworth Bldg., New York 7.

FEB. 20-22; OPTICAL SOCIETY OF AMERICA; Winter Meeting; Hotel Pennsylvania.

MARCH 3-6; IRE WINTER MEETING; Hotel Commodore, New York City, with Radio Engineering Show at Grand Central Palace.

MARCH 22-27; WESTERN METAL CONGRESS AND EXPOSITION; Oakland Civic Auditorium, Oakland, California.

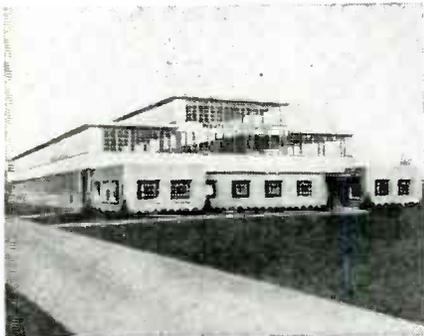
MARCH 31-APRIL 2; MIDWEST POWER CONFERENCE; Palmer House, Chicago; sponsored by Illinois Institute of Technology and directed by Prof. S. E. Winston.

MAY 13-16; 1947 CONFERENCE AND SHOW; Radio Parts and Electronic Equipment Shows, Inc., Chicago, Illinois.

BUSINESS NEWS

CARBONNEAU INDUSTRIES, Grand Rapids, Michigan, plans full-scale production soon on a complete line of loudspeakers.

INDUCTIVE EQUIPMENT CORP. has moved into its new building in Gettysburg, Pa. having 50,000 square feet of space for manufacturing magnet wire, coils, trans-



New plant of Inductive Equipment Corp.

formers, rectifiers, and various types of high-frequency equipment.

ROCKBESTOS PRODUCTS CORP., New Haven, Conn., recently added 11,000 square feet to its facilities for manufacture of permanently insulated wires, cables, and cords.

ILLINOIS CONDENSER Co., Inc. is in full operation now at its modern

Who Winds it?

that's what makes a Coil!

All the materials which go into the making of a coil may be available but more, much more is required.

There must be specialized machines and, above all, the "know-how" which comes only through engineering skill and years of experience.

The integrity of your supplier is your real assurance of dependability.

Our knowledge and modern facilities are always at your service.

COTO-COIL CO., INC.
COIL SPECIALISTS SINCE 1917
 65 Pavilion Ave., Providence 5, R. I.

S.S. White **MOLDED RESISTORS**

The "All-Weather" Resistors



- Noiseless in operation
- Strong and durable
- Good performance in all climates

STANDARD RANGE

1000 ohms to 10 megohms

- NOISE TESTED •

At slight additional cost, resistors in the Standard Range are supplied with each resistor noise tested to the following standard: "For the complete audio frequency range, resistor shall have less noise than corresponds to a change of resistance of 1 part in 1,000,000."

HIGH VALUES

15 to 1,000,000 megohms

S.S. WHITE INDUSTRIAL

THE S. S. WHITE DENTAL MFG. CO. DIVISION



DEPT. R. 10 EAST 40th ST., NEW YORK 16, N. Y.

FLEXIBLE SHAFTS • FLEXIBLE SHAFT TOOLS • AIRCRAFT ACCESSORIES
SMALL CUTTING AND GRINDING TOOLS • SPECIAL FORMULA RUBBERS
MOLDED RESISTORS • PLASTIC SPECIALTIES • CONTRACT PLASTIC MOLDING

One of America's AAAA Industrial Enterprises

No Spreading Ourselves Out Too Thin!

Certainly, we could expand our facilities and offer you a more complete line. But, then, we couldn't do as well on deliveries as we're now doing!

So to serve you best, we are continuing our present maximum production on a limited line—thus assuring you the usual prompt and efficient Kenyon service.

THE MARK OF EXCELLENCE



KENYON

TRANSFORMER CO., Inc.
840 BARRY ST., NEW YORK, N. Y.

**FOR RADIO AND ELECTRONICS
PARTS • SETS • EQUIPMENT**
ask **NEWARK** they'll have it!

IF YOUR NEEDS in radio or electronics parts, sets or equipment are available

★ Literature and full information on ANY manufacturer's products will be sent promptly on request. Wire or phone for quick action.

★ Our big bargain counters are loaded with new parts and unusual special equipment. Inquiring minds enjoy these displays.

anywhere, you'll save time by phoning or wiring Newark Electric. Tremendous, up-to-the-minute stocks are maintained in all three stores.

COMPETENT TECHNICAL MEN handle your inquiries intelligently and promptly and can quote prices and delivery dates on specific merchandise. Orders shipped same day. When writing address Dept. R-5 MAIL ORDERS FILLED FROM EITHER NEW YORK OR CHICAGO.



N.Y.C. Stores: 115 W. 45th St. & 212 Fulton St. Offices & Warehouse: 242 W. 55th St. N.Y. 19

Dept R-5
NEWARK ELECTRIC COMPANY, INC.
Please send informative literature on the following:

NAME: _____
ADDRESS: _____
CITY: _____ STATE: _____

P.A. Depts. in
all stores. Set
& Appl. Depts.
in N. Y. C.

ALLIED DISCS

and



RECORDING EQUIPMENT

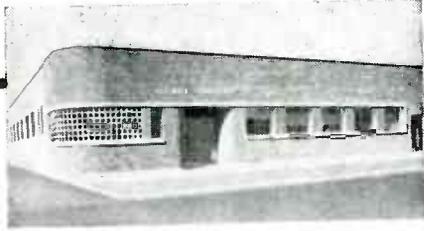
ALLIED Discs are favored by noted broadcasters and other users, for their high fidelity. Test them on your work. One of the first companies to make instantaneous recording equipment, ALLIED offers you the benefits of its seasoned skill.

Write for our New Descriptive Bulletin.

ALLIED

RECORDING PRODUCTS CO.

21-09 43d Ave., LONG ISLAND CITY 1, N. Y.



new air-conditioned single-story plant located at 1616 N. Throop St. in Chicago.

EMERSON RADIO AND PHONOGRAPH CORP., New York City, will operate Jefferson-Travis Inc. as a wholly owned subsidiary, utilizing Emerson distributing facilities for J-T marine radio equipment.

STAVER MFG. CO., Jackson Heights, New York, was formed recently by Edward F. Staver, formerly with Fred Goat Co., Inc. The new firm will manufacture electron tube parts, wire forms, clips, caps, shields, and light metal stampings.

ELECTRONIC APPARATUS, INC., New York, N. Y. has acquired a controlling interest in Tuck Electronic Corp., Jersey City, N. J., engaged in design, development, and manufacture of specialized industrial and testing electronic apparatus.

GENERAL RADIO Co., Cambridge, Mass. has started work on a new four-story addition to its main plant, to secure 30,000 square feet



Next spring General Radio's plant will appear like this. New addition has steps on roof

more manufacturing space and bring the total up to 140,000 square feet.

PRESS WIRELESS MFG. CORP. announces that its engineering division is being moved from Long Island City to Hicksville, Long Island, N. Y. to expedite production.

CAPITOL RADIO ENGINEERING INSTITUTE, Washington, D. C., has had

Brush Low-Cost Paper Tape Means Magnetic Recording for Everyone!

No matter what type of magnetic recorder you design, the low cost, excellent fidelity and uniformity of Brush Paper Tape make it your best all-round recording medium. With this new development by the pioneer and leader in the field of magnetic recording you can bring magnetic recording to the great mass market of all America! Brush Paper Tape will be furnished you either in bulk in varying widths or 1225 ft. ¼-inch wide on a metal reel.

Look at these advantages of Brush Paper Tape . . .

- Easy to handle
- Extreme low-cost
- Can be edited...spliced
- Greater dynamic range
- Minimum wear on heads
- Excellent high frequency reproduction at slow speed
- Permanent . . . excellent reproduction for several thousand play-backs

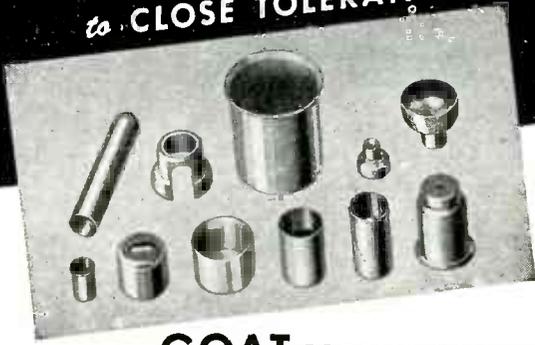
Other Brush developments in magnetic recording components include Brush Plated Wire and vastly improved Tape and Wire Recording Heads and Cartridges.

Write today for further information

The Brush Development Company

3405 Perkins Avenue • Cleveland 14, Ohio

NEED SMALL BULBS and
DEEP DRAWN PARTS
to CLOSE TOLERANCES?



**GOAT PRECISE-FORMED
DEEP-DRAWN METAL PARTS**

Improved Quality at Lower Cost!

Deep drawing, sizing and coining, in conjunction with quality control techniques devised by the Goat Company, make possible the economical production of small parts to tolerances unattainable a few years ago. The new method makes expensive annealing operations unnecessary. The use of these economically produced, precision parts reduces both material costs and assembly costs.



Send us your design prints for
engineering recommendations
Address Dept. EL

LET US
REDESIGN
FOR
STAMPING

GOAT METAL STAMPINGS,
Division of The Fred Goat Co., Inc.
314 DEAN STREET BROOKLYN, N. Y.

OUR STORY

is best told in person.
We'll be glad to tell
it at your convenience.

HENRY P. SEGEL
Company

Now in our 23d year

Electronics Manufacturers'
Representatives and Field Engineers

143 Newbury St., Boston 16, Mass.
179 Kenyon St., Hartford 5, Conn.

NEW SOLDERING GUN

Heats in 5 Seconds



**SPECIAL SOLDERING GUN
ADVANTAGES**

TIP STAYS TINNED
NO BURNING



SEE WHERE
YOU SOLDER



SOLDER AROUND
CORNERS

Service and maintenance men can save time by the fast heating of the Soldering Gun. By use of the new induction principle, 5 second soldering heat is supplied from a light weight built-in transformer.

The loop type tip gives you other advantages that are important in soldering. Good balance with weight close to your hand makes it easier to use. The narrow tip gets in between a lot of wiring with ease. Connections can be made without burning insulation. The tip can be formed readily to work in tight places.

See your radio parts distributor for a demonstration, or write direct for descriptive bulletin.

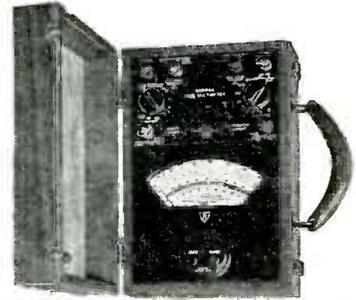
- ★ 100 Watts 115 Volts 60 Cycles
- ★ Intermittent Operation With Trigger Switch
- ★ Can't Overheat or Burn Out
- ★ Impact Resisting Case
- ★ Handle Stays Cool
- ★ Good Balance—Weight Close To Hand

806 Packer Street

WELLER MFG. CO. • Easton, Pa.

Export Dept.—25 Warren Street, New York 7, N. Y.
In Canada—Atlas Radio Corp., Ltd., 560 King Street N. W., Toronto, Ont.

**RAWSON TWIN
MULTIMETER**



Type 5012 Accuracy 1/2 of 1% DC
Size 12"x8"x6"

A Combination AC—Multimeter and DC
Multimeter

Range of Measurements

- DC 1 microampere to 1 Ampere.
- 20 Microvolts to 1000 volts.
- AC (thermocouple type)
- 2 Milliampere to 3 Amperes.
- 60 Millivolts to 1000 volts.

Write for bulletin
WE ALSO SUPPLY

REGULAR DC METERS
THERMOCOUPLE AC METERS
MULTIMETERS
FLUXMETERS
ELECTROSTATIC VOLTMETERS

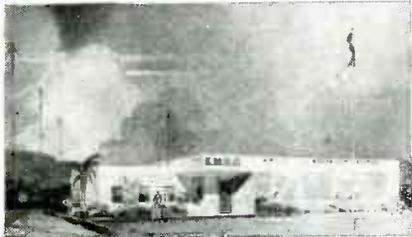
Special apparatus built to order

**RAWSON ELECTRICAL
INSTRUMENT COMPANY**
111 POTTER ST. CAMBRIDGE, MASS

Representatives
CHICAGO LOS ANGELES NEW YORK CITY

both its correspondence and residence courses in radio engineering accredited by the Engineers' Council for Professional Development.

KMPC, North Hollywood, California, has enlarged its transmitter



Artist's sketch of enlarged KMPC transmitter building. Directional antenna array at left will give equivalent of 200-kw service to greater Los Angeles

building to incorporate a new RCA 50-F 50-kw transmitter scheduled to go on the air in January 1947.

RADIOMARINE CORPORATION OF AMERICA installed a modern marine loran receiver aboard the S. S. America while the ship was being reconditioned for peacetime service.

WOR, NEW YORK CITY, has installed an SCR-268 radar antenna on the roof of the building housing its f-m station WBAM, for experimental f-m transmissions to Washington, D. C. on 47.1 and 106.5 mc in cooperation with the Federal Communications Commission. Another version of this same antenna was used in the moon radar experiments.

FAIRCHILD CAMERA & INSTRUMENT CORP., Jamaica, N. Y. has purchased a plant in Burlington, Vermont for its new wholly-owned subsidiary company to be known as Fairchild Industries, Inc.

HOFFMAN RADIO CORP., Los Angeles, Calif. has established in what was once a car repair barn in Los Angeles its cabinet factory, involving some 76,000 sq ft of floor space.

PERSONNEL

LEONARD HOLE has been named assistant director of television for CBS, and will assume many administrative responsibilities in the operation of Columbia's television station WCBS-TV in New York City. During the war he flew combat missions over France and

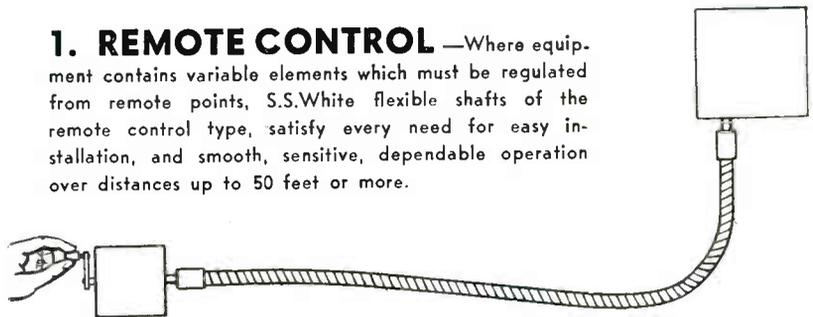
3 COMMON PROBLEMS

IN ELECTRONIC EQUIPMENT DESIGN

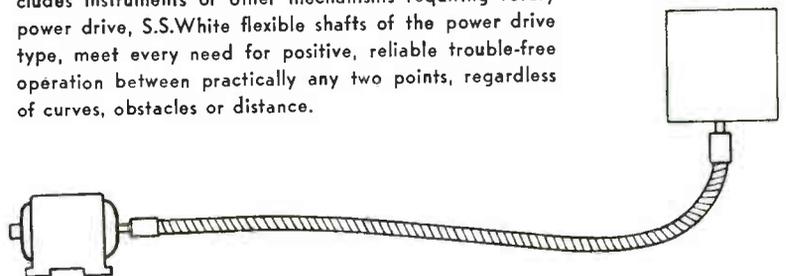


ONE SIMPLE ANSWER

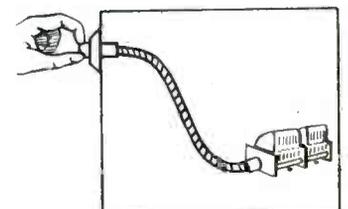
1. REMOTE CONTROL —Where equipment contains variable elements which must be regulated from remote points, S.S.White flexible shafts of the remote control type, satisfy every need for easy installation, and smooth, sensitive, dependable operation over distances up to 50 feet or more.



