
NOVEMBER · 1946
electronics
A McGRAW-HILL PUBLICATION
OPEN HEARTH FURNACE

electronics

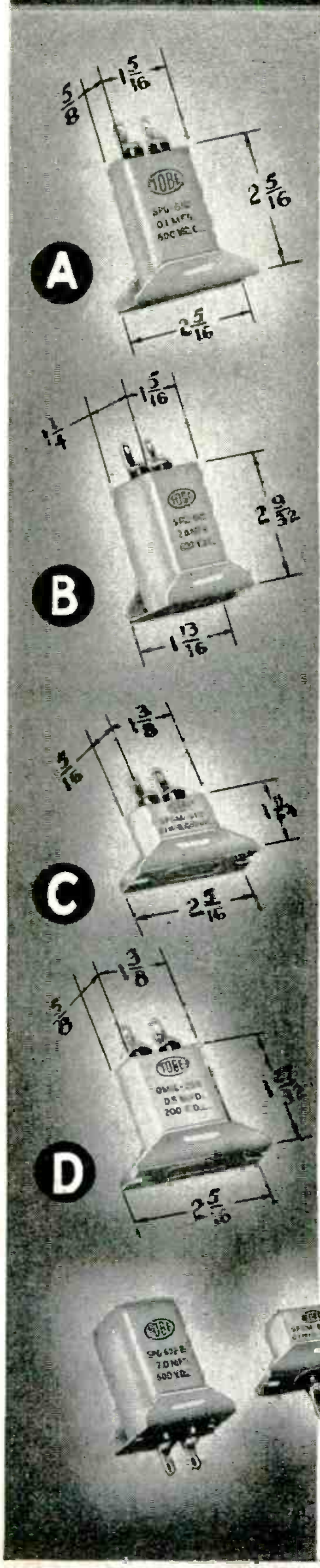
A McGRAW-HILL PUBLICATION

NOVEMBER • 1946

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, November, 1946, Vol. 19; No. 11. 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, [illegible].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 $15.00 for one year, $30.00 for three years. Please indicate position and company connection on all subscription orders. Entered as second Class matter August 29, 1936, at Post Office, Albany, New York, under the Act of March 3, 1879. BRANCH OFFICES: 520 North Michigan Avenue, Chicago 11, Ill.; 68 Post Street, San Francisco 4; Aldwych House, Aldwych, London, W. C. 2; Washington, D. C. 4; Philadelphia [illegible] Cleveland 15 Detroit 26; St. Louis [illegible] Boston 16; Atlanta 3, Ga.; 621 So. Hope St., Los Angeles 14; [illegible] Building, Pittsburgh 22.

CHECK these SPECIFICATIONS



These data explain the outstanding performance of Tobe" Oil-Mites" . . . demonstrate their qualifications for use under extreme humidity and temperature environment . . . show the diversity of mounting provisions, sizes, housings, and electrical ratings for convenient incorporation in electronic and electrical apparatus.

Winding: non-inductive.
Impregnation: mineral oil.
Case: seamless drawn steel, hermetically sealed; non-magnetic case (copper or brass) can be furnished.
Terminals: non-removable tinned copper solder lugs riveted to phenolic bushings.
Terminal Seal: oilproof gaskets between all adjacent surfaces in terminal assembly; terminal solder-sealed to assembly rivets; metal-to-glass-sealed terminals can be furnished if specified.
Case Finish: tinned all over.
Markings: type number, voltage and capacitance rating, and terminal identification ink-stamped on case.
Insulation Resistance: never less than 2,000 megohms.
Dissipation Factor: less than 0.008 at 1,000 cycles.
Operating Temperature: minus 55C to plus 85C.

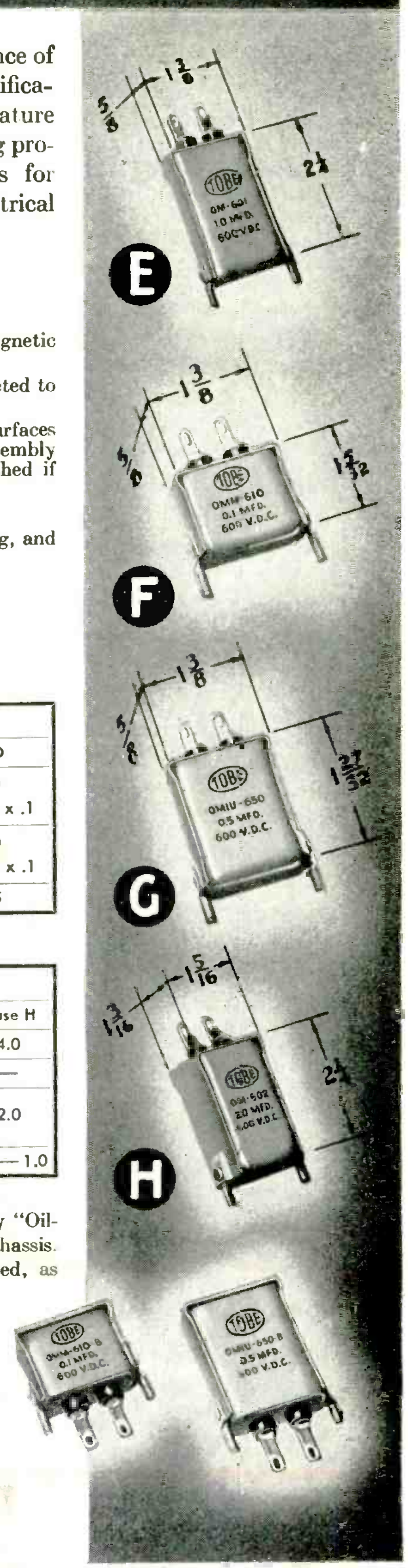
With Attached Channel Bracket

VDC	MFD			
	Case A	Case B	Case C	Case D
100	—	4.0	.01 — .25 2 x .05, 2 x .1	.01 — 1.0 2 x .05, 2 x .1
200	—	—		
400	—	2.0		.01 — .50 2 x .05, 2 x .1
600	.01 — 1.0			
1000	.05 — .50	1.0	.01 — .1	.01 — .25