2. POWER DRIVE —Where equipment includes instruments or other mechanisms requiring rotary power drive, S.S.White flexible shafts of the power drive type, meet every need for positive, reliable trouble-free operation between practically any two points, regardless of curves, obstacles or distance.



3. COUPLING —The use of short lengths of S.S.White flexible shafting inside equipment as couplings between variable elements and their control dials, gives complete freedom in placing both the elements and the dials for space saving, easy assembly and wiring, and convenient operation and servicing.



FOR DETAILS—WRITE FOR BULLETIN 4501

It gives essential facts and engineering data about S.S.White flexible shafts and their application.

S.S. WHITE INDUSTRIAL DIVISION
THE S. S. WHITE DENTAL MFG. CO. DEPT. E 10 EAST 40TH ST., NEW YORK 16, N. Y.



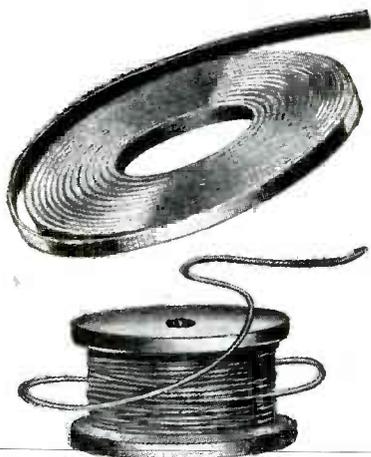
FLEXIBLE SHAFTS • FLEXIBLE SHAFT TOOLS • AIRCRAFT ACCESSORIES
SMALL CUTTING AND GRINDING TOOLS • SPECIAL FORMULA RUBBERS
MOLDED RESISTORS • PLASTIC SPECIALTIES • CONTRACT PLASTICS MOLDING

One of America's AAAA Industrial Enterprises

**BE SURE TO
SPECIFY**



**PHOSPHOR
BRONZE
WIRES**



The production of "Elephant Brand" Phosphor Bronze Wire has been completely controlled by us from ingot to finished size, since 1874. It is a true bronze wire, containing nothing but virgin copper, tin, and phosphorus. The introduction of phosphorus into this composition reduces the oxides and, with the purified metals, forms a most homogeneous and uniform alloy. These essential factors are established scientific facts, and have proven the superiority of "Elephant Brand" Phosphor Bronze Wire.

This wire contains no zinc—which eliminates the danger of season-cracking, thus has the highest fatigue limit. It is made in various tempers to meet specific requirements. "Elephant Brand" Wire is drawn accurately to size, is absolutely uniform throughout the coil, and will not season—crack, regardless of the time that it is carried in stock. All wire can be supplied bright-annealed. Available in the following forms:

ROUND WIRE. In coils for spring manufacturers

FLAT WIRE. In coils or lengths

TINNED BINDING, for armature work

STRAIGHTENED (Round) in lengths

ELEPHANT BRAND PHOSPHOR BRONZE

THE PHOSPHOR BRONZE SMELTING CO.
2200 Washington Ave., Philadelphia 46, Pa.
Original Manufacturers of Phosphor Bronze
in U. S. A. . . . Established 1874

NEWS OF THE INDUSTRY

(continued)

Germany using aircraft and bombs remotely controlled by radio, radar, and television.

ERNEST FREDERIK WERNER ALEXANDERSON was awarded the Valdemar Poulsen Gold Medal by the Royal Danish Academy of Science for his work in the fields of radio and television. Dr. Alexanderson, consulting engineer with General Electric Co., holds over 300 patents including that of the high-frequency alternator.

FREDERICK R. LACK, vice-president of Western Electric Co., will be president of the American Standards Association for 1946.

A. E. BACHMANN, civilian specialist in underwater sound, submarine countermeasures, and mine warfare devices during the war, has been transferred from engineering to sales at Collins Radio Co., and will be in charge of their special products such as railroad radio entertainment systems, industrial control devices, and Autotune applications.



A. E. Bachmann



H. W. Parker

HENRY W. PARKER becomes technical adviser for Sylvania Electric Products Inc. This new post was created to stimulate review of new developments of interest to the central engineering laboratories, as well as propose new projects for research and development.

AMOS H. CAREY has been appointed director of manufacturing for John Meck Industries, Plymouth, Indiana. He was formerly in charge of manufacturing for RCA in Camden.

WALTER EVANS, vice-president in charge of all radio activities for Westinghouse Electric Corp., received the Certificate of Appreciation from the War Department for "his contribution to the Signal

Current
Conversion
with **ATR**
Quality Products



BATTERY ELIMINATORS

FOR CONVERTING A.C. TO D.C.
New Models . . . designed for testing D.C. electrical apparatus on regular A.C. lines. Equipped with full-wave dry disc type rectifier, assuring noiseless, interference-free operation and extreme long life and reliability.

- Eliminates Storage Batteries and Battery Chargers.
- Operates the Equipment at Maximum Efficiency at All Times.
- Fully Automatic and Fool-Proof.



LOW POWER INVERTERS

FOR INVERTING D.C. TO A.C.
Another New ATR Model . . . designed for operating small A.C. motors, electric razors, and a host of other small A.C. devices from D.C. voltages sources.



STANDARD AND HEAVY DUTY INVERTERS

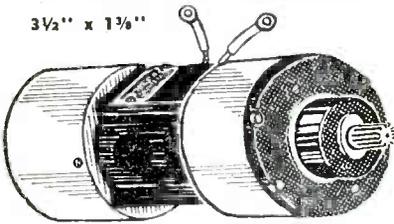
FOR INVERTING D.C. TO A.C.
Specially designed for operating A.C. radios, television sets, amplifiers, address systems, and radio test equipment from D.C. voltages in vehicles, ships, trains, planes, and in D.C. districts.

WRITE FOR NEW CATALOG—
JUST OFF THE PRESS!

AMERICAN TELEVISION & RADIO CO.
Quality Products Since 1931
ST. PAUL 1 MINN. U. S. A.

REVERSIBLE GEARED MOTOR

3 1/2" x 1 3/8"

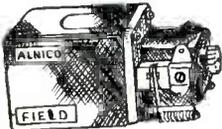


Operates on Flashlight batteries, speed depending on the voltage. Fairly strong on 6 volts, full power and speed on 27 volts. Designed to be used in bombsights, automatic pilots, etc. Two types, 145 or 250 RPM. Either speed a bargain at.....

\$5.00

BASIC MOTOR 2 X 1 X 1

ELECTRICALLY SAME AS GEARED MOTOR



\$3.00

ALNICO MAGNETS

ARE AGAIN AVAILABLE

3/8 x 3/8 x 3/4

SMALL HORSESHOES



2 for **\$1.00**

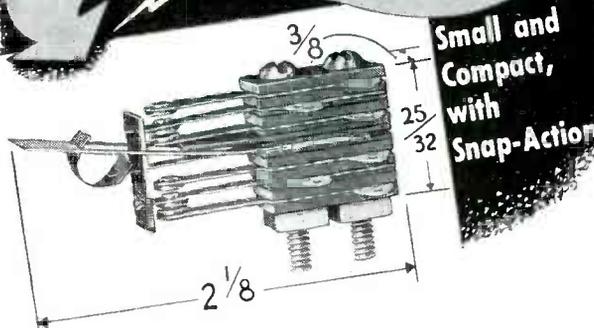
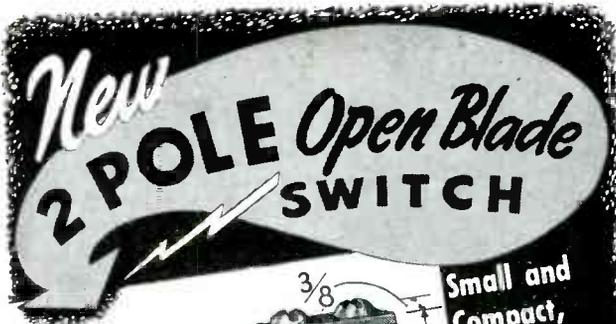
EST
1923

BLAN

EST
1923

Experimenters and Inventors Supplies

64 Day St., New York 7, N. Y.

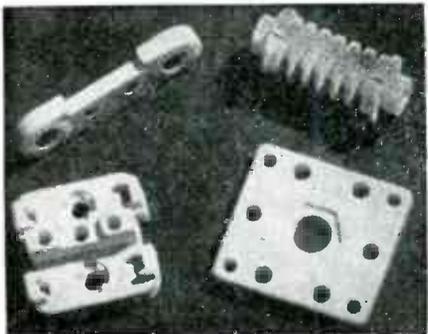


Small and Compact, with Snap-Action

Here is the 2 pole open blade snap-action ACRO switch that many alert electrical engineers have been looking for. Built with the well known patented Rolling Spring that assures positive action. Made in both single and double throw contacts. Standard operating pressures from 3 to 5 oz. Rating: 15 Amps, 125 Volts A.C.

Movement differential—approximately 1/16" Terminals as illustrated or at rear of switch. Variations in operating characteristics are possible as well as a 3 pole design if needed to suit your application. Write for print, giving us your engineering details for quick action.

ACRO ELECTRIC COMPANY
1316 SUPERIOR AVENUE · CLEVELAND 14, OHIO



Lavite STEATITE CERAMIC

Properties and Characteristics of Our LAVITE S1-5 Steatite Ceramic Body

Compressive Strength	96,000 lbs. per square inch
Tensile Strength	7,200 lbs. per square inch
Flexural Strength	10,500 lbs. per square inch
Modulus of Rupture	20,000 lbs. per square inch
Dielectric Strength	235 volts per mil
Dielectric Constant	6.42
Loss Factor	2.90
Power Factor	4.46
Bulk Specific Gravity	2.6645
Density (from above gravity)	0.096 lbs. per cubic inch
Hardness (Mohr scale)	7.0
Softening Temperature	2,350° F.
Linear Coefficient of Expansion	8.13x10 ⁻⁶
Moisture Absorption (ASTM D-116-42-A)	0.009%

Design engineers and manufacturers in the radio, electrical and electronic fields are finding in LAVITE the precise qualities called for in their specifications—high compressive and dielectric strength, low moisture absorption and resistance to rot, fumes, acids, and high heat. The exceedingly low loss-factor of LAVITE plus its excellent workability makes it ideal for all high frequency applications.

We will gladly supply samples for testing.

D. M. STEWARD MFG. COMPANY

Main Office & Works: Chattanooga, Tenn.
Needham, Mass. Chicago Los Angeles

Large or Small

SQUARE, ROUND OR RECTANGULAR

PAPER TUBES

FOR COIL WINDING



SEND FOR ARBOR LIST OF OVER 1000 SIZES

Inside Perimeters from .592" to 19"

With specialized experience and automatic equipment, PARAMOUNT produces a wide range of spiral wound paper tubes to meet every need... from 1/2' to 30' long, from .592" to 19" inside perimeter, including many odd sizes of square and rectangular tubes. Used by leading manufacturers. *Hi-Dielectric, Hi-Strength.* Kraft, Fish Paper, Red Rope, or any combination, wound on automatic machines. Tolerances plus or minus .002". Made to your specifications or engineered for YOU.

Paramount PAPER TUBE CORP.

616 LAFAYETTE ST., FORT WAYNE 2, IND.

Manufacturers of Paper Tubing for the Electrical Industry



Look to ILLINOIS for

ELECTROLYTIC CAPACITORS

of finest quality!

At Illinois' new plant the accent is, as always, on highest quality Electrolytic Capacitors. "Not how many, but how good" has been the fixed company policy over the years and has been directly responsible for our steady growth. A model of efficiency, our new plant features the very latest in equipment, newest production techniques and air conditioning. These factors combined with the best basic materials, closer, more rigid control and a skilled engineering staff show clearly why Illinois is better geared than ever to produce the finest in condensers.



Your copy of our latest catalog is ready for you. Write for it today



ILLINOIS CONDENSER CO.
1676 NORTH THROOP STREET • CHICAGO 22, ILL.

Corps in connection with the development and production of radio and radar equipment during World War II".

CHARLES R. DENNY was named by President Truman on Dec. 4 to be chairman of the Federal Communications Commission. He had been



C. R. Denny, new FCC head

acting chairman since Paul A. Porter left to become head of OPA.

JOHN R. GASTON is president and chief engineer of Inductive Equipment Corp., Gettysburg, Pa. He was formerly manager of the transformer division of Federal Telephone and Radio Corp.

W. R. G. BAKER, vice-president in charge of electronics department of General Electric Co., was presented with the Certificate of Appreciation by the War Department for his "outstanding contribution to the war effort by the development, design, and production of complex Signal Corps radio and radar equipment".

LOUIS GERARD PACENT, president of Pacent Engineering Corp., received the War Department's Certificate of Appreciation for "developing and adopting manufacturing techniques which involved mass production of communication equipment".

R. C. COSGROVE, general manager, Crosley Division, The Aviation Corp., received the War Department's Certificate of Appreciation for "outstanding contributions to the war effort by directing the design, development, and production of Signal Corps radio sets and radar devices".

LAURISTON S. TAYLOR, chief of the X-Ray Section, National Bureau of Standards, was awarded the Medal

AMPERITE THERMOSTATIC METAL TYPE DELAY RELAYS

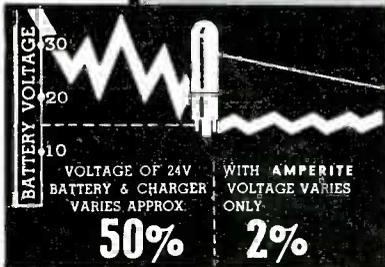
PROVIDE DELAYS RANGING FROM 1 TO 120 SECONDS

FEATURES:—Compensated for ambient temperature changes from —40° to 110° F... Hermetically sealed; not affected by altitude, moisture or other climate changes... Explosion-proof... Octal radio base... Compact, light, rugged, inexpensive... Circuits available: SPST Normally Open; SPST Normally Closed.

PROBLEM? Send for "Special Problem Sheet" and Bulletin.



AMPERITE REGULATORS



Amperite REGULATORS are the simplest, lightest, cheapest, and most compact method of obtaining current or voltage regulation... For currents of .060 to 8.0 Amps... Hermetically sealed; not affected by altitude, ambient temperature, humidity.

Write for 4-page Illustrated Bulletin.

AMPERITE CO., 561 Broadway, New York 12, N. Y.
In Canada: Atlas Radio Corp., Ltd., 560 King St., W. Toronto

40-500 MC GEN. Limited Quantity Available

AIR CORPS TYPE TS-47/APR hi-freq Sig Gen mfd. by Fairchild. Range 40 to 500 MC (in 2 ranges). Mfg. specs—1% accuracy at 68 F. Silver plated butterfly oscill. tank circuit. Extremely rugged. 500 cps pulse or 1000 cps sine wave AM mod. from self contained Heising mod. Output up to 3 milliwatts 40 to 400 mc, up to 1 milliwatt 400 to 500 mc. Self contained vert. radiator or 52 ohm co-ax. cable term. Contains power sup. designed 115-240 vac 50-2400 cps or ext. bat. RF output variable. Excellent for pre-flight check of VHF receivers and hi-freq work demanding accuracy and versatility in above freq range. Brand new and complete with tubes in carrying case. Dim. 11¼" H X 9¼" W X 6¾" D. **YOUR COST \$165.00**



FIELD MIKE SIG. CORPS T-21B

- 2 Tube res-coupled Amp.
- Condenser Mike
- Remote Control Relay
- Rugged Construction

FIELD ARTILLERY microphone Sig. Corps type T-21B designed to be arranged in the field in computed geometric pattern for the purpose of determining range and intensity and direction of gunfire. Internal 2 stage res. coupled amp uses 1 type "30" and 1 type "32" tubes. Contained relay controls filament circuit from remote point on applying "B" volt. Condenser mike head designed to respond at detonation freqs. IDEAL for use with geophysical sonic, explosion warning, well "sounding" and mine safety equip. Housed in rugged brass cylinder. Dim. 7" dia. X 16¼" H. Diagram supplied. All units brand new (less tubes) in sealed cartons. **YOUR COST \$23.50**

20% Remittance—Balance C. O. D.
All Prices FOB N.Y.C.

KELVIN ELECTRONICS
74 Cortlandt St., New York 7, N. Y.



Life-Time Switch?

We think so—and so do our customers. Our tests are discontinued after 30,000 on-off cycles. They're good!

SPST ROTARY SNAP SWITCH

3A—125 V., 1A—250 V. Catalog No. 100
1/8" IPS x 5/16" Shank, Single Hole Mounting
6" Leads, One Knurled Nut

Listed by
Underwriters' Laboratories, Inc.

Slater ELECTRIC & MFG. CO., Inc.
31-63 56th ST. WOODSIDE, L. I., N. Y.

WRITE FOR
EULLETIN

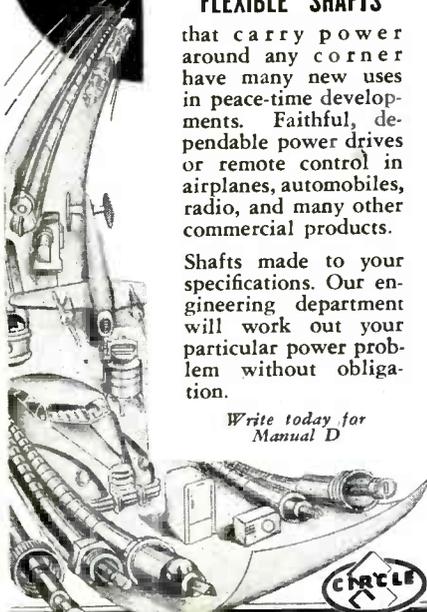
Flexible SHAFTS

FLEXIBLE SHAFTS

that carry power around any corner have many new uses in peace-time developments. Faithful, dependable power drives or remote control in airplanes, automobiles, radio, and many other commercial products.

Shafts made to your specifications. Our engineering department will work out your particular power problem without obligation.

Write today for
Manual D



F. W. STEWART MFG. CORP.
4311-13 RAVENSWOOD AVE.
CHICAGO 13, ILL.
WEST COAST BRANCH:
431 Venice Blvd.; Los Angeles 15, Cal.

Alnico permanent magnets

Specializing in the production of highest quality Alnico Magnets in all grades including new triple strength No. 5.

Production material checked to assure highest uniform quality of product.

Castings made to customer's special order on the basis of sketches or blue prints furnished.

Information and suggestions furnished on request.

GENERAL

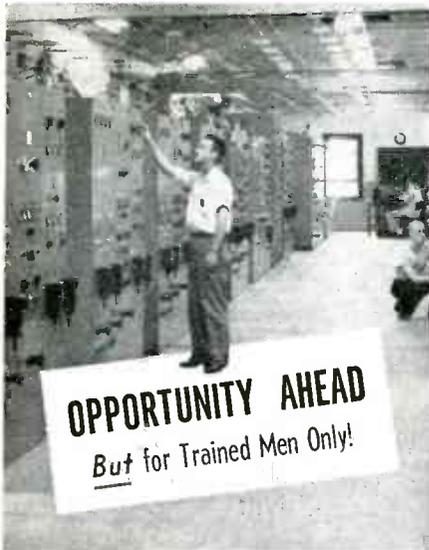
MANUFACTURERS OF HIGH COERCIVE MAGNETIC ALLOYS



MAGNETIC CORPORATION

10001 ERWIN AVENUE
DETROIT 5, MICHIGAN

CAPITOL RADIO ENGINEERING INSTITUTE
— Where Professional Radiomen Study



—Press Wireless Photo

CREI Home Study Training Will Keep You Ahead of Competition — Keep Others from By-Passing You to Better Jobs— By Keeping You in Pace with the Industry

Never was there such an opportunity as exists today in Radio Communications. Thousands of highly trained expert technicians and engineers will be required.

You can pick your FUTURE. You can enjoy a permanent, profitable and lasting career.

CREI's home study training *now* will prepare you for these important career jobs. Easy-to-read-and-understand lessons are provided and each student has the benefit of individual guidance and careful supervision from a trained instructor. This is real-honest-to-goodness practical engineering training that will prepare you for a good job in many interesting fields of Communications.

Act now! See for yourself how easily you can fit yourself into one of these secure, good paying jobs in tomorrow's Communications. Mail your coupon today.

VETERANS! CREI IS APPROVED FOR "G. I." TRAINING!

CAPITOL RADIO ENGINEERING INSTITUTE

An Accredited Technical Institute

Dept. E-2, 16th and Park Road N. W.
Washington 10, D. C.



MAIL COUPON FOR COMPLETE FREE DETAILS
And Outline of Course

Capitol Radio Engineering Institute
16th and Park Road N.W., Washington 10, D.C.
Gentlemen: Please send me complete details describing CREI home study courses. I am attaching a brief resumé of my experience, education and present position.

Name

Street

City Zone.... State.....

I am entitled to training under the G. I. BILL.

Member of National Home Study Council—National Council of Technical Schools—and Television Broadcasters Association

of Freedom for his part in developing improved methods for bombing, and the Bronze Star Medal for his work under combat conditions in Europe.

FRED L. MOHLER, chief of the Atomic Physics Section of the National Bureau of Standards, was awarded the Medal of Freedom for working out a comprehensive analysis of bombing accuracy while a member of the Ninth Bomber Command in Continental Europe.

BRUCE R. LAFFERTY has been appointed general service manager by the Hallicrafters Co. of Chicago. His 18 years of radio experience includes work with the group installing the first experimental CAA instrument landing systems for airports.



B. R. Lafferty



E. F. Hembrooke

EMIL F. HEMBROOKE, director of equipment and engineering for Muzak Corp. since 1945, has been elected a vice-president of the firm.

EUGENE MITTELMANN has resigned his position as director of electronic research and development at Illinois Tool Works to set up his own research and electronic development organization in Chicago.

WILLIAM J. HALLIGAN, president of The Hallicrafters Co., was presented with the War Department's Certificate of Appreciation for "outstanding contributions to the war effort in the engineering and production of complex radio equipment for the Armed Forces during World War II".

FRANK M. FOLSOM, executive vice-president of RCA in charge of the RCA Victor Division, received the War Department's Certificate of Appreciation for outstanding contributions to the U. S. Army Signal Corps program during the war.

It Costs You Less To Pay a Little More For SILCOCKS-MILLER PLASTIC PARTS



When you require plastic parts fabricated to close tolerances, you can always depend on Silcocks-Miller.

This organization pioneered in the precision fabrication of parts from plastic sheets, tubes and rods. Out of this long experience, Silcocks-Miller engineers offer you the understanding, skill and facilities to produce plastic parts to your exact requirements or to help you work out suitable designs.

This know-how saves you time, trouble and money. That's why "it costs you less to pay a little more for Silcocks-Miller quality."

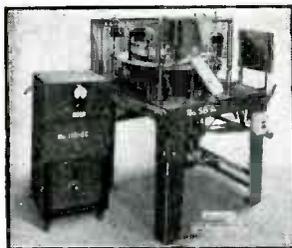
Write for Illustrated brochure

THE SILCOCKS-MILLER CO.

10 West Parker Avenue, Maplewood, N. J.
Mailing Address: South Orange, N. J.

SPECIALISTS IN HIGH QUALITY, PRECISION-MADE PLASTICS FABRICATED FOR COMMERCIAL, TECHNICAL AND INDUSTRIAL REQUIREMENTS.

**EISLER
ELECTRICAL & ELECTRONIC
EQUIPMENT
ELECTRONIC TUBE EQUIPMENT**



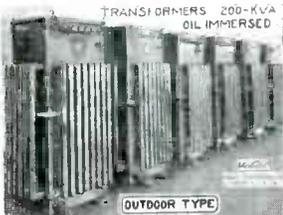
**24 HEAD
RADIO TUBE
EXHAUSTING
MACHINE**

◆ We Make Complete Equipment For The Manufacture Of Incandescent Lamps, Radio and Electronic Tubes.

TRANSFORMERS OF ALL TYPES

For LIGHTING FURNACES POWER PHASE CHANGING DISTRIBUTION ETC.

Air, Oil, or Water Cooled



TRANSFORMERS 200-KVA OIL-IMMERSED

OUTDOOR TYPE

Sizes 1/4 To 250 KVA

SPOT WELDERS!

OF ALL TYPES FOR ALL PURPOSES SIZES 1/4 TO 250 KVA
Butt Welders - Gun Welders
Arc Welders
Neon Sign Units
Fluorescent Tube
Manufacturing Equipment



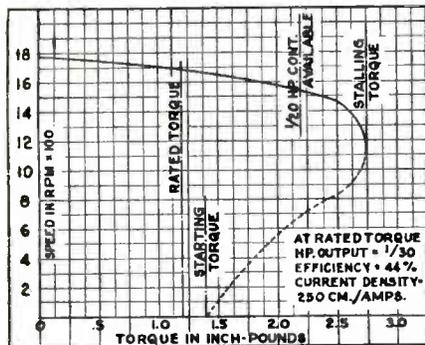
**CHAS. EISLER
EISLER ENGINEERING CO.**

751 So. 13th St. (Near Avon Ave.), Newark 3, N. J.

NEW MODEL



**ELINCO TYPE ALP
TYPICAL PERFORMANCE CURVE**



Type ALP-191; 110 volt 60 cyc. single-phase Capacitor start & run. Motor Capacitor Value 4.25 Mfd. Curve #235.

Elinco ALP Frame Motors are 3 3/8" x 4-5/16" capacitor start and run, two and four pole AC motors, internal fan cooled. Continuous duty rating—as induction motor to 1/30 h.p. at 1700 r.p.m.; as synchronous motor to 1/60 h.p. at 1800 r.p.m. Substantially higher ratings are available at speeds of 3400 and 3600 r.p.m. respectively. Also, higher rating for intermittent duty.

Write for Temporary Bulletin 46-A
**ELECTRIC INDICATOR CO.
STAMFORD, CONNECTICUT**



**THE GENERAL ELECTRIC
VARIABLE RELUCTANCE PICKUP**

RECORD enthusiasts are critical customers—whether they be devotees of Bach or boogie-woogie. Better and better reproduction of their favorite recordings is an insistent demand that must be met.

The General Electric Variable Reluctance Pickup can help you to meet that demand. It will appeal immediately to the technical mind due to its simplicity and direct resolution of difficulties often associated with phonograph pickups.

Check this list of major features:

- Low Needle Talk
- Negligible needle scratch
- Low Distortion
- Permanent sapphire stylus
- Minimum record wear
- Frequency response 30-10000 cycles
- Not affected by adverse climatic conditions

For complete information write to:
General Electric Company, Electronics Department, Syracuse 1, N.Y.

GENERAL  ELECTRIC

100-PT

**LOGARITHMIC AC VOLTMETER
—WIDE BAND AMPLIFIER—**



Advanced Design gives you a sensitivity and frequency response never before obtained.

No other Voltmeter offers all these advantages

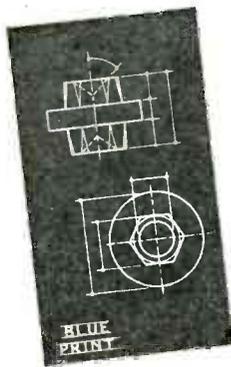
- Range .0005 to 500 volts
- Frequency 5 CPS to 2.0 MC
- Logarithmic voltage scale
- Linear DB scale
- Input 2 Megohm 15 MMF
- Accuracy ±2%
- Stability ±1% 105 to 125 V.

Ideal for Audio, Supersonics, Lower Radio Frequency Spectrum. Measures Stage Gain, RF and IF Amplifiers on Broadcast Receivers.

Write For Complete Information

Instrument Electronics
42-17A Douglaston Parkway Douglaston, L. I., N. Y.

ANOTHER SPECIAL BY PROGRESSIVE





QUALITY PROMCO BRAND

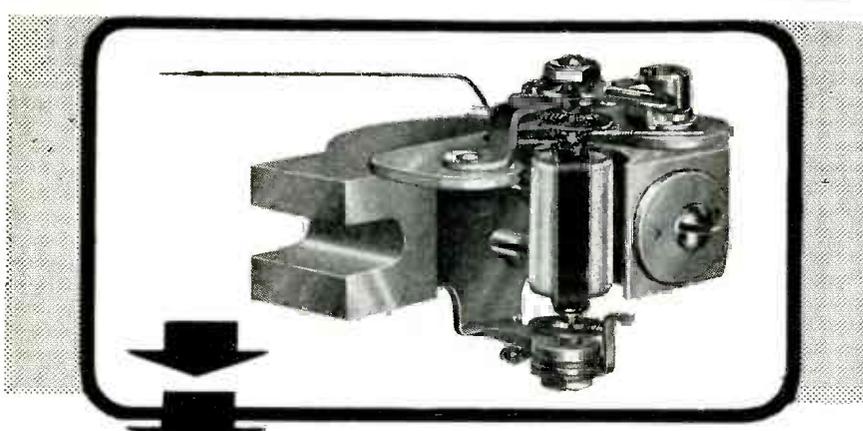
ACTUAL SIZE

ENLARGED FOR DETAIL

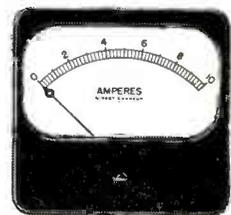
CATALOG SHOWS DOZENS MORE

Special heads, threads and finishes on any metal or alloy adapted to cold upset. Weekly output: 25,000,000 pieces. Many specials, suggesting production savings for you, illustrated in latest catalog. Includes weights per 1M standard pieces, dec. equivs. of fractions, other purchasing and engineering helps. Write for Catalog 18.

The PROGRESSIVE MFG. CO.
50 NORWOOD ST. TORRINGTON, CONN.



Burlington
INSTRUMENTS



Precision Movement • Dependability Unlimited

Alnico Magnets in all DC Instruments—Phosphor bronze control springs—perfectly aligned jewel supports—non-shifting balance weights—added to its many other superior construction features enables Burlington Instruments to maintain critical characteristics.

All ranges AC or DC available in 2½", 3½", 4½" sizes, rectangular and round.

Inquiries invited for your specific requirements.