With Reversible Hold-Down Bracket

VDC	MFD			
	Case E	Case F	Case G	Case H
100	—	.01 — .25 2 x .05, 2 x .1	.01 — 1.0 2 x .05, 2 x .1	4.0
200	—			—
400	—		.01 — .5 2 x .05, 2 x .1	2.0
600	.01 — 1.0			
1000	—	.01 — .1	.01 — .25	.05 — 1.0

Uniformity of size adds to the convenience afforded by "Oil-Mites," allowing gang installation above or below the chassis. Both upright and inverted mounting can be furnished, as illustrated. Where necessary, variation can be made in style and position of terminal lugs.



Reprints of this specification page are available and will be sent on request. For detailed data on "Oil-Mites" and other Tobe Capacitors ask for Catalog 4611-E

TOBE DEUTSCHMANN *Corporation* CANTON, MASSACHUSETTS

...high octane gasoline

...electric household appliances

partners in creating

K+E

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

● Creative men...engineers and engineering draftsmen...plan and build things to last. By the same token they look for instruments and equipment that will last. The tracing paper they draw on must be permanent. Their drawings must serve as lasting records. They may even have to use these same drawings years later to make new reproductions.

For 79 years there has been a lasting partnership between Keuffel & Esser Co. equipment and materials and the engineers and draftsmen of America. This partnership has been so general, that there is scarcely an engineering or construction project but what K & E products have played their part in it.

One of these products is ALBANENE* Tracing Paper. Its 100% pure white rag fibers are stabilized and transparentized with Albanite, a K & E synthetic solid. ALBANENE is permanent. Free from oils, it cannot "bleed" nor lose its transparency with time. For complete details, write to your nearest K & E distributor or to Keuffel & Esser Co., Hoboken, N. J.

*Reg. U. S. Pat. Off.

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

Electric Guitar 22½", molded by F. E. Reinhold, Los Angeles
Manufacturer: Kissel Co., Los Angeles
Sold by: Conn Instrument Co.

want to strike a new note in your product?

use RESINOX

Here is another ideal example of complete harmony between material and product needs.

Resinox . . . now being used in large area moldings . . . meets the following important requirements for this attractive new-style electric guitar:

1. Molds readily to intricate design . . . minimizes handwork.
2. Handsome color and finish are inherent . . . and lasting
3. High impact strength
4. Resistant to high heat, water, acids
5. Exceptional electrical insulating properties
6. Good sound insulation . . . hushes errant vibrations

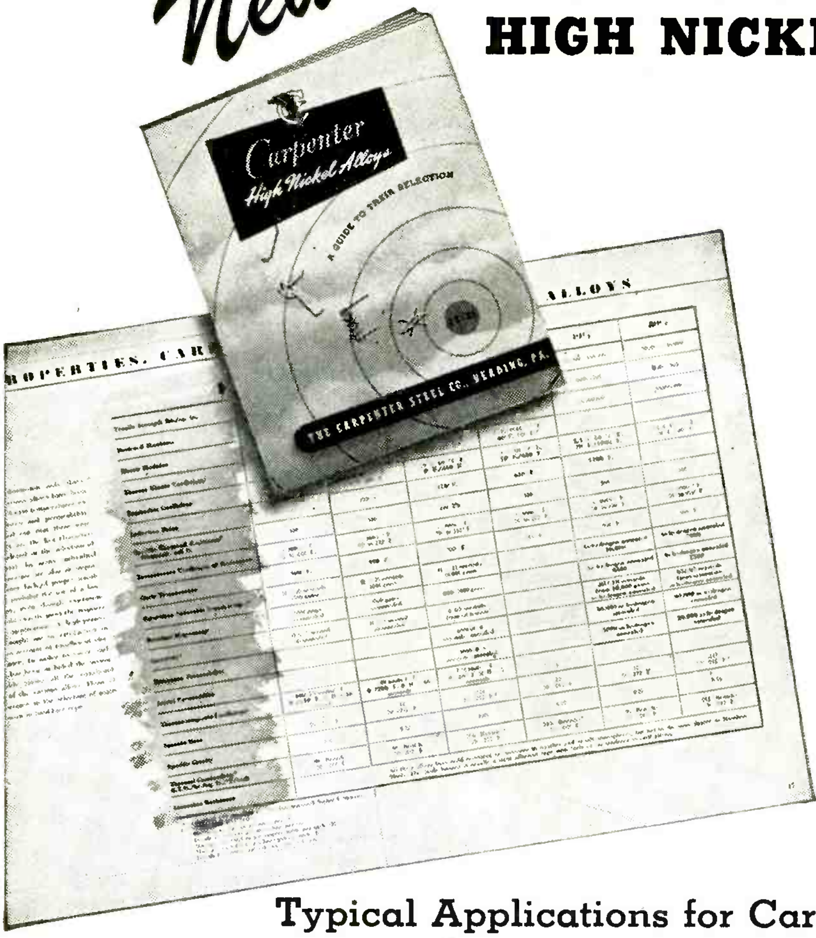
MONSANTO PLASTICS
SERVING INDUSTRY . . . WHICH SERVES MANKIND

You may or may not make musical instruments, or communication devices . . . but Resinox and Monsanto's Family of Plastics do offer a wide variety of properties — a wide variety of opportunities for all to improve product *and sales* by astute applications.

Full details on Resinox, Monsanto's famous thermo-setting phenolic molding material . . . or any other Monsanto Plastic are yours for the asking. Simply address: MONSANTO CHEMICAL COMPANY, Plastics Division, Springfield 2, Massachusetts. In Canada, Monsanto Ltd., Montreal, Toronto, Vancouver.

Resinox: Reg. U. S. Pat. Off.

New TECHNICAL INFORMATION ON HIGH NICKEL ALLOYS FOR . . .



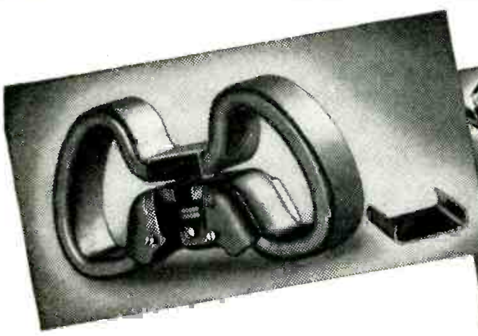
Low Expansion
Temperature Compensation
Glass Sealing
Magnetic Permeability

This information, much of it never before published, will help you find new ways to improve product performance with iron-nickel alloys. Carpenter's new 22-page bulletin includes a complete chart showing the general effect of various percentages of nickel on the magnetic and expansion properties of iron.

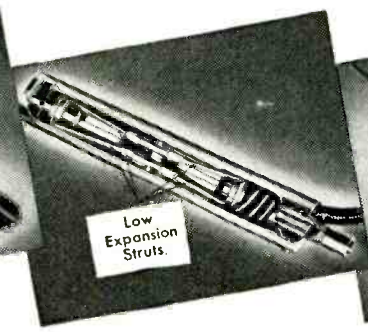
Typical applications for High Nickel Alloys are described and illustrated, and a Table of Physical Properties gives basic data on these alloys.

For a copy of the new Carpenter High Nickel Alloy Bulletin, drop us a note on your company letterhead, indicating your title. Your Bulletin will be sent promptly.

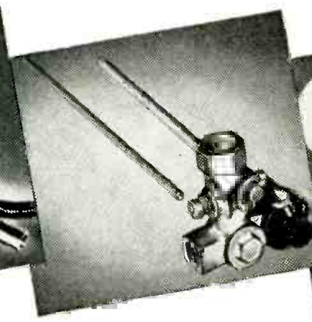
Typical Applications for Carpenter High Nickel Alloys



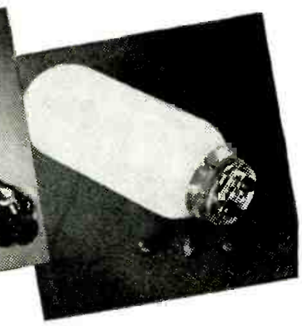
Watthour meter permanent magnet assembly with shunt of Carpenter Temperature Compensator "30".



Thermal switch using Carpenter Low Expansion "42" for low expansion struts as indicated.



Water heater thermostat employing Carpenter Free-Cut Invar "36" together with a high expansion alloy.



High wattage lamp with ferrules of Carpenter Glass Sealing "42" used to bring out leads.

THE CARPENTER STEEL COMPANY—170 W. Bern St., Reading, Pa.

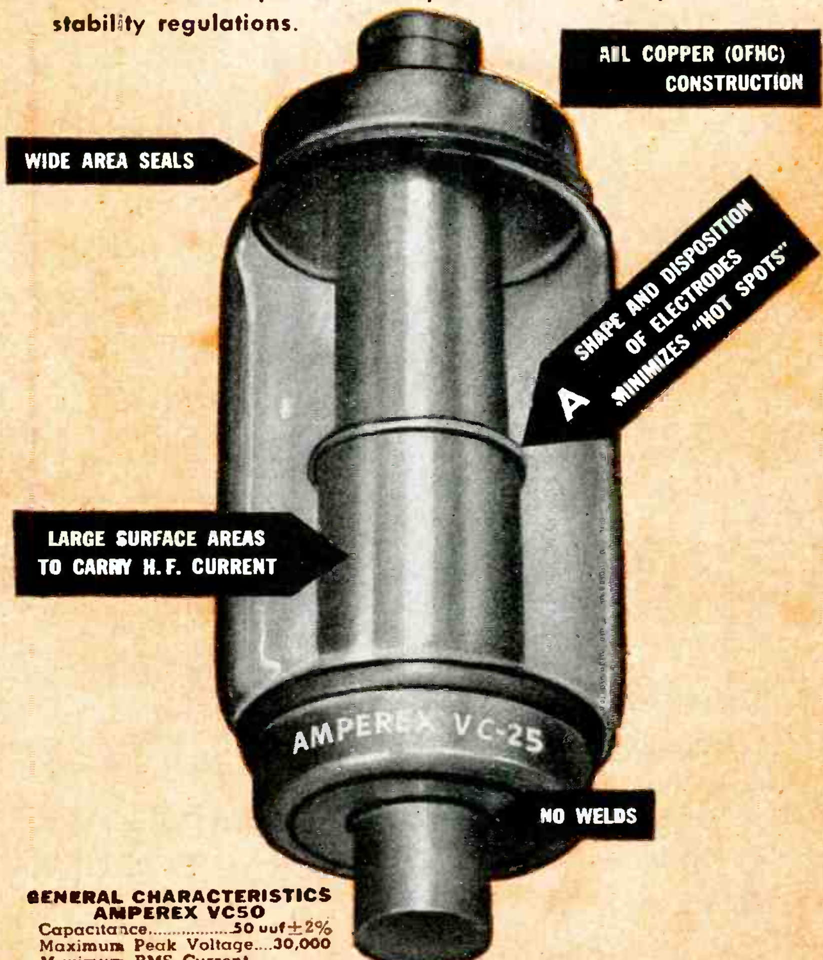
Carpenter
High Nickel Alloys

- Temperature Compensator "30"
- Carpenter Invar "36"
- Carpenter Free-Cut Invar "36"
- Glass Sealing "42"
- High Permeability "49"