BURLINGTON INSTRUMENT COMPANY 115 FOURTH ST. BURLINGTON, IOWA

NEW BOOKS

Principles of Radar

By members of the staff of the Radar School of M. I. T. McGraw-Hill Book Co., Inc., 1946, Second Edition, approximately 800 pages printed by offset from manuscript, \$5.00.

THE FIRST edition of this book, the first on the subject generally available, was undertaken late in 1942 to serve as a basic text for training Army and Navy officers. The material was prepared by individual members of the teaching staff. The present edition represents a reworking of much of the earlier material, the addition of new material, and the elimination of much text describing circuits which are already obsolete.

As any officer who took the M. I. T. radar course will state, radar is not a simple subject and this is not a book which one can sit down and consume like a twenty-five cent whodoneit. In fact, it would require an exceptionally absorptive mind to master the contents of the book in six months. A recital of some of the chapter headings with their approximate dimensions will indicate what the student will learn if he takes up radar seriously. The chapter on timing circuits requires 23 sections and about 100 pages; similarly, receivers take up 30 sections and another 100 pages. Other hundred-page chapters are those on r-f lines and antennas; almost the same space is needed for triode transmitters, for modulators, wave guides and resonators and about half this amount for servos and synchros.

There is not a radar picture in this book. It is straight theory and design data and not installation, operation or maintenance. It is packed full of quantitative determinations using modern tubes and components, plus all the micro-quantities involved in microwave equipment.

Although the subject, radar, may seem to be vertical, the contents of this book have rather horizontal bearing on the new world of microwaves and all those techniques which employ pulses, transients, cathode-ray tubes, magnetrons and klystrons, wave guides, megacycles and megawatts, square and tri-

What Makes A Mailing Click?

● Advertising men agree —the list is more than half the story.

McGraw-Hill Mailing Lists, used by leading manufacturers and industrial service organizations, direct your advertising and sales promotional efforts to key purchasing power. They offer thorough horizontal and vertical coverage of major markets, including new personnel and plants. Selections may be made to fit your own special requirements.

New names are added to every McGraw-Hill list daily. List revisions are made on a twenty-four hour basis. And all names are guaranteed accurate within two per cent.

In view of present day difficulties in maintaining your own mailing lists, this efficient personalized service is particularly important in securing the comprehensive market coverage you need and want. Ask for more detailed information today. You'll probably be surprised at the low over-all cost and the tested effectiveness of these hand-picked selections.

for Results



McGraw-Hill
DIRECT MAIL LIST SERVICE

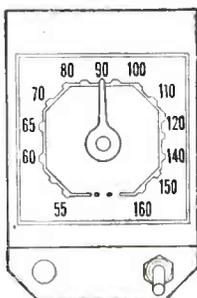
McGraw-Hill Publishing Co., Inc.

DIRECT MAIL DIVISION
330 WEST 42nd ST.
NEW YORK 18, N. Y.

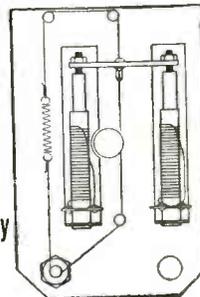
ATTENTION

MANUFACTURERS and
DISTRIBUTORS

SUPERHETERODYNE PERMEABILITY TUNERS



- 535 to 1660 KC Complete
- 3 Color Dial and Drive
- All units Pre-Tracked at Factory



We also make a Slide Rule type unit for Supers and TRF type to replace a single condenser.

Open facilities for Die work, Stamping, Coils, Assembling. Complete and extensive Engineering and Electrical laboratories available. Send us your inquiries for quotations.

AERMOTIVE EQUIPMENT CORP.

1632 CENTRAL ST.

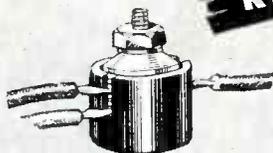
KANSAS CITY, MO.

H. BRAVERMAN

NEW YORK OFFICE

161 WASHINGTON ST., N. Y. 6, N. Y.

*** ELECTROX
LOW CAPACITY
RECTIFIERS**



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

Quality rectifiers, made for manufacturers of quality instruments by one of the oldest manufacturers of dry disc rectifiers. Electrox Rectifiers are especially adapted to the specific needs of individual users - at no premium in cost.

Write for Cir. 446.

Electrox Division

THE SCHAUER MACHINE CO.
2119 Reading Road Cincinnati 2, Ohio

● METAL AND
PLASTIC
SPECIALTIES

● STAMPINGS

● SCREW
MACHINE
PARTS

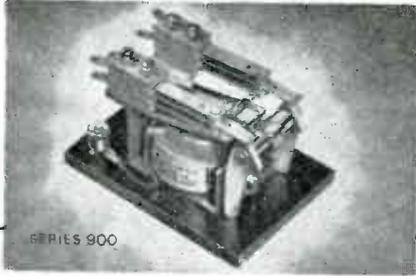
INSTRUMENT HOUSINGS • PANELS • CHASSIS
Manufactured to your Requirements

Experienced fabrication and dependable service for all types of radio and electronic parts. Send us your drawings and specifications for quotation.

STAMFORD METAL SPECIALTY CO., 429 W. BROADWAY, N. Y. 12

Metal Work of Every Description

ADVANCE Impulse Relay



NO A.C. HUM... NO POWER CONSUMPTION

Where these two factors are important... the impulse relay finds wide application.

Essentially an electrically operated toggle-switch, the impulse relay is energized only for an instant when switching is desired. With each "impulse" of power, contacts are shifted and held by a pawl-ratchet-cam mechanism. At all other times the coil consumes no power... makes no hum.

For all voltages A.C. or D.C., and available in DPST and DPDT combinations with contact ratings up to 10 amps.

Further details and free catalog on request



ADVANCE ELECTRIC & RELAY CO.
1260 West 2nd St., Los Angeles, California • Phone Michigan 9331

DECADE SCALING UNIT



**TYPE
YYZ-1**

THIS unit offers the research laboratory a quick and effective means of counting the number of pulses from any desired source. It will prove invaluable in such studies as:

- Nuclear Research
- Radioactivity
- Mass Spectrography

In addition it will be found extremely useful:

- For Timing Purposes
- For Counting Rapidly Recurring Phenomena
- For Use in Conjunction with Calculating Machines

For additional information, write: General Electric Company, Electronics Department, E-6411, Syracuse 1, N. Y.

GENERAL  ELECTRIC

164-P1

NEW BOOKS

(continued)

angular wave forms, followup systems, and many other subjects which are not even mentioned in many prewar textbooks.

The book is rather difficult to read because it is not made by letterpress, and some of the lettering on diagrams is small. The subject matter, however, which one needs to really understand the new techniques and how to use them is certainly in this book in very practical form. If the dimensions seem large, it is because the dimensions of radar and kindred subjects are large; if it seems that much time would be required to learn the "trade", there is no better time to start; and there is no doubt that *Principles of Radar* is a good place for the serious engineer to dig in.—K. H.

German-English Science Dictionary

By LOUIS DEVRIES, *Professor of Modern Languages, Iowa State College.* McGraw-Hill Book Co., Inc., New York, 1946, Second Edition, 558 pages, \$4.50.

ALTHOUGH prepared primarily for the field of entomology, physiology, physics, botany, chemistry and medicine, this handy volume will prove useful to the electronic engineer who must study German literature on applications of electronics in the above-mentioned fields. In this second edition the list of German abbreviations and corresponding English meanings has been more than doubled in length. Also included in the appendix are abbreviations of German periodicals, tables of German units of measure, and German names of the elements where they differ from the English.—J.M.

Electronic Control Handbook

By RALPH R. BATCHER AND WILLIAM E. MOULIC. *Caldwell-Clements, Inc., New York, N. Y., 1946, 344 pages, \$4.50.*

A GUIDE to the design, selection, and operation of automatic process control systems employing electronic circuits. The theory of control systems is taken up first as regards antihunting, process delays,

LESS THAN 5% DISTORTION
With 20 Watts at 60 Cycles
FREED 60 CYCLE FILTER

Type 1050



FIVE INSTRUMENTS In ONE

- 1 Constant Voltage Transformer
- 2 Variac
- 3 60 Cycle Low Pass Filter
- 4 Two Decade Attenuator—, 1% Precision
- 5 1% 150 Volt A.C. Voltmeter

Indispensable for calibration of instruments, where the form factor of the applied voltage is important (A.C. instruments and vacuum tube voltmeters) and for measurements of harmonic distortion of amplifiers, transformers and tubes. The instrument is entirely self contained and A.C. operated.

*Send for catalogue
of Laboratory Test Equipment*

FREED TRANSFORMER CO., INC.

78 Spring St., New York 12, N. Y.

FOR THE MOST EXACTING APPLICATIONS

Where dependability and economy are vital, leading manufacturers specify Westfield nuts of special design.

Send us your drawings and specifications for recommendations and prices.

WMP
WESTFIELD METAL PRODUCTS CO. Inc.
 WESTFIELD, MASS.
 Custom Made Nuts In Brass, Steel and Various Alloys

Tired...

of thumbing through files and folders for information on product sources and product specifications?

Use the 1946
electronics
BUYERS' GUIDE

You'll find informative, catalog-type copy of leading manufacturers of electronic components, equipment, and allied products in this convenient, year 'round reference book.

and don't forget

TO WATCH FOR THE
1947-48 ISSUE . . .
COMING JUNE 15th

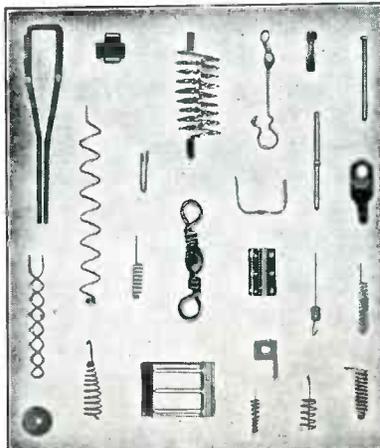
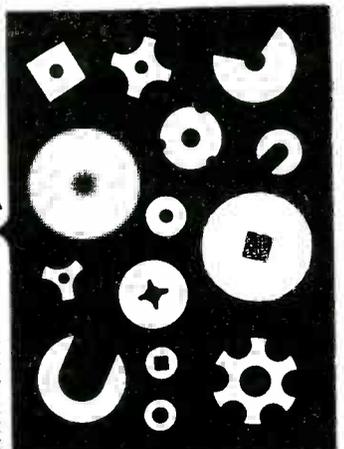
QUADRIGA WASHERS

Meet requirements of the electronic field — QUADRIGA WASHERS, to your specifications. Prompt delivery of any quantity. Special flat, tension and spring, formed and drawn, cupped and finishing. Write for valuable catalog.

ALSO SMALL METAL STAMPINGS, ANY DESIGN

THE QUADRIGA MFG. CO.
 221-A W. Grand Ave., Chicago 10, Ill.

DESIGNED FOR PRECISION JOBS.



SMALL PARTS

Filaments, anodes, supports, springs, etc. for electronic tubes. Small wire and flat metal formed parts to your prints for your assemblies. Doubles pointed pins. Wire straightened and cut diameter up to 1/8-inch. Any length up to 12 feet.

LUXON fishing tackle accessories.

Inquiries will receive prompt attention.

ART WIRE AND STAMPING CO.

227 High St.

Newark 2, N. J.

speed of response, proportional position control, throttling range, and more complicated arrangements up to that designated as proportional plus floating plus second derivative controller.

Available types of transducers are taken up in detail, with illustrations of typical examples for such industrial applications as wire or sheet gaging and conversion of movement into capacitance. An entire chapter deals with temperature conversion elements. Other chapters deal with control amplifiers, control oscillators, counting and timing controls, passive networks such as bridge circuits, synchros and servo-systems, solenoids and relays, saturable reactors, and control motors.—J.M.

Radio Tube Vade-Mecum

By P. H. BRANS. Editions Techniques P. H. Brans, 28 rue du Prince Leopold, Anvers (Borgerhout) Belgium, 1946, 6th edition. Distributed by Editors and Engineers, Ltd., 1300 Kenwood Road, Santa Barbara, Calif., 232 pages, paper cover, \$2.50.

A NEW TABLE giving complete characteristics of German and Italian army transmitting tubes, magnetrons and accelerator tubes has been added to the latest edition of this world receiving tube manual, the 5th edition of which was reviewed in the July 1946 issue of ELECTRONICS.

The 6th edition for distribution in this country uses only English, rather than the multilingual presentation of the 5th edition, thus simplifying the task of reading through the preliminary instructive material in the front of the book. In this edition is a coupon entitling the reader to supplements free of cost, to be issued every three months until the 1947 edition appears. Because of the revision of material, the 24 additional pages represent more than the equivalent amount of added information.—A. A. MCK.

THE TELEPHONE systems of Paris and Enghein, France have been linked by 9 and 10 cm f-m channels, with a relay station at Montmorency. Twelve calls can be handled simultaneously each way.

Announcing

The 1st volume in the long-awaited
Massachusetts Institute of Technology
RADIATION LABORATORY SERIES

Bringing you

the engineering data you need to design RADAR SYSTEMS

Here is an important book which presents the general principles of the design of various radar systems. From the standpoint of the designer the book discusses the basic considerations which underlie and are particular to systems design. After a general approach to problems encountered, it takes up the leading design considerations for the important components that make up a radar set. Two new and important auxiliary techniques—moving target indication and the transmission of radar displays to a remote indicator by radio means—are fully treated. Detailed examples of actual systems are included. Anyone interested in the varied applications of radar will find this new volume of immense value as a basic, useful reference.

Ready
Soon

RADAR SYSTEM ENGINEERING

Edited by Louis N. Ridenour, Editor-in-Chief, Radiation Laboratory Series; Associate Professor of Physics, University of Pennsylvania. Approximately 900 pages, 6 x 9, \$7.50.

This is the first of twenty-eight volumes prepared principally by members of the Radiation Laboratory maintained during the war at the Massachusetts Institute of Technology under contract with the National Defense Research Committee of the Office of Scientific Research and Development. The Laboratory was the foremost U.S. research and development institution in the field of microwave radar. The accuracy and usefulness of the material made available in these volumes is attested by their authoritative background.

Contents

- | | |
|---|--|
| 1. Introduction | 9. Antennas, Scanners, and Stabilization |
| 2. The Radar Equation | 10. The Magnetron and the Pulsar |
| 3. Properties of Radar Targets | 11. R-F Components |
| 4. Limitations of Pulse Radar | 12. The Receiving System—Radar Receivers |
| 5. C-W Radar Systems | 13. The Receiving System—Indicators |
| 6. The Gathering and Presentation of Radar Data | 14. Prime Power Supplies for Radar |
| 7. The Employment of Radar Data | 15. Examples of Radar System Design |
| 8. Radar Beacons | 16. Moving-Target Indication |
| | 17. Radar Relay |

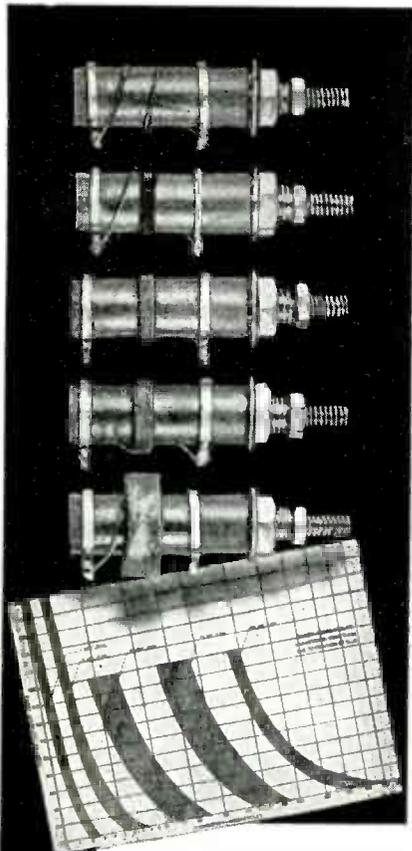


EXAMINE
10 DAYS
FREE

McGraw-Hill Book Co., 330 W. 42nd St., N.Y. 18
Send me M.I.T. Radiation Laboratory Series,
Vol. 1—Radar System Engineering for 10 days' examination on approval. In 10 days I will send \$7.50 plus few cents postage or return book post-paid. (Postage paid on cash orders.)

Name
Address
City and State
Company
Position L-2-47

For Canadian price write
Embassy Book Co., 12 Richmond St. E., Toronto 1



This graph shows frequency ranges covered by each unit. Write us for your full-size copy.

Five Standard Slug-Tuned LS3 Coils Cover 1/2 to 184 mc

For strip amplifier work, the compact (1 1/8" high when mounted) LS3 Coil is ideal. Also for Filters, Oscillators, Wave-Traps or any purpose where an adjustable inductance is desired.

Five Standard Windings—1, 5, 10, 30 and 60 megacycle coils cover inductance ranges between 750 and 0.065 microhenries.

CTC LS3 Coils are easy to assemble, one 1/4" hole is all you need. Each unit is durably varnished and supplied with required mounting hardware.

SPECIAL COILS

CTC will custom-engineer and produce coils of almost any size and style of winding... to the most particular manufacturer's specifications.

- Turret Lug
- Split Lug
- Double-end Lug
- Swager
- Terminal Board
- HPB Crystal

Consult CTC for
**Three-Way
Component Service**

Custom Engineering... Standardized Designs...
Guaranteed Materials and Workmanship
CAMBRIDGE THERMIONIC CORPORATION
437 Concord Avenue, Cambridge 38, Mass.

PROFESSIONAL SERVICES

Consulting — Patents — Design — Development — Measurements

in

Radio, Audio, Industrial Electronic Applications

H. RUSSELL BROWNELL

Consulting Engineer

Specializing in Measurements & Testing
Instruments & Techniques - Electrical - Elec-
tronic - Magnetic.

188 West 4th St. New York 14, N. Y.
Chelsea 2-4208

ELM LABORATORIES

**ELECTRONIC-MECHANICAL
RESEARCH & DESIGN**

Patented ELM Developments include
PREGRAME Automatic Radio Program Tuner,
Famous "Gerty" Direction Finder Loop, Sealed
Xtal Holder, Home Receiver Designs,
20 South Broadway Dobbs Ferry, New York
Phone Dobbs Ferry 4058

JOSEPH RAZEK, Ph.D.

Consulting Physicist

Electric and Mechanical Engineering Problems
Instruments and Control Devices Electronics
Specialists in Colorimetry, Spectrophotometry and
Industrial Color Control
Laboratory and Shop Facilities
202 Darby Road Llanerch, Pa.
Phone Hilltop 6910

EDWARD J. CONTENT

Acoustical Consultant

and

Audio Systems Engineering, FM, Standard Broad-
cast and Television Studio Design.

Roxbury Road Stamford 3-7459
Stamford, Conn.

PAUL E. GERST & CO.

CONSULTING ENGINEER

Specialists in
Electrical Product Design

El. Machinery, Apparatus & Applications
El. Appliances, Hi-Frequencies Apparatus
Electronics, Radio Communications

205 W. Wacker Dr. Chicago 6, Ill.

ARTHUR J. SANIAL

Consulting Engineer

Loudspeakers and Allied Devices

168-14 32 Ave. Flushing, N. Y.

DONALDSON ELECTRONICS LABORATORY

Research and Development

Shoran Radio Survey Consultant
Custom Built "Scopes" - Trick Circuits
Microsecond Sweeps - Microwave Systems
Industrial Applications

P.O. Box 1486 San Antonio, Texas

C. M. HATHAWAY

Consulting Engineer

Research and Development
Product Designs

Tool & Methods, Engineering
Pilot Manufacturing

1315 S. Clarkson St., Denver 10, Colorado

TECHLIT CONSULTANTS, INC

Technical literature and art. Specialists in elec-
tronics. Instruction manuals, sales brochures,
catalogues, isometrics, perspective, photo-retouch-
ing, schematics, wiring diagrams. Expert work at
low cost. We have never missed a deadline.

140 Nassau Street New York 7, N. Y.

STANLEY D. EILENBERGER

Consulting Engineer

INDUSTRIAL ELECTRONICS

Design—Development—Models
Complete Laboratory and Shop Facilities
6309-13—27th Ave.

Kenosha, Wis. Telephone 2-4213

INDUSTRIAL DEVELOPMENT ENGINEERING ASSOCIATES

Engineering Consultants

Electronic Control, Motion Picture &
Sound Equipment
Development—Design—Models

5874 College Ave. Indianapolis 5, Ind.

RAYMOND M. WILMOTTE INC.

A Complete Engineering Service
for the

Application of Electronics to Industry
Consultation Design Construction
236 West 55 Street 1713 Kalorama Road N. W.
New York 19, N. Y. Washington, 5, D. C.

ELECTRONEERS

Electronic Consultants

Industrial - Communications - Medical
Write or phone for preliminary survey without
charge.

489 Fifth Ave. New York 17, N. Y.
MUrray Hill 2-2492

RICHARD C. KLEINBERGER

Licensed Professional Engineer

Electronic Heating Applications

20 Cushman Road, White Plains, N. Y.

YARDENY ENGINEERING CO.

Remote Controls (Wires and Wireless)

Automatic Devices

Electronic • Electrical • Mechanical
Consultation • Designing • Manufacturing
Licensing

105 Chambers Street New York, N. Y.
Worth 2-3534, 3535

YOUR card here builds prestige for
you and helps to make your name
familiar in the field. The cost is
extremely small in proportion to its
value as a business aid.

ALBERT PREISMAN

Consulting Engineer

Television, pulse Techniques, Video
Amplifiers, Phasing Networks,
Industrial Applications

Affiliated with
MANAGEMENT-TRAINING ASSOCIATES
3308-14th St., N.W. Washington 10, D. C.

PAUL D. ZOTTU

Consulting Engineer

INDUSTRIAL ELECTRONICS

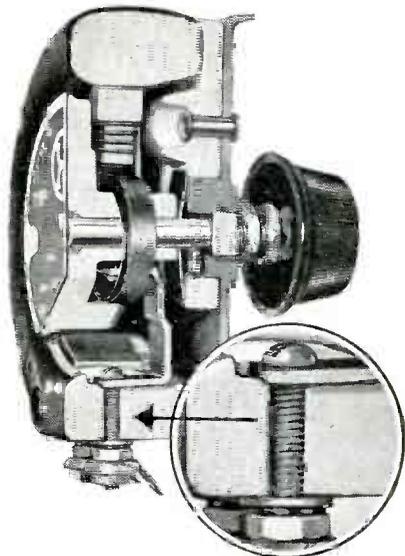
High Frequency Dielectric and Induction Heating
Applications, Equipment Selection, Equipment and
component Design, Development, Models.
272 Centre St. Newton, Mass.

RIG-9240

THE
REAL
VALUE

*of placing your unusual problem in the hands of
a competent consultant eliminates the elements
of chance and uncertainty from the problem and
provides real facts upon which to base decisions.*

RUGGED Screw Terminals for a **RUGGED** Rheostat



The sturdy screw terminals are integral with the massive ceramic winding core—a great core that gives 25% more capacity. These solid screw studs cannot be deformed nor ripped loose.

And this is only one of several exclusive features of this line of rheostats, ranging from 50 to 500 watt capacity.

Our 10 watt and 25 watt rheostats also, and many different types of Hardwick-Hindle resistors, offer other exclusive advantages.

Write us today. Our engineers are at your service.



HARDWICK, HINDLE, INC.
RHEOSTATS and RESISTORS

Subsidiary of THE NATIONAL LOCK WASHER COMPANY
NEWARK 5, N. J. ESTABLISHED 1886 U. S. A.

BAKELITE SHEETS, RODS AND TUBES

On special mill shipments we can give prompt delivery. Also complete fabrication service backed by over 20 years of experience.

**ELECTRICAL
INSULATION CO., INC.,**
12 Vestry St., New York 13, N. Y.

Backtalk

This department is operated as an open forum where our readers may discuss problems of the electronics industry or comment upon articles which ELECTRONICS has published.

Loran for Aircraft

Dear Sir:

As an operational navigator of some eighteen years experience in both marine and air navigation, I am deeply concerned as to a statement made in your lead article in the September 1946 issue of ELECTRONICS.

In referring to the CAA omnidirectional beacon, which your author admits is two years away commercially, and for which only a small portion of the \$300,000 the CAA has allocated for radio and radar research it is presumed will be available, your author makes the following statement: "omnidirectional ranges, *are said* to be superior to loran for use on long over-water courses, and over large land areas, such as jungles and deserts where locations of numerous ranges on the ground is impossible."

I would appreciate knowing "Who" said, the beacon was an improvement over loran, and upon what actual service or demonstration this statement was made. Consider that some \$300,000,000 have been invested in loran, and that these stations are now operating on the air and are *not* two years away commercially . . .

In January, 1946, at NAS Floyd Bennett Field, New York, I put my research plane and loran navigator through . . . a flight demonstration of loran, that if anything, proved it was more practical and more accurate for air traffic control, air traffic holding patterns, and in conjunction with GCA or radar instrument let-downs than any system yet devised by the CAA.

Considering the fact that none of the present loran stations were sited for air-navigation, or air-traffic control, and that NAAS, Charlestown, Rhode Island, is not in ideal loran coverage, the New York

CONTACTS

FOR THE FIELD OF ELECTRONICS



FINE RIBBONS OF TUNGSTEN and MOLYBDENUM

Quality and accuracy in our fabrication of Tungsten & Molybdenum Ribbons have characterized our service to the Electronic industry.

A development of

H. CROSS Co.
15 Beekman St., New York 7, N. Y.



Solve Wire Stripping Problems with "SPEEDEX" WIRE STRIPPER KIT

The famous "Speedex" Wire Stripper complete with 7 interchangeable blades for stripping any size wire from No. 8 to No. 30 will be the handiest tool in the shop. Strips 800 to 1000 wires per hour—cuts wires too. Just press the handle and the job is done. For use with solid or stranded wires.

WRITE DEPT. E FOR FULL PARTICULARS
GENERAL CEMENT MFG. CO.
ROCKFORD, ILLINOIS, U. S. A.



ELECTRON TUBE MACHINERY OF ALL TYPES STANDARD AND SPECIAL DESIGN

.....

We specialize in Equipment and Methods for the Manufacture of

- RADIO TUBES
- CATHODE RAY TUBES
- FLUORESCENT LAMPS
- INCANDESCENT LAMPS
- NEON TUBES
- PHOTO CELLS
- X-RAY TUBES
- GLASS PRODUCTS

On Production or Laboratory Basis

.....

Kahle ENGINEERING CO.
1309 SEVENTH STREET
NORTH BERGEN, N. J., U. S. A.

WE manufacture a complete line of equipment

SPOT WELDERS, electric from ¼ to 50 KVA	AC ARC WELDERS from 100 to 400 Amps	
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		

EISLER ENGINEERING CO.
731 So. 13th St. (near Avon Ave.) Newark, New Jersey

RADIO BOOKS BY MAIL

OVER 125 TITLES IN STOCK

SAME-DAY SHIPMENT ON 98% OF ALL MAIL ORDERS. Books of nearly all radio publishers. If you don't know price, send deposit and we'll ship C.O.D.

SEND STAMP FOR CATALOG TO
EDITORS AND ENGINEERS, Ltd.
1303 Kenwood Road • Santa Barbara, California

MICROMETER FREQUENCY METER

for Checking Transmitters from 100 Kc to 175 Mc. within 0.01 per cent

LAMPKIN LABORATORIES
Bradenton, Fla. U. S. A.

TELEVISION POWER UNITS

Small, compact, designed by experts.
5,000 V. D.C.—10,000 V. D.C.
Ready to mount—4" x 5" x 5"

For manufacturers and amateurs

WILLARD TELEVISION CORP.
1639 No. California Chicago 47, Ill.

FILMGRAPH PAT'D Conference Recorders

UNINTERRUPTED Longtime (up to 12 hours) Conference & Telephone Recordings on Safety Film Models for Dictation "TALKIES"

ECONOMICAL PERMANENT INSTANTANEOUS PLAY-BACK

MILES REPRODUCER CO., INC. 812 BROADWAY, N. Y.

PRINTED TAPE

— For "Parts" Marking —

TOPFLIGHT TOOL CO.
Huber Bldg., York, Pa.

High Speed Production Of Quality R. F. Coils and Sub-Assemblies, For Discriminating Manufacturers

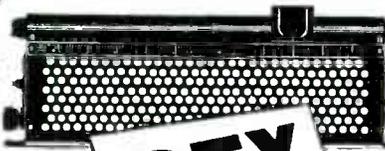
Clippard INSTRUMENT LABORATORY, INC.
1126 Bank Street, Cincinnati 14, Ohio

TELEVISION POWER COILS

Built for high voltages
5,000—10,000—30,000 V. D. C. working

FOR MANUFACTURERS and AMATEURS

MONROE COIL CO.
1606 No. California Ave. Chicago 47, Illinois



REX RHEOSTATS

REX RHEOSTAT COMPANY, BALDWIN, L. I., N. Y.

PROTECTED & UNPROTECTED RHEOSTATS WITH LUBRICATED CONTACTS

ROTARY DRIVE RHEOSTATS WITHOUT BACK LASH

PROTECTED & UNPROTECTED **ADJUSTABLE RESISTORS UP TO 1000 WATT**

PROMPT SHIPMENTS

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.

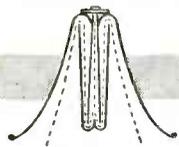
Classified Advertising Division
ELECTRONICS

INDUSTRY COMES TO SUN RADIO FOR ELECTRONIC EQUIPMENT

SUN RADIO & ELECTRONICS CO., Inc.
ESTABLISHED 1922

122-124 DUANE ST. NEW YORK 7, N. Y. BRADLEY 7-1840

UNIVERSITY REFLEX CONSTRUCTION



Engineered for
efficiency and quality

University Speakers

The conversion efficiency of UNIVERSITY loudspeakers over the useful speech frequency range is 35 to 50 percent! Parallel to this superior sensitivity, is naturalness of tone and a ruggedness which permits every model to be unconditionally guaranteed for one year. Magnets of higher magnetomotive force, greater rigidity and concentricity of voice coils resulting in smaller air-gap clearances, better heat dissipation in the voice coil, diaphragms with a higher fatigue characteristic, and exclusive "rim centering" construction are a tribute to UNIVERSITY design.



UNIVERSITY LOUDSPEAKERS • INC

225 VARICK STREET
NEW YORK 14, N.Y.



MODEL LH
WITH 5AH DRIVER—
High efficiency reflex
speaker, best for all-
around, high-power P. A.
use.



MODEL MM-2TC—
Submergence and explo-
sion proof, may be cleaned
with live steam—for ship,
railroad or mine.