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, dialectric 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

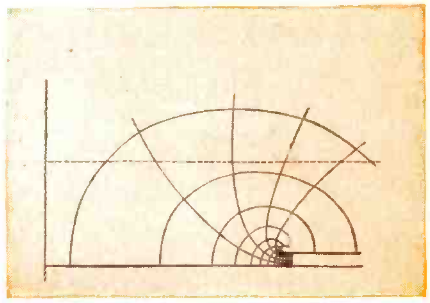
Capacitance.................50 uuf ± 2%
Maximum Peak Voltage....30,000
Maximum RMS Current
65 Amps at 10 Mc.
40 Amps at 60 Mc.
Dimensions:
6½" ± 3/32" x 2½" Max.

WRITE FOR
COMPLETE TECHNICAL RATING AND DATA SHEETS

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



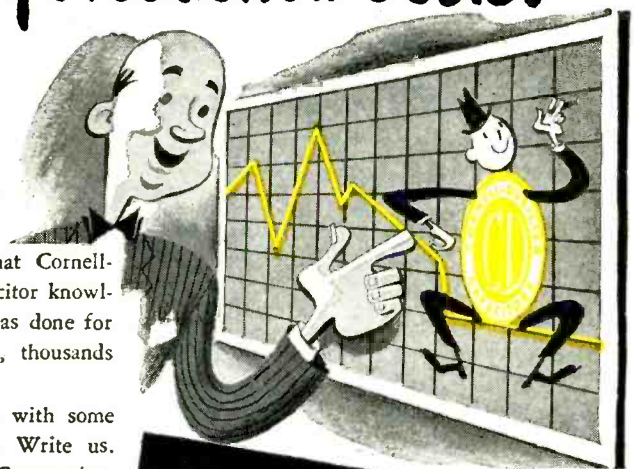
Type of equipotential and electrostatic flux lines established by probing electrolytic bath to determine shapes and disposition of electrodes. (POINT "A" IN PHOTOGRAPH)

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.

"Hey, You're Sitting On My Production Costs!"



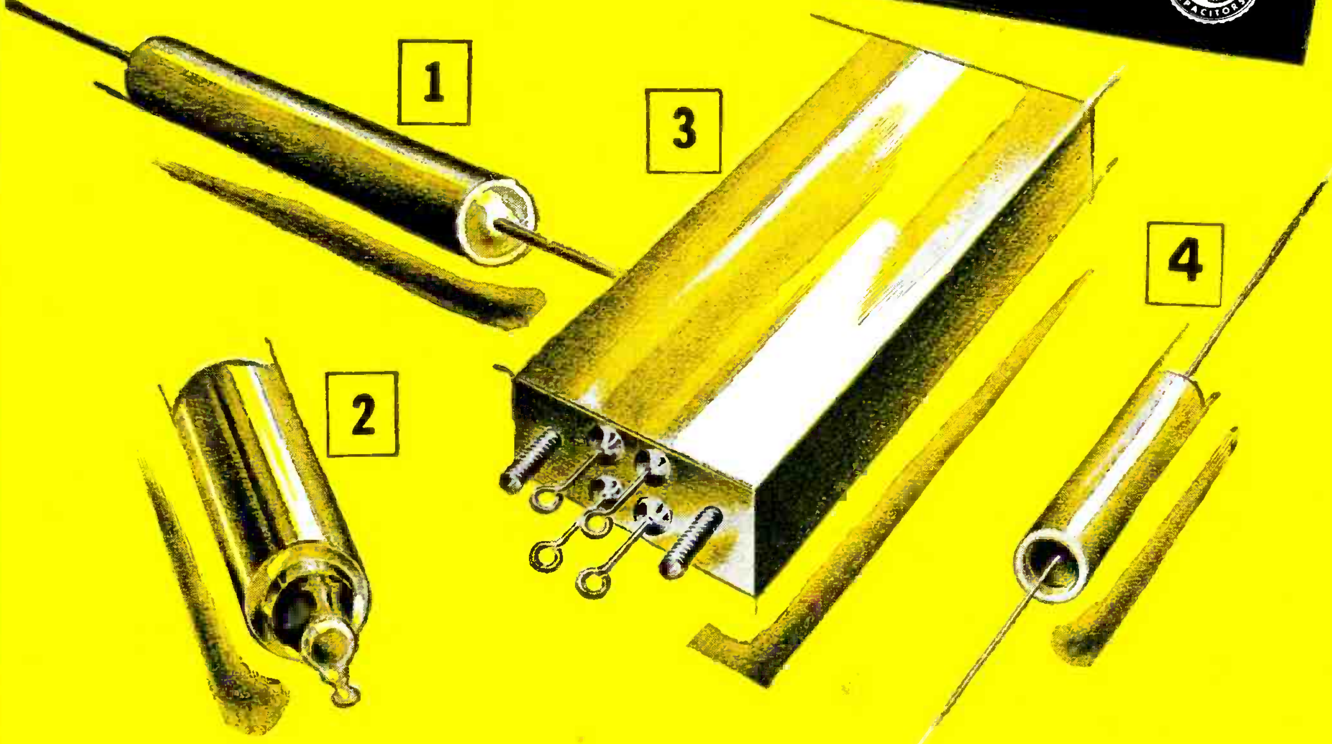
I wrote a delighted manufacturer of electrical household appliances.

We grant you, a balance sheet is a strange place for an engineer to cool his heels. But this is just another way of showing you that "specialization" and "engineering flexibility" aren't merely words we throw around at Cornell-Dubilier; they carry weight . . . much weight! The fact that Cornell-Dubilier engineers were able to let loose 100% of their brain power and experience in designing capacitors shown below is proof that Cornell-Dubilier's specialized capacitor knowledge can save you, as it has done for many other manufacturers, thousands of production dollars.

Perhaps we can help you with some special capacitor problem. Write us. Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey. Five other plants in New Bedford, Providence, Worcester and Brookline.

CORNELL-DUBILIER
world's largest manufacturer of
CAPACITORS

MICA • DYKANOL • PAPER • ELECTROLYTIC



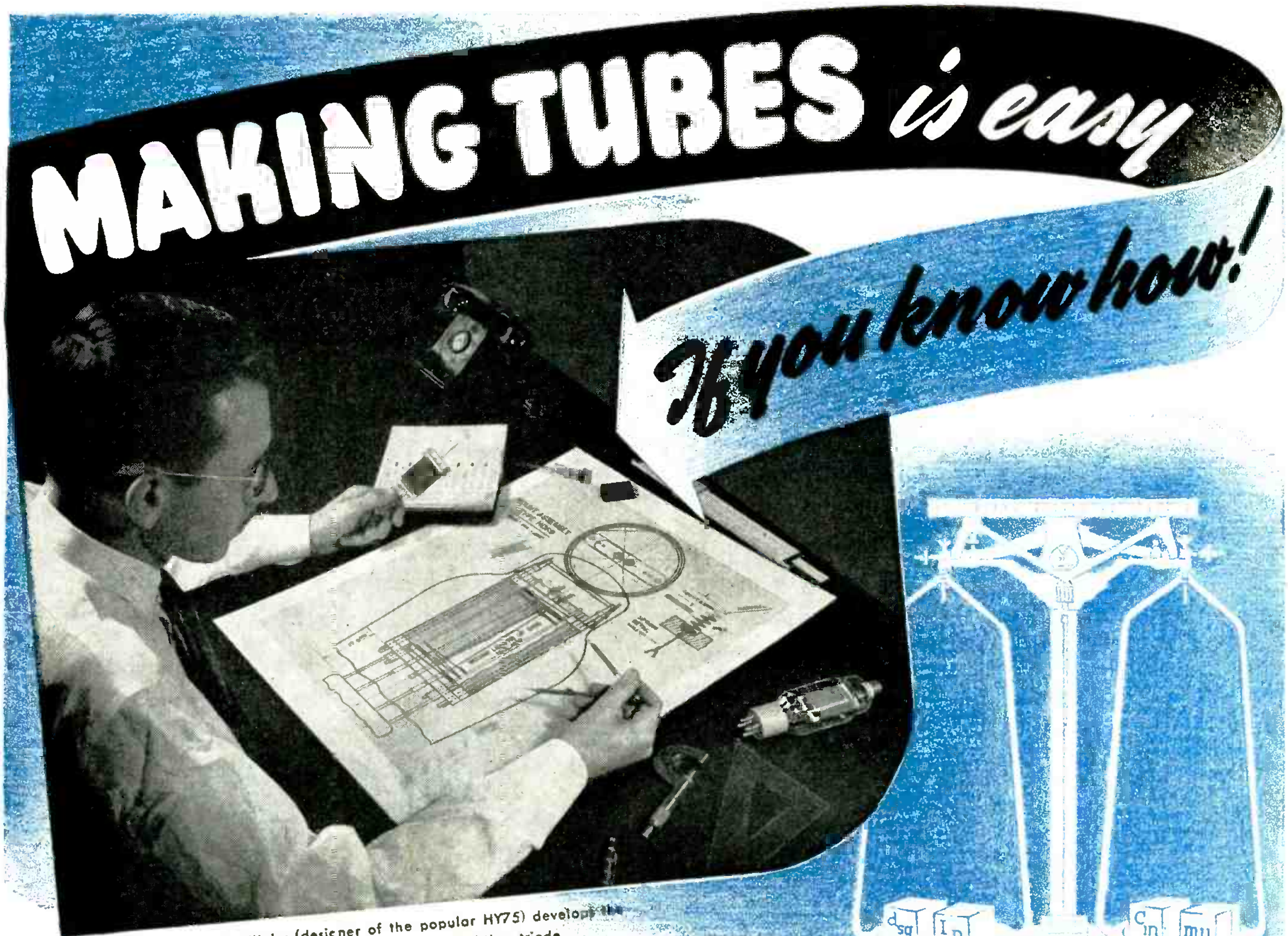
A FEW OF C-D's MADE-TO-ORDER CAPACITORS

CAPACITOR #1. Here is a capacitor designed specifically for automobile horn spark suppression. Fits into horn housing with minimum of assembly operations. Leads firmly, mechanically anchored to stand extreme vibration.

CAPACITOR #2. This capacitor was designed for high temperature application in equipment operating at 105° C. Unit is hermetically sealed and provided with glass, solder sealed terminals.

CAPACITOR #3. Built for operation with telephone relay and amplifier equipment. Construction makes for ease of assembly into parent apparatus and assures a life-time of trouble-free service.

CAPACITOR #4. Tubular paper capacitor for bypass applications in radio receivers. This unit is encased in a metal tube which is then fully insulated with a cardboard sleeve. Meets all UL requirements for non-combustible case type capacitor.