Pat. Pend.

BACKTALK

(continued)

demonstration of loran was remarkable.

When one considers that radio ranges of any kind, assuming vhf range of seventy miles, will necessitate the 700-knot navigator to tune in ten or more per hour, and perform a flight pattern across the radio range jungle, trans-continental, that looks like a spider's web. Double the speed into supersonic range, and I am sure your radio ranges, omnidirectional or otherwise, can only be tagged "horse and buggy aids". Perhaps they may have some use when the CAA attempts to slow the airplane of the future down at its terminal for a landing aid.

W. J. CATLETT, JR.,
Commander, U. S. Navy
Technical Development
Committee for Air
Newport, Rhode Island

Editors Note: The opinion expressed in the article does not represent the considered opinion of Electronics editors but is a statement of opinion held in some Government circles. The Editors, in fact, heartily agree with Commander Catlett. He expresses his opinions as an individual and they do not reflect the policy or opinion of either the Navy Department or the Institute of Navigation.

UHF Tank Circuit

Dear Editor:

UPON READING carefully my paper "Composite Tank Circuit for Uhf" which appeared in ELECTRONICS for September 1946, I find a number of errors. The first sentence under the subheading *Operating Principle* should read, "The internal impedance of the tube was found, by experimentation, to be capacitive (instead of inductive) at lower frequencies, but to become capacitive (not inductive) as the upper frequency limit of the tube's oscillating range was approached."

The first sentence of the following paragraph should conclude, "... the necessary inductive reactance." The next to last sentence in the same paragraph should read in part, "... input to the grid-plate is inductive, the line must present a capacitance ...".

In Table I, the first wavelength given for the tube type 1628 should be 49 cm rather than 59. In Eq. 4, a numeral one was omitted before the plus sign in the denominator. In the following paragraph the sentence beginning, "If $C = 0, \dots$ " should read, "... which was before less than ...".

P. L. BARGELLINI
Florence, Italy

JONES 500 SERIES PLUGS and SOCKETS

(Heavy Duty)



P-506-CE

Designed for 5000 Volts and 25 amperes per contact. Socket Contacts of phosphor bronze, knife-switch type, silver plated. Plug Contacts are of hard brass, silver plated. Made in 2, 4, 6, 8, 10 and 12 Contacts.



S-506-DB

All Plugs and Sockets are Polarized. Long leakage path from Terminal to Terminal and Terminal to ground. Caps and Brackets

are of steel, parkerized. Plug and Socket blocks interchangeable in Caps and Brackets. This series is designed for heavy duty electrical work and will withstand severest type of service.

Write for Bulletin No. 500 describing this line of Heavy Duty Plugs and Sockets.

HOWARD B. JONES DIVISION
CINCH MFG. CORP.
100 W. GEORGE ST. CHICAGO 18

Find Out Now About

★ STAR ★ CERAMICS

There are many kinds for special uses, such as applications calling for resistance to electricity, heat, moisture, chemicals or weathering agents. There are more than a score of formulas in actual production at one time in our factory.

Send for "A Brief Survey of Technical Characteristics of molded Ceramic Products." It is right to the point.



The STAR PORCELAIN CO.

Electronics Dept.

Trenton 9, N. J.

SEARCHLIGHT SECTION

EMPLOYMENT • BUSINESS • OPPORTUNITIES • EQUIPMENT—USED or RESALE

UNDISPLAYED RATE:

90c a line, minimum 4 lines to figure advance payment count 6 average words as a line.
POSITIONS WANTED (full or part-time salaried individual employment only), 1/2 above rates.
PROPOSALS 75 cents a line an insertion.

INFORMATION:

BOX NUMBERS in care of any of our New York, Chicago or San Francisco offices count 10 words additional in undisplayed ads.
DISCOUNT of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

DISPLAYED—RATE PER INCH

The advertising rate is \$9.00 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.
AN ADVERTISING INCH is measured 7/8 inch vertically on one column, 3 columns—30 inches—to a page.

NEW ADVERTISEMENTS received by 10 A. M. February 10th will appear in the March issue, subject to limitation of space available.

DIELECTRIC HEATING ENGINEERS

We have three open territories in the middle and far West, and the South, for qualified sales engineers.

Our Requirements:

1. Enthusiasm and ambition
Familiarity with industries processing non-metallic solids.
3. A basic knowledge of electricity and components of electrical circuits.
4. A serviceable automobile.
5. A mature personality.

We offer:

1. Contracts covering exclusive territories.
2. Demonstration equipment for use in solving prospects problems.
3. Ample publicity, established accounts and lists of prospects.
4. Factory training.
5. Adequate compensation to start.
6. A liberal commission on all sales.
7. A chance in an industry with a future.

Write us for an interview stating your qualifications for one of these positions.

P-289, Electronics
330 West 42nd St., New York 18, N. Y.

Progressive electrical manufacturer of parts widely used in both the electrical and electronic field is expanding a sales program and as a result will require additional representatives in the territories listed below:

(Sales will be both to distributors and to manufacturers)

Kansas, Western Nebraska and Iowa
Minneapolis and surrounding area
Pittsburgh and West Virginia area
Philadelphia — Baltimore area

If interested, please write to box number indicated, underlining in detail lines now represented, types of industry now contacted and approximate annual dollar volume at this time for all lines represented. Address

RW-298, Electronics
520 North Michigan Ave., Chicago 11, Ill.

AERODYNAMICISTS MECHANICAL ENGINEERS ELECTRONICS ENGINEERS PHYSICIST-MATHEMATICIAN ADMINISTRATIVE ENGINEER

Competent to assume additional responsibility in an expanding engineering organization as staff and project engineers on new, diversified, challenging work in the development of complex aviation devices. Only those applicants possessing initiative and the ability to think analytically are desired.

Plant is located approximately 200 miles west of New York City in south-central portion of New York State. 40 hour work week permits leisure to enjoy area's many outdoor activities and scenic advantages. Wages paid are equal to, or above, locality average.

For further details write to:

Personnel Manager,

LINK AVIATION, INC.
BINGHAMTON, NEW YORK

WANTED MATHEMATICIAN

Knowledge of electrical and mechanical means of solving equations. To work on computer development with New York City concern. Additional knowledge of servo systems desirable.

P-268, Electronics
330 West 42nd St., New York 18, N. Y.

WHEN
Answering Advertisements

PLEASE do not send original letters, certificates or photographs. We cannot be responsible for their return. Please send photostat or carbon copies.

Engineers

Broadcast Radio receiver
Project Engineers, Television
receiver Project Engineers and
Mechanical Engineers experienced in broadcast receiver engineering methods. Excellent opportunity for advancement in a growing engineering department.

Reply giving full details to

Personnel Manager
BENDIX RADIO
Division of Bendix
Aviation Corporation
Baltimore 4, Maryland

WANTED—ELECTRONIC ENGINEER

By development laboratory of fifty-year old manufacturing concern located in western New York. Graduate with several years experience in radar, navigation, fire control, servo or similar systems. Must have extensive knowledge of circuit fundamentals and be able to design circuit and apparatus for implementing broad new systems and to carry the work through prototype and pilot model stages.

P-269, Electronics
330 West 42nd St., New York 18, N. Y.

POSITIONS VACANT

RESEARCH ENGINEERS — Progressive Mid-western Equipment Manufacturer located in attractive town of about 70,000 has opening for research engineers in the fields of powder metallurgy, high dielectric ceramics and glass technology applied to high vacuum tubes. University graduates with several years experience will find interesting activity in established laboratory at competitive salaries. Members of our staff have been notified. Apply P-277, Electronics, 520 North Michigan Ave., Chicago 11, Ill.

PATENT DEPARTMENT of large industrial corporation requires experienced Patent Attorneys or Agents, at least one with electronic background, for expanding research effort. Minimum supervision. Office in New York suburb. Southwest Connecticut. P-292, Electronics, 330 W. 42nd St., New York 18, N. Y.

COIL DEPARTMENT Head, experienced in set-ups, winding, impregnation, and testing home receiver type RF and IF coils and chokes, wanted by Television and Radio Manufacturer in New York area. Give experience and salary expected. P-293, Electronics, 330 W. 42nd St., New York 18, N. Y.

WANTED: Graduate radio engineer for Research and Development work on high frequency antennas and transmission line. Firm is a progressive subsidiary corporation of one of the nation's largest radio manufacturers, and is located in the Middle West. Salary to be commensurate with qualifications of accepted person. P-294, Electronics, 520 N. Michigan Ave., Chicago 11, Ill.

PRODUCTION ENGINEER. Experienced in glass machinery products and technique. Also, fluorescent chemicals and coating application to glass. Excellent opportunity. Write, giving full details in first letter. P-295, Electronics, 330 W. 42nd St., New York 18, N. Y.

EMPLOYMENT SERVICES

SALARIED POSITIONS \$2,500-25,000. This thoroughly organized confidential service of 37 years' recognized standing and reputation carries on preliminary negotiations for supervisory, technical and executive positions of the calibre indicated, through a procedure individualized to each client's requirements. Retaining fee protected by refund provision. Identity covered and present position protected. Send only name and address for details. R. W. Bixby, Inc., 278 Dun Bldg., Buffalo 2, N. Y.



EMPLOYMENT SERVICES (Continued from page 277)

EXECUTIVES \$3,000-\$25,000. This reliable service, established 1927, is geared to needs of high grade men who seek a change of connection under conditions assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited. Jyra Thayer Jennings, Dept. E, 109 Church Street, New Haven, Conn.

POSITIONS WANTED

TRANSFORMER ENGINEER — Graduate E.E., age 35, 11 years experience, all phases of audio and power transformer design, familiar with manufacturing methods, seeks responsible position. PW-296, Electronics, 330 W. 42nd St., New York 18, N. Y.

ENGINEER presently employed as supervisor of test equipment design section for large manufacturer desires position with smaller progressive organization actively planning production of television receivers. Have successfully organized both prewar and postwar television receiver production test programs. Familiar with preproduction model analysis, test process, establishment of standards, production methods of assembly and test, equipment costs, quality and reject control. Age 35. Position must carry direct responsibility for setting up and initiating production—with commensurate salary. PW-297, Electronics, 330 W. 42nd St., New York 18, N. Y.

AVAILABLE

EXECUTIVE Electronics Engineer

With administrative and technical experience in manufacturing and design of electronic vacuum tubes seeks position of high executive responsibility with mass manufacturer of equipment, components, or vacuum tubes. All locations considered. All replies confidential.

PW-291, Electronics
330 West 42nd St., New York 18, N. Y.

PACIFIC NORTHWEST Sales Representative

Established consulting electrical engineering firm desires to represent high quality manufacturers in electrical and industrial electronic fields. Excellent contact with industrial planners and plant engineers.

PAVEY AND SPARLING
814 Second Ave. Bldg.
Seattle 4, Washington

WANTED

WANTED

To purchase or license patents on patentable ideas on Transformers.

Particularly interested in ideas pertaining to Transformers and reactors for use with fluorescent lamps.

Advance Transformer Company
1122 W. Catalpa Avenue
Chicago 40, Illinois

New England

SALES REPRESENTATIVE

Desires connection with high quality manufacturers in electronic fields.

Long experience in all phases of electronics.

MORRILL P. MIMS COMPANY

M. P. Mims, W5BDB/1

43 Leon St. Boston 15, Mass.

NATIONAL DISTRIBUTION AVAILABLE

For Manufacturers who make products suitable for sale to Radio, Electrical, Electronic Jobbers and Industrials. We have a complete sales staff for national and export distribution. Reply with samples or description of product.

RA-228, Electronics
330 West 42nd St., New York 18, N. Y.

Electronic

POWER GENERATOR

Variable Frequency

0-130 volt AC—300-3500 cycles;
1400 watts

Manufactured by

Communication Measurement Labs.

Model #1400

Complete Guaranteed

\$750.00

F. O. B.
N. Y.

GREENWICH SALES CO.

59 Cortland St.
Tel. Whitehall 3-3052
New York 7, N. Y.

SHEET METAL MACHINERY

NEW and Used — Brakes — Shears
Forming Rolls — Folders — Punches—
Di-Acro, Pexid, Niagara & Whitney
Equipment

B. D. BROOKS CO., INC.

Han. 5226
361 Atlantic Ave., Boston, Mass.

METERS
AND INSTRUMENTS

VOLTMETERS	BRIDGES (Wheatstone)
AMMETERS	MEGOhmmeters
MICRO	RHEOSTATS
AMMETERS	VARIABLE
Ohmmeters	TRANSFORMERS
FREQ. METERS	RELAYS

ELECTRO-TECH Equipment Co.
119 Lafayette St., New York 13, N. Y.

IN STOCK FOR IMMEDIATE SHIPMENT

- 13 T.B.K. Transmitters will operate on 2000 KC to 18000 KC. Less Tubes and Power Supply at \$400.00.
- 2000 Dynamotors 28 V. Input 260 V. Output. Mfg. by Black & Decker & West. \$1.35 each.
- 1500 Micro Switches GE Type Z-YZ-RQI at 45¢ each.
- 500 New Steel Junction Boxes 14 ga. 17"x25"x6 1/2" with Screw Type Brass Hinges for lid. Watertight at \$2.75 each.

And over \$250,000 worth of Radio Parts, Transformers, Chokes, Fuse Holders, Insulators, Grommets, Shock Mounts, Relays, Condensers, Potentiometer Solenium Rectifiers, Bathing Condensers, Tuning Condensers, Resistors, Allen head socket screws 4/40—6/32—8/32—10/24, Screws, Nuts, and Washers, all sizes.

Mail us your inquiries

Reliance Merchandizing Co.
Arch cor. Croskey Sts.
Ritenhouse 6-4927, Phila. 3, Pa.

SURPLUS PARTS and EQUIPMENT

55,000 Sq. Ft. of Government-owned electronic parts and equipment. All material inspected and tested; backed by usual 90-day manufacturers' guarantee.

Sorry, no retail sales; all purchases against company orders only.

COMMUNICATION MEASUREMENTS LABORATORY

Central Agent for War Assets Adm.

DISPLAY ROOM: 350 W. 40TH ST.

Main Office: 120 Greenwich St., New York 6

R. C. A. TYPE 2050 THYRATRON TUBE

1000 only available for immediate shipment subject to prior sale at \$80.00 per hundred.

BARRY & DROWN
137 Main St. Buffalo 3, New York

FOR SALE

2 ALTEC LANSING LIMITER AMPLIFIERS

Model A 322. Used about 1 year.

FS-290, Electronics
330 West 42nd St., New York 18, N. Y.

RECEIVER

HRO-5T; BRAND NEW

Includes 9 coil sets 50 to 430 Kcs, and 480 to 30,000 Kcs. Complete with tubes, two power supplies (110/220 volts A.C. and 6 volts D.C.), also spare parts and tubes.

Immediate Delivery. Price, \$200.00 each
MASPETH TELEPHONE & RADIO CORP.
427 Flatbush Ave. Ext., Brooklyn, N. Y.

If this or other advertising does not supply the information concerning products or services wanted, please write:

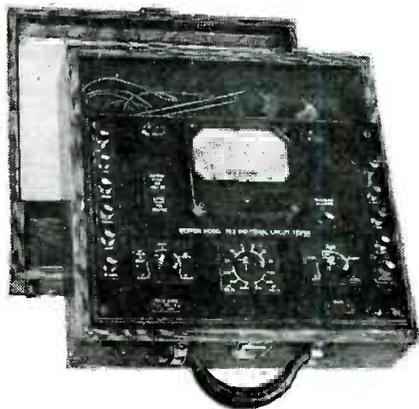
ELECTRONICS,
New York City



INDUSTRIAL CIRCUIT TESTER

WESTON MODEL 785

NEW - FACTORY - GUARANTEED



Recognized throughout Industry as the most Complete Single Unit for maintenance and test purposes: Aircraft, Communications, Radio, Electronics, Laboratories, Lighting and Power, Motors, Plant Maintenance, Repair Shops, etc.

- D.C. VOLTAGE—Six Full Scale Ranges of: 1/10/50/200/500/1000 volts (20,000 Ohms per volt).
- A.C. VOLTAGE—Six Full Scale Ranges of: 5/15/30/150/300/750 (1,000 Ohms per volt).
- D.C. CURRENT—Six Full Scale Ranges of: 50 Microamps 1/10/100 Milliamps 1/10 Amps.
- A.C. CURRENT—Four Full Scale Ranges of: .5/1/5/10 Amperes.
- RESISTANCE—Five Full Scale Ranges of: 3,000/30,000/300,000 Ohms 3/30 Megohms. Center Scale Values 25/250/2,500/25,000/250,000 Ohms.

COMPLETE WITH THE FOLLOWING:

- (A) I.R.C. Precision Wire Wound Resistor (Surplus-New) 1/5 of 1% accuracy to extend the 750 volt A.C. range of the 785 to 1500 Volts A.C.
- (B) Current Transformer (Surplus-New) to extend the 5 Amp. A.C. range of the 785 to 50, 100, and 200 Amps. A.C.

For Shop use, less carrying case

ONLY \$78.91

F.O.B., N. Y.

For Field use, with oak carrying case

ONLY \$93.37

F.O.B., N. Y.

25% deposit required
on C. O. D. shipments

WILCOX CW 3 RECEIVER

SURPLUS—NEW



The CW Receiver is a highly selective crystal controlled superheterodyne unit operating of any fixed frequency in the band of 1900 kc to 16,500 kc. The total band is covered by means of four groups of plug-in coils. Extension of the range above or below the specified range may be had by means of special groups of plug-in coils. Plug connections are provided for 110 volt, 60 cycle AC power source and for connection of receiver output.

- FIXED FREQUENCY RECEIVER
- 7 TUBE SUPERHET CIRCUIT
- CRYSTAL CONTROLLED LOCAL OSCILLATOR
- COILS SUPPLIED COVER 5.6 to 10 MEGACYCLE BAND
- AUDIO AMPLIFIER STAGE CAPABLE OF PRODUCING ZERO LEVEL DB OUTPUT ACROSS A 500 OHM LOAD
- TUBE COMPLEMENT
 - 2—6K7
 - 1—6K8
 - 2—6C8G
 - 1—6SN7
 - 1—80
- COMPLETE SET OF EXTRA SPARE TUBES
- FITS STANDARD 19" RACK, 19" WIDE, 3½" HIGH, 11½" DEEP
- GRAY & BLACK FINISH
- PACKED IN WOODEN SHIPPING CASE
- WEIGHT ONLY 14 LBS. NET
- SHIPPING WEIGHT 42 LBS.
- COMPLETE WITH INSTRUCTION BOOK, COILS, LESS CRYSTAL

ONLY \$21.95

F.O.B., N. Y.

25% deposit required
on C. O. D. shipments

PORTABLE A. C. AMMETERS



SURPLUS
NEW
WESTON
MODEL
528

DUAL RANGE 0-3 Amp. and 0-15 Amp. full scale for use on any frequency from 25 to 500 cycles. The ideal instrument for all commercial, industrial, experimental, home, radio, motor and general repair shop testing. Comes complete with a genuine leather, plushlined carrying case and a pair of test leads. A very convenient pocket sized test meter priced at less than 50% of manufacturers list. Your cost

ONLY \$12.50

F.O.B., N. Y.

PORTABLE A. C. VOLTMETERS

(See illustration of Ammeters)

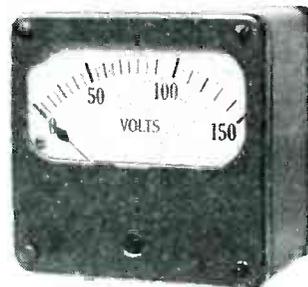
SURPLUS NEW WESTON
MODEL 528

DUAL RANGE 0-15 and 0-150 Volts for use on any frequency from 25 to 125 cycles. Complete with plushlined leather carrying case and a pair of test leads. This Voltmeter, with the matching model Ammeter as illustrated above, makes an ideal pair of test meters for any mechanic to carry around in his tool box.

ONLY \$12.50

F.O.B., N. Y.

A. C. VOLTMETER SURPLUS - NEW - GUARANTEED



WESTINGHOUSE, HA 5½" Square Case. Projection Mounted 0-150 Volts. Accuracy with 1% 5" Scale with 30 divisions easily read at a distance. Ideal for production or any type of job where critical line voltages must be maintained. List Price \$37.00. Your cost.

ONLY \$14.50

F.O.B., N. Y.

MARITIME SWITCHBOARD

ELECTRONICS — February, 1947

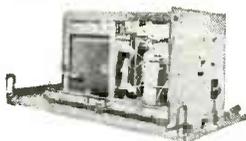
● Worth. 4-8217.

336 Canal St., N. Y. 13, N. Y.



HI-VOLTAGE POWER SUPPLY

**POWER UNIT
RA58-A
\$116**



Ideal for breakdown insulation testing, or as a source of power for a pulse transmitter. This unit supplies continuously variable voltages between 500 and 15,000 volts, DC at 35 ma. A voltage Doubler circuit using two 705a rectifiers and two 1 mf condensers is employed. RMS ripple voltage at maximum power is 6%. THIS UNIT OPERATES FROM 115 v/60c. Variable voltage is obtained by means of a Variac in the primary circuit of the high voltage transformer. Size is 21"x17 1/2"x29" deep. Net weight 314 lbs.

OIL FILLED CONDENSERS

G.E., C-D, W.E., and other well known brands			
1 mf 300 vdc...	.25	4 mf 600 vdc pyr	.70
2 mf 300 vdc...	.30	6 mf 600 vdc pyr	.95
4 mf 300 vdc...	.35	8-8 mf 800 vdc...	1.49
4 mf 400 vdc...	.55	15 mf 220 ac/600 dc	
5-5 mf 400 vdc...	1.15		
2 mf 550 vdc...	.30	1 mf 1000 vdc...	.90
.25 mf 600 vdc...	.25	2 mf 1000 vdc...	1.10
.85 mf 600 vdc...	.30	1 mf 1500 vdc...	1.20
1 mf 600 vdc...	.35	4 mf 1500 vdc...	.20
2 mf 600 vdc...	.40	1 mf 2000 vdc...	1.10
3 mf 600 vdc pyr	.65	2 mf 600 ac/-000	.95
		1 mf 2500 vdc...	1.75

HI-VOLT CONDENSERS

2 mf 4000 vdc 23F47	.....	\$5.75
G.E. Pyranol 23F49 1 mf 5000v list	.....	5.95
C-D TC-50010 1mf 5000v (list \$30)	.....	4.50
G.E. 14F191 1 mf 10,000v (list \$37)	.....	6.75
1-1 mf 7000vdc GE pyranol	.....
25F774	.....	\$4.95
.06 mf 15,000vdc GE pyranol	.....
26F585-G2	.....	\$5.95
.75 mi. 20,000vdc GE pyranol	.....
14F136	.....	\$22.00



HI-VOLT TRANSFORMER



AMERTRAN PLATE TRANSFORMER, 115 v—60-cycle primary, 6200 volt-ct-700 mil second-ary. Size 11"x14"x10". **\$39.95**

2.6 Hy 800 Ma Choke. Stud Terminal **\$5.95**

Power Supply for LM-18 freq. meter

Output: 290v @ 20 ma; 13v @ 600 ma. Input: 105-125v @ 60 cps; 260 ma; 27.6 W. with type 84 rectifier tube; shock mounted. **\$14.75** Complete with input and output plugs.

NEW C.R. TUBES



Tube Type	Aprox. List	Your Cost
3BP1	15.00	3.95
3FP7	27.00	2.98
5BP1	20.00	4.95
5BP4	27.00	7.95
5CP1	45.00	4.95
5CP7	48.00	6.00
5FP4	35.00	4.95
5FP7	32.00	4.95
5JP2	48.00	8.95
837	2.80	1.50
872A	7.50	2.45
705A	22.50	6.75
241B-WE	85.00	50.00
861	155.00	85.00
Sockets for 5CP1; 3BP1, & 5HP1 and similar types of tubes	.....	\$.95

SELSYN MOTORS

Size 5G 115 V—60 cps. NEW!

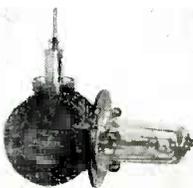
Ideal for remote control, or for antenna rotation. **\$7.75**

All merchandise guaranteed. Mail orders promptly filled. All prices F. O. B. New York City. Send Money Order or Check. Shipping charges sent C. O. D. Send for Flyers.

COMMUNICATIONS EQUIPMENT CO.

131-E Liberty St., New York City 7, N. Y. TELEPHONE WH 4-7658

WAVE GUIDE PARTS



MAGNETRONS!!
Type 2J32 (JAN.) is designed for 10 cm. operation. Rated at 300 kw peak pulse power. Complete information supplied. Brand new. The 2J32 is listed at \$200. Our Price...\$25.00
3J31's just received. One cm. magnetron listed at \$95.00.

OUR PRICE

KLYSTRON oscillator tubes 2K25/723 ab designed for 3 cm operation. New. With complete data. Listed at \$38.00, reduced to... 7.75
1B24 TR tube (3 cm)..... 2.98
Duplexer using 1B24..... 10.00
30 mc oscillator-amplifier with 2 6AC7's. Uses 723ab, Waveguide input, xtal detector. With 6AC7's..... 10.00
With 6AC7's, 723ab and 1N21..... 16.50
Thermistor Beads (D-170396), for use with UHF and Micro-Wave Equipment (List \$7.00). In separate sealed containers..... .95

3 CM WAVE GUIDE SECTIONS

Silver Plated Directional Couplers with a 20 DB drop with:
A. Straight wave guide section 6"..... \$ 3.95
B. 15° bend in wave guide 13"..... 5.90
C. 30° bend in wave guide 10" long..... 4.75
D. 90° bend in wave guide 15" long also 90° bend in coupler..... 6.50

SECTIONS

E. 2 1/2 foot silver plated with 90° bend (2" radius)..... 5.50
a 20 DB drop with:
with pressurizing nipple and coax coupler..... 3.95
G. 2 1/2 foot 3 cm wave guide choke to cover fitting..... 4.95
H. 5 foot 3 cm wave guide section per foot..... 1.95
I. Feed Horn 3 cm..... 3.50

Send for List
All merchandise guaranteed. Mail orders promptly filled. All prices F. O. B. New York City. Send Money Order or Check. Shipping charges sent C. O. D.

COMMUNICATIONS EQUIPMENT CO.

131-E Liberty St., New York City 7, N. Y. TELEPHONE WH 4-7658

Special Values

Panel & Portable Meters

D. C. Microammeters:
50-100-200-500 microamps. High Resistance Voltmeters Vacuum Thermo-Couple Meters 3 1/2" & 4 1/2" Round & Rectangular

Multirange Portables:
readings from 10 microamps. full scale

Precision Electrical Instrument Co.
146 Grand Street New York 13 N. Y.

SENSATIONAL VALUE!

Model 689-IF

WESTON OHMMETER

Limited Quantities. Immediate Delivery.



A convenient, pocket size ohmmeter for checking circuits by the resistance and continuity method. The energy for the resistance readings is supplied by a self contained 1.5 volt No. 2 standard large flashlight cell. Variation in battery voltage is compensated by a magnetic shunt adjustable from the outside of the case. Built to meet U.S. Army Requirements for Accuracy and Durability! This Ohmmeter also has a double range 0-10 and 0-1000 ohms for the accurate measurement of low resistance values. This type is widely used for production testing armature and field resistances of small motors, relay and coil testing, transformer winding tests and other similar appliances.

Model 689-IF comes complete with operating instruction, test leads and LEATHER CARRYING CASE.

List Price \$25.50 Special **\$14.85**



Leather Case

METROPOLITAN ELECTRONIC & INSTRUMENT CO.

DEPT. E, 6 MURRAY STREET, NEW YORK 7, N. Y.

SPECIAL BUY IN

DELCO DUAL BLOWER



SPECIAL \$15.95

Immediate Delivery

Blows 200 CFM; 110 Volt AC, 60 Cycles; overall length 10 3/4"; overall width 6 3/4"; each blower opening 2" in diameter; intake opening 2 5/8" in diameter. Unit has DELCO sealed in motor requiring no lubrication—built-in mounting brackets; ideal unit for cooling large tubes or exhaust for laboratory use—also perfect for Photo Darkroom application.

We also carry a complete line of electronic and communication equipment. Send for latest bulletin I B.

Write or Wire to—

NIAGARA RADIO SUPPLY CORP.
160 Greenwich St. New York 6, N. Y.
Bowling Green 9-7993

SURPLUS EQUIPMENT SALES

H. F. Constant impedance, 50 ohm coaxial connectors, type N: UG21U \$0.75 UG58U \$0.75 UG27U \$1.00 SO239 \$0.50 M359 \$0.50
Measurements model 78B, R.F. signal generator, 15-25 mc and 150-230 mc, good order..... \$15.00
3" cathode ray scope, rad. P indicator, ID-93/ APG-13A complete with 3BP1 and 10 tubes, new, 115v 400cps..... \$25.00
Oil filled capacitors:
.05 mfd 2500 WVDC G.E. Pyranol 26F160..... 1.75
1 mfd 2500 WVDC G.E. Pyranol 23F121..... 7.50
.15 mfd 4000 WVDC G.E. Pyranol 25F279..... 1.50
25 mfd 4000 WVDC Sprague P-9717..... 1.00
2 mfd 4000 WVDC G.E. Pyranol 23F47..... 5.00
5-5 mfd 5000 WVDC G.E. Pyranol 26F729..... 4.00
2 mfd 10000 WVDC G.E. Pyranol 26F433..... 6.00
1 mfd 15000 WVDC G.E. Pyranol 14F263..... 25.00
Micas
.01 mfd 1250 WVDC 15c .005 mfd 2500 WVDC 35c
.00015 mfd 5000 WVDC, 6 amps at 3 mc, 3 amps at 1 mc..... \$3.00
Silver button micas 15 and 500 mmid, .10c each Transformers (115v 60 cps)
6000 v rms 30 ma, 16000 v insul., potted, G.E. \$9.50
5500 v rms 2 ma, 2.5 v 2.5 amps 12000 v ins., 6.3 v 6 amps 4800v ins..... \$7.50
2.5 v 2.5 amps 16000 v ins., 7 v 7 amps 16000 v ins. tapped at 2.5 v, potted, G.E..... \$7.50
1120 v 600 ma c.t., 2x5v 6.2 amps c.t., 3 kv ins., 6.3 v 3 amps 1700 v ins., 6.3 v 3 amps, 1.7 kc ins. potted..... \$12.50

Write for Bulletin

ELECTRO IMPULSE LABS.
SHREWSBURY, NEW JERSEY

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.