Edwin F. Dillaby (designer of the popular HY75) develops the mount structure for a new transmitting triode.

TUBE DESIGN is a BALANCING ACT

The job of a vacuum tube designer would really make you tear your hair. Drawing mainly on long experience — only the bare principles of tube design are found in books — the design engineer must co-ordinate the innumerable interlocking characteristics you specify.

Using standard parts when possible — hand-fabricating others, he assembles and processes engineering samples. Some characteristics may fall outside limits. Then begins a seesaw of compromises. Screen diameter is lowered; input capacitance rises. Plate current is raised; amplification factor drops. Back and forth teeters the design. Interlocking electrical, mechanical, physiochemical, ceramic, and metallurgical characteristics must be reconciled one after another. Finally the harassed designer submits apparently satisfactory tubes for application tests.

You guessed it. Changes are required. The balancing act begins anew. Innumerable variables are again co-ordinated. Science and creative craftsmanship triumph; everyone is satisfied. Production takes over. Sure, it's a swell tube. But could this lead be changed, this spacer eliminated, this material substituted? Well, you see what we mean.

Through the years, Hytron design engineers have sweated for you. They have originated: GT, subminiature, vhf, instant-heating tubes. They have improved standard types including: OC3, OD3, 1616. Their experience will continue to craft for you the best in tubes.

SPECIALISTS IN RADIO RECEIVING TUBES SINCE 1921

HYTRON

RADIO AND ELECTRONICS CORP.

MAIN OFFICE: SALEM, MASSACHUSETTS

YOU'VE EVERYTHING TO GAIN BY GETTING IN TOUCH WITH *Accurate* FOR THE SPRINGS YOU NEED

Ask us to make your springs for you. Find out for yourself that we're pleasant people to do business with . . . that we make your springs exactly the way you want them . . . and that — here at Accurate — you receive intelligent cooperation, quality workmanship and on-time deliveries.

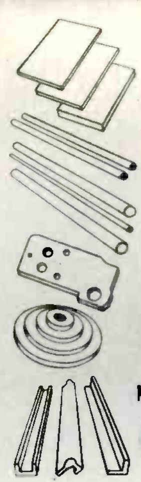
If you need engineering help, you'll discover that our engineers can quickly help you determine the right spring for your job. Perhaps our engineers can improve your product's performance through proper spring application. You *can't* lose.

WRITE FOR THE ACCURATE HANDBOOK ON SPRINGS

ACCURATE SPRING MANUFACTURING CO.
3830 West Lake Street • Chicago 24, Illinois

Springs — *Accurate Springs* — *Wire Forms • Stampings*

Using Strength, Light Weight, and Finish



BEFORE nylon graduates to its glamorous occupations the yarn is sized. The machine that applies the size also winds the yarn upon a tube at high speed.

The hundreds of loops of yarn contract as they dry, choking the tube with tremendous force.

Synthane, from which many nylon sizing bobbins are made, easily resists the powerful crushing action of the drying yarn.

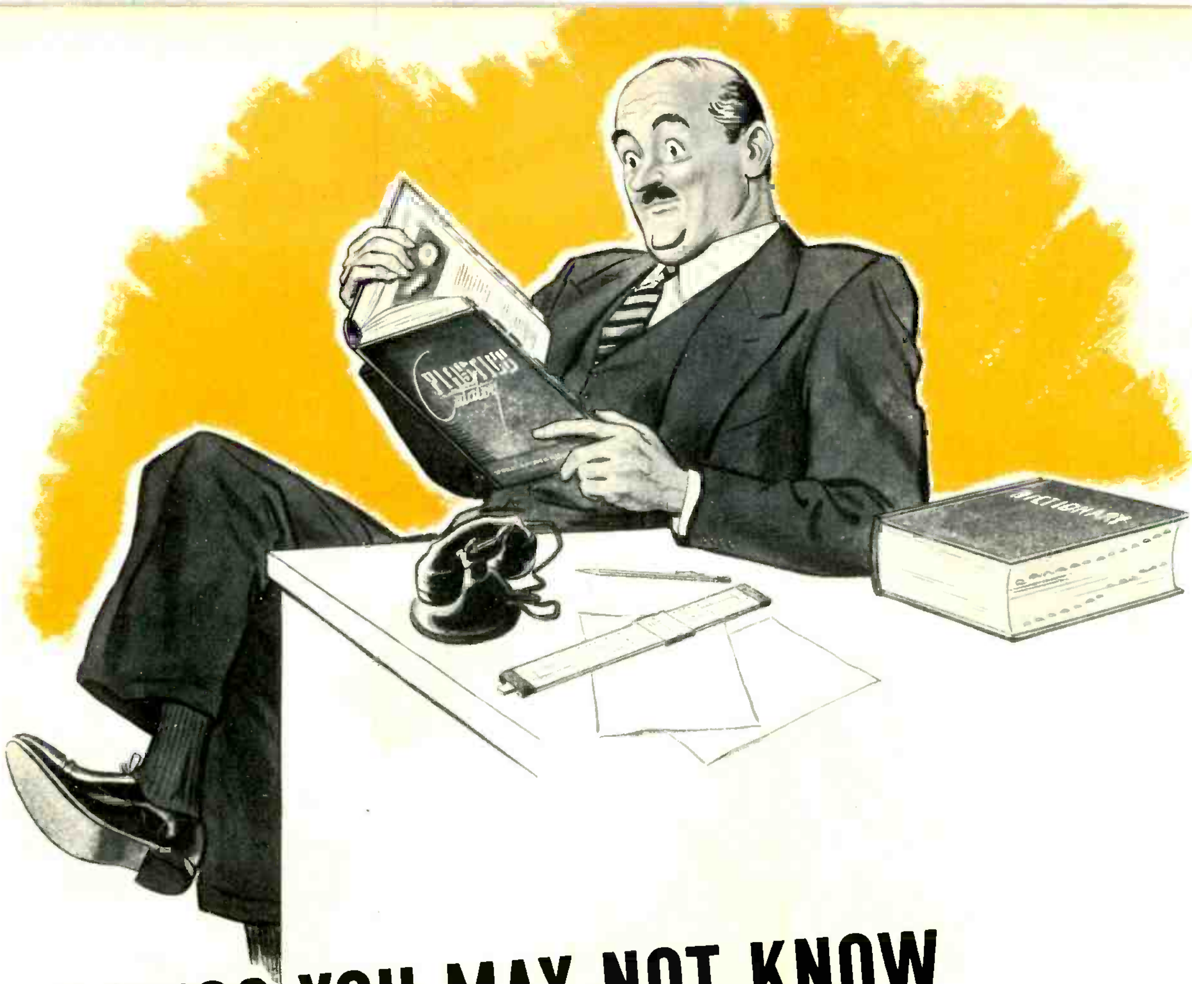
Because of light weight, tubes made from Synthane can be started and stopped faster and with less effort. Synthane also takes a variety of surface finishes suitable for use with nylon.

If these few of Synthane's many advantages suggest a place for plastics in your product, let us help you—before you design if possible. Meanwhile, send for the complete Synthane catalog.

SYNTHANE CORPORATION • 6 RIVER ROAD • OAKS • PENNSYLVANIA

SYNTHANE
S

SYNTHANE TECHNICAL PLASTICS • DESIGN • MATERIALS • FABRICATION



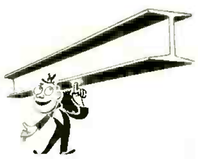
SOME THINGS YOU MAY NOT KNOW ABOUT LAMINATED PHENOLIC PLASTICS

As your copy of *Plastics Catalog** will tell you, the standard types of laminates have been standard for a good many years and "their properties and characteristics are dependably constant."

For instance, you can count on our type of laminated phenolic plastics—Synthane—for excellent dielectric properties—high dielectric strength, low power factor, low dielectric constant. It's also easy to machine.

Strength? Among plastics Synthane is one of that family highest in tensile, compressive, flexural and impact strengths. Compares favorably with metals on strength for weight basis.

**An approximately 1200-page compendium of plastics issued by the publishers of Modern Plastics.*



Light weight? The light weight of Synthane is one of its most important properties. Synthane weighs about half as much as aluminum. It has ample strength for electrical applications and for most mechanical uses.

Corrosion Resistant? Yes, Synthane resists nearly all oils and solvents, many acids and salts. Often used because it has a longer life per dollar than comparable materials.

But Synthane really stands out and stands up when you want a *combination* of all the above (and more) characteristics.

If you have an application where these properties of Synthane would be helpful—use Synthane. Always use plastics where plastics belong. Use coupon to get complete Synthane Catalog.