TAB

That's A Buy

NEW GUARANTEED

ELECTRONIC PARTS

Table listing various electronic components like RF Choke, Condensers, and Electrolytic capacitors with their prices.

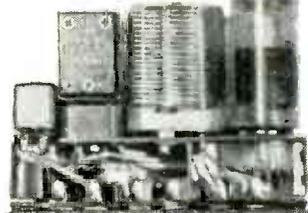
NEW SELSYNS TYPE XXI AG

SYNCHRONOUS AC REPEATER 115V 60 cy—Made for Gunfire control—Guaranteed—Ordnance Insp.—Hi-accuracy—Continuous duty—Packed for overseas shipment, complete with Insp. Calibration report. Per pair \$7.95.



Table listing various electronic components like W. E. Crystals, Dynamic microphone, and various resistors.

BC-746-B DUAL CRYSTAL TUNING UNIT



Contains Two plug in CRYSTALS FT243/BT Cut & coils, Variable Cond 140mmf. xtal socket complete \$1.25

With carborundum finishing stone. Two BC74-B units \$2.25. CRYSTALS AMATEUR FREQ'S FT243/BT Four for \$3.00. CRYSTAL STD 200KC = 10cys-Vacuum \$5.95

Table listing various electronic components like Condensers, Resistors, and Transformers with their prices.

METERS, BRIDGES, AMPLIFIERS



Table listing various electronic components like meters, bridges, and amplifiers with their prices.

Precision Wire—25000, 294000, 314000, 333500. Wound Resistors—353503, 400000, 402000, 422000. IRC, SHALLCROSS—458000, 478000, THREE FOR \$1.50. MEPCO INST RES., 500000, 600000, 700000; 3 FOR \$1.95. CO., OHMITE FOR IMEGOHM 1% accy Three for \$2.45. SPRAGUE 10Meg TenKV MEGOMAX MFAL \$1.75. SPRAGUE 12Meg 12KV MEGOMAX MFAL 1.95 (S24). IRC WW 1/2 of 1% HMETCLLY SEALED NAVY RESISTORS (S24) 1.69. STANCOR AUDIO P to G H. V. inslt. \$9.99. STANCOR PULSE BTO TELEV TRANSF. 1.95. STANCOR 855VCT/325ma & 490V/325ma. 4.50. CHOKF 501V/125ma Cased nifed CHT. 2.50. TRANSF 10V/25Amp, 2.5V/35A, 770V/7ma, pri TRANSF 7 or 14V/8A, 10 or 20V/8A, pri 210 to 240V 4.95. C'RAY TRANSF RAYTHEON 770V/2.5ma, 2.5V/3A, 115V 60 to 400cy Pri, & 2AP1 tube & socket 8.25. Modulation Transf 3600ohms/70ma, Sec 720. 8.25. LINE TO MEGOHM COIL 500ohms/6ohms 1.49. WESTON 654 Doughnut transf 200/5amps. 3.50. Choke GE 2.65Henry/850ma/10ohms. 3.95. C'Ray Transf 1320V & 750VCT/110ma, 5V/3A, 2.5V/3.25A 6.3V/2.75A, Pri 115V/50-60cy HV insl Navy THORADARSON 9.95. Above Transformer complete with High & low Voltage Rectifier tubes, choke, resistors, Condens & BPT1 tube & Diaphetal socket-ideal basic C'Ray supply 16.95. WRITE FOR OTHER SIZES FROM STOCK

New Remote Control unit RM-53 (RC-261)



For voice operation of transmitter distances up to 1/2 mile from radio set—Complete with manual—Contains PL55 & PL68 cords & plugs, jacks Malloy 41PT switch.

Two 4mfid wch condens. Transformer multi-tap UTC-600ohmCT line to G. line to 150 or 250 ohms. KURMAN sensitive 4MA Relay DP one normally open, other closed. Toggle switch, bushings & water-proof box "TAB" SPECIAL \$3.49. WITH T17 CABBIN MICROPHONE \$5.25

Table listing various electronic components like GR VARIAC, TRANSAT, SOLA LAB, LITTLEFUSES, and Resistor Kit.

ANTENNA A-27 (Phantom)

new in metal box with calibration card 2 to 4.5mc's; useable as dummy antenna load frequencies to 28mc's contains Variable Xmitting Cardwell or Millen Type 12515 condenser 18 to 157-nmf (\$7.50) easily converted to split stator & 2 Ward Leonard plague resist Non Incl 12-ohms/4watt incl Manual & Spare leads SPECIAL \$1.95



\$2 Min. order FOB N.Y.C. Add Postage all orders and 25% deposit Worth 2-7230. Send for catalog 99. Specialists in International Export, School, College & Industrial trade. Moneyback "TAB" Guarantee.

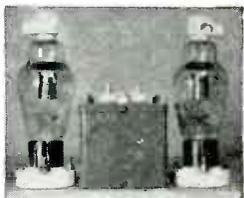
Table listing various electronic components like WE 307A RF Pentode, WE 339A RF Pentode, WE 708A UHFH, WE 717A Door Knob tube, 2C28 JAN New UHFH, RX215 RAYTHEON, GE 811 Boxed GTD, 1625 JAN new beam, 3BP1 & Socket, 5AP1 or 5BP1, 6H6, 3A4, 6C4, 2050, 2X2, RK60/1641, 6S17, 1E7G, 6S47, 618G, 6SN7, 6J6, 6V6, 9002, 9006, 6AK5, 6AG7, 6S07, 6V105, VR105, 5Y3CT, Neon glow lamp, Neon glow lamp, Mazda 49 min Bay, Mazda 44 min Bay, Neon U-4/GT.

Table listing various electronic components like RCA 808 JAN-CRC, GE & WST 807 JAN, GE & RAY 955 JAN, 954 BOXED JAN, 956, 957, 958A, RCA 6AC7 JAN, 872A new & socket, 3124 H. V. Rectifier, NU2V3G JAN, GE #46A/2C40, RCA 829B/3E29.



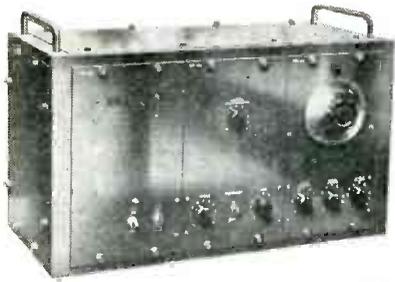
Table listing various electronic components like 35L6 New gtd, 35Z5 New gtd, 50L6 New gtd, 12SQ7 New gtd, Mazda #323-3V, GE Transformers, 4000V/2ma shielded, C'Ray #1 6.3V/2A, 2.5V/1.75A, 20000V HV Insulation, PH-TRANSF, Auto-Transf, Transformer Sec 90, 80, 70V at 1Amp, 6.8V-1V/10A, 6.5V/6A, 5V/3A, 5V/3A, Transf 750V CT/220ma GE-Cased, COLLINS 115/230V-50/60cy-16.6V/1.25A, 12.6V/3.5A cased HV Insulated, Two 6.3V/3A, 7V/14A, 5V/6A, 5V/3A, THEIRAMADOT Transf cased S. C. cont duty, PRT 200, 210, 220, 230, 240, 440V/50/60cys, Sec. 3800VCT/6KV/2.7AMPS (\$365), COLLINS CHOKE 6Hy/1.2AMP/300ohm/12500 wkg cased HV Insulated, Mismatched cased choke 10Hy/150ma, NAVY TWO for, GE Dual 15Hy/85ma choke cased H.V. insl., Transf 1200VCT/350ma, pri 105-120V/50-cy.

Raytheon 866A filament transformer 115V 60c pri. 2.5Vet 11A Sec and Two new 866A tubes. With caps and sockets \$7.00 Raytheon Transformer only \$3.25



872A's Combination Rectifiers. Transformer Kenyon short sockets. New GTD. \$12.00 TRANSF Cased Pri105to250V/60cy, Sec 2240V 500ma, 12V/4.5A, 19.2V/2.A. \$11.50

WE "OUNCER" MIN PP/P to PP/G input. \$1.20 WE inpt & P' Driver transfs 6V6/805. 6.95 Kenyon dynamic mike to Grid transf. \$1.95 Transf 100VCT/300V/110ma, 6.3V/5V/3A, Three Sec 1000VCT/300V/110ma, 6.3V/5V/3A, Three 6.3V 15A, 6.3V/1.25A & Two H-cased chokes 10Hy 60ma & 25 oil condns 3mfid/330-VAC/1000 WVDC GE Pyranol & RK60 Tube 9.95 Transf line to line 500, 333, 250, 200, 125, 500ohms-LDB Cased THEIRAMADOR mfr. 1.95 RAYTHEON Cased 840VCT/110ma, 540VCT 21ma 5V/3A, 3V/3A, 6.3V/1A, 6.3V/6A, 115V 60cy Pri & Two 10Hy/110ma Hmfclly cased chokes & oil condns Two 2.5&5mfid/600WVDC 8.95 Pulse Transf 0.4MU sec Horiz. BTO Tele- vision 1.49 RAYTHEON VIDEO TRANSF UX9204A-Tele 1.95 UTC OUNCER MIN. DYNAMIC MIKE T. G. 75 Collins Transf 210-250V/50-60cy Sec 2.5V/15A 4.95 STANCOR 2100V/10ma C'RAY 5.95 STANCOR 6.3V/6A, 2.5V/1.75A, 2.5V/1.79A 3.95 STANCOR 6.4V/12A, 6.4V/10.6A, 5V/3A, 5V/3A HV insl. 4.95



PUBLIC ADDRESS

by ACOUSTICAL

for the very best in
REPRODUCTION • DESIGN
WORKMANSHIP • SERVICE

We will gladly send you full details and specifications of the full range of ACOUSTICAL P. A. Equipment on request.

 **ACOUSTICAL** MANUFACTURING CO., LTD.
HUNTINGDON ENGLAND
TELEPHONE: HUNTINGDON 361

SAY MODERN METHODS SLASH SCREW COSTS 86%

By Means of Special Developments

KEENE, N. H. (Special) — A saving of \$58,653 in screw costs alone for one customer, together with a reduction in weight amounting to 31½ tons, is the remarkable achievement credited to engineers of the New England Screw Company of this city. The saving was made through development of a special screw which replaced two screws formerly used.

"This saving is directly attributable to our Engineering Department," the president of the 50 year old firm, declared today. "Our customer asked us to develop a single part to replace two screw machine parts which were the bottleneck in otherwise high-speed production. Subsequent research revealed how we could make a saving of 43% in material on one item and 230% on the other. In actual production we used 23,370 pounds of brass wire as against 87,172 before. And the single part does the job better!"

Illustration on left shows one of the many special screws developed by this firm. Their



Engineering Department will gladly co-operate with the engineers of any manufacturer using standard or special screws or head-shanks. The new catalog which fully describes the manufacture of New England Screws, will be sent to any company requesting it.

NEW ENGLAND SCREW CO.
KEENE, NEW HAMPSHIRE



CUP WASHERS
for Binding Screws

Preferred

as a source of precision-made WASHERS and STAMPINGS manufactured to your specifications



WHITEHEAD STAMPING CO.

1691 W. Lafayette Blvd.

Detroit 16, Michigan

THERE'S A DRAKE SOLDERING IRON FOR EVERY TYPE OF ELECTRONIC WORK

From that mighty mite



the Drake No. 400 to the high-speed production "honey"



the Drake No. 600-10 there is a high quality Drake Soldering Iron "just right" for the job.

Drake Heat Controls and the Drake "Magic Cup" Stand are important soldering aids.



SEE
YOUR RADIO PARTS JOBBER

DRAKE ELECTRIC WORKS, INC.
3656 LINCOLN AVE. CHICAGO, ILL.

PRECIOUS METALS IN ALL FORMS FOR THE ELECTRONIC INDUSTRIES

PLATINUM
WIRE · RIBBON
FOIL
SEAMLESS TUBING



SILVER
WIRE · SHEET · TUBING
SILVER BRAZING
ALLOYS & FLUXES

FOR A COMPLETE LIST OF OUR PRODUCTS

SEND FOR OUR NEW FOLDER, E-20

"PLATINUM, GOLD & SILVER FOR SCIENCE, INDUSTRY & THE ARTS"

THE AMERICAN PLATINUM WORKS

231 NEW JERSEY R. R. AVE.
NEWARK 5, N. J.

PRECIOUS METALS SINCE 1875

Radio Comm Co.
 2767
 280
 280
 278
 281

RCA PREFERRED TYPE POWER TUBES

QUICK-REFERENCE POWER-FREQUENCY TABLE



Type No.	Class	Maximum Input Power (Watts) CCS Unmodulated Class C Ratings at:											
		1.6 Mc.	7.5 Mc.	15 Mc.	25 Mc.	50 Mc.	75 Mc.	110 Mc.	150 Mc.	200 Mc.	250 Mc.	300 Mc.	600 Mc.
9C21	Triode	150000	150000	150000	150000								
9C22	Triode	100000	91000	80000	75000								
9C25	Triode	40000	40000	40000	40000	25000	25000	25000					
9C27	Triode	40000	40000	40000	40000	25000	25000	25000					
892	Triode	30000	22500	17000									
892R	Triode	18000	13500	10500									
889-A	Triode	16000	16000	16000	16000	16000	14000	11000	8000				
889R-A	Triode	16000	16000	16000	16000	13500	10000						
8D21*	Tetrode	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	
7C24	Triode	5000	5000	5000	5000	5000	5000	5000					
833-A	Triode	1800	1800	1800	1750	1500	1200						
6C24	Triode	1500	1500	1500	1500	1500	1500	1500	1500				
4-125A/4D21	Tetrode	500	500	500	500	500	500	500	500	425	335		
8000	Triode	500	500	500	500	400	300						
813	Beam Power	360	360	360	360	300							
8005	Triode	240	240	240	240	195							
828	Pentode	200	200	200	200	160	130						
811	Triode	155	155	155	155	155	125						
812	Triode	155	155	155	155	155	125						
826	Triode	125	125	125	125	125	125	125	125	125	125	100	
829-B*	Beam Power	120	120	120	120	120	120	120	120	120	105		
8025-A	Triode	75	75	75	75	75	75	75	75	75	75	75	75
815*	Beam Power	60	60	60	60	60	60	60	55	40			
807	Beam Power	60	60	60	60	60	50	40					
2E24†	Beam Power	40	40	40	40	40	40	40	33				
832-A*	Beam Power	36	36	36	36	36	36	36	36	36	32		
2E26	Beam Power	30	30	30	30	30	30	30	25				
802	Pentode	25	25	25	25	20	16						

*Twin type—input values per tube for push-pull operation.

†Recommended only for highly intermittent applications. Input values are ICAS ratings.

The accompanying table of ratings vs. operating frequency provides the design engineer with a simple and rapid means of choosing the most suitable RCA tubes to meet the power and frequency requirements of equipment in the design stage.

Technical Literature

Detailed data on all the types listed

are provided in the RCA HB-3 TUBE HANDBOOK. Technical bulletins covering tube types in which you are interested will be sent on request.

Application Engineering Service
 RCA tube application engineers will be pleased to cooperate with you in selecting the use of any other

RCA tube types to your equipment designs. Just write RCA, Commercial Engineering, Section 5-40B, Harrison, N. J.



RCA Laboratories, Princeton, N. J.
 THE FOUNTAINHEAD OF
 MODERN TUBE DEVELOPMENT



TUBE DEPARTMENT

RADIO CORP. DEPARTMENT OF AP