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__________

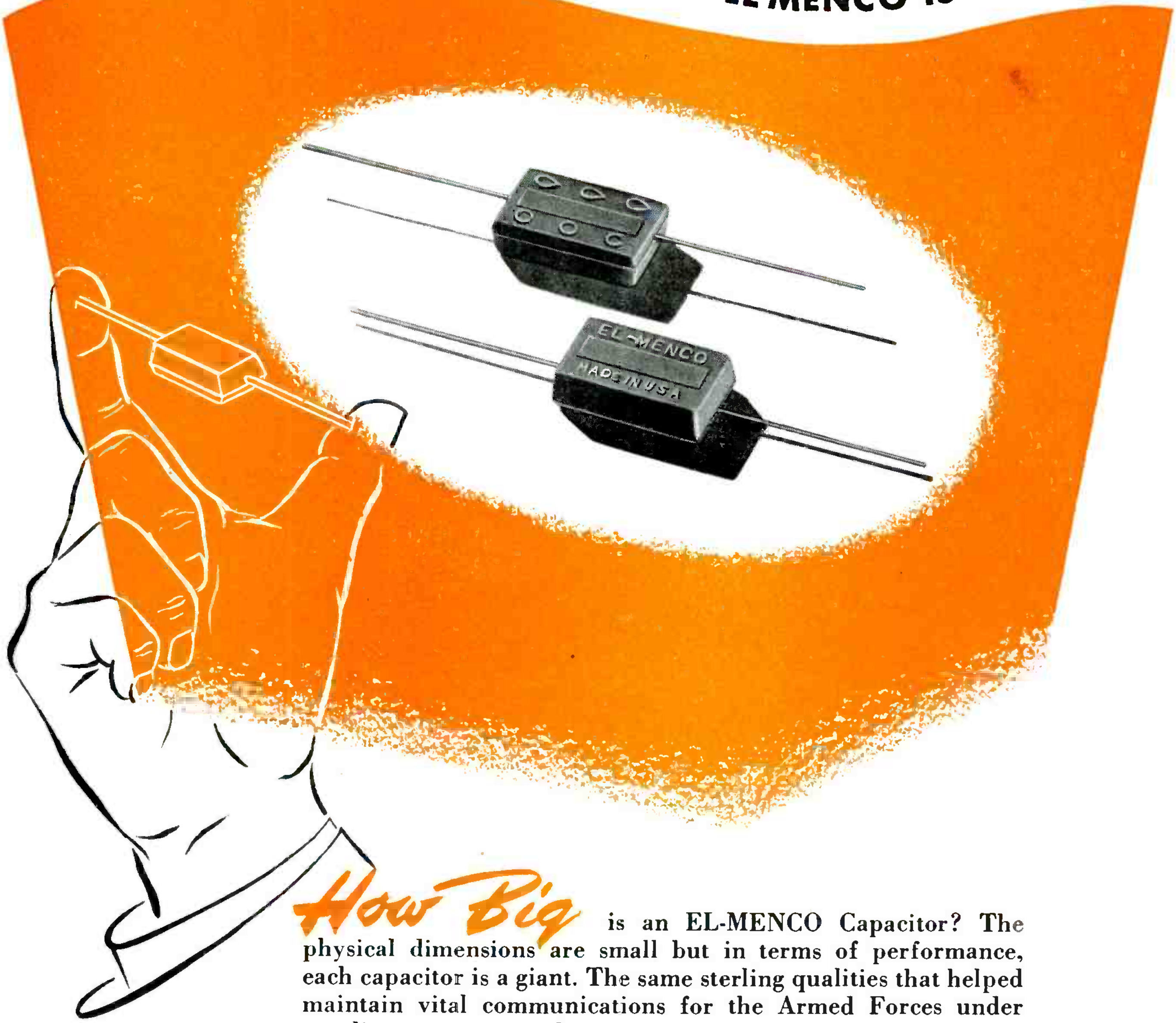
FOR MORE THINGS YOU MAY NOT KNOW

SYNTHANE

S

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

IF DEPENDABILITY IS THE REQUIREMENT—EL-MENCO IS THE CHOICE



How Big is an EL-MENCO Capacitor? The physical dimensions are small but in terms of performance, each capacitor is a giant. The same sterling qualities that helped maintain vital communications for the Armed Forces under grueling wartime conditions are in every EL-MENCO Capacitor that goes into your circuit.

We who design and make EL-MENCO Capacitors are proud of the reputation of dependability that our products have earned. We pledge our every effort to its continuance.

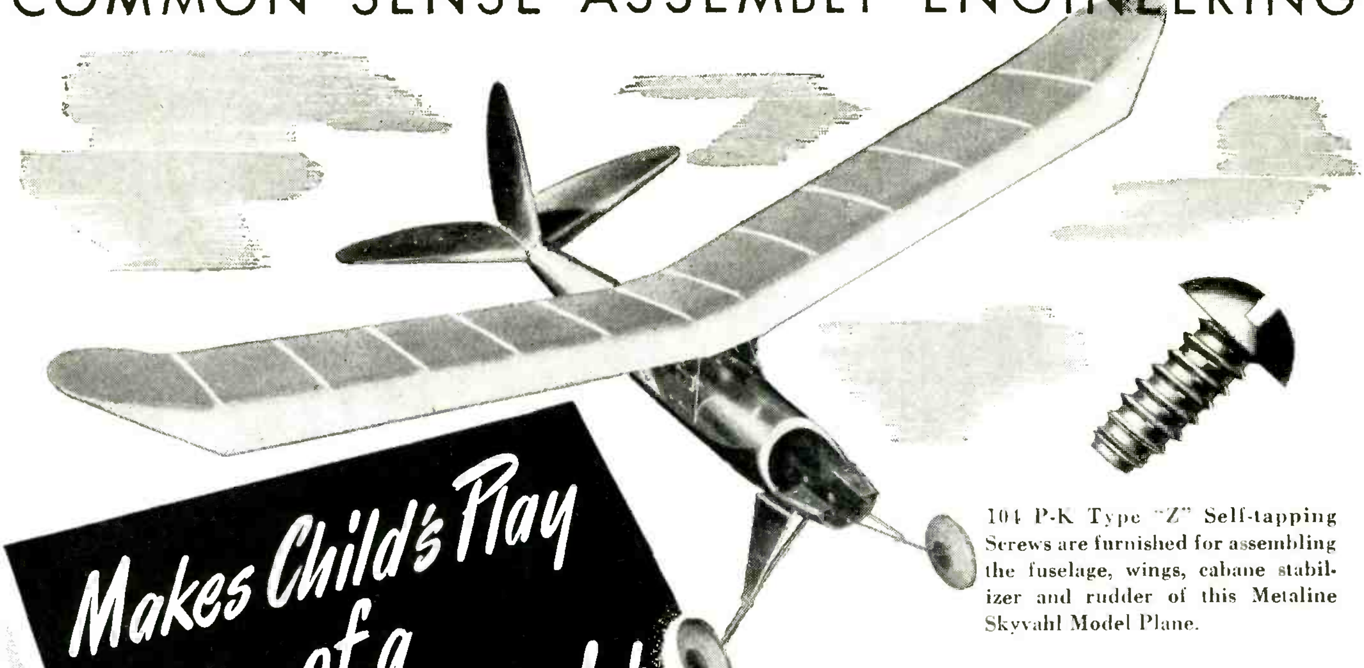
THE ELECTRO MOTIVE MFG. CO., Inc. Willimantic, Conn.

Foreign Radio and Electronic Manufacturers communicate direct with our Export Department at Willimantic, Conn. for information.

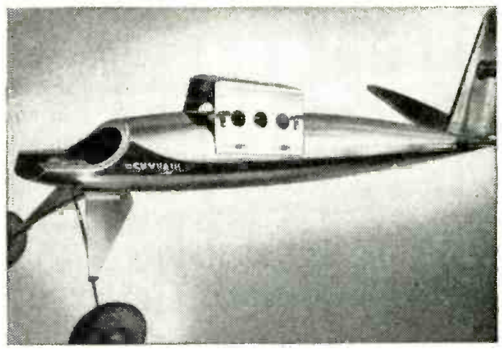
MOLDED MICA **El-Menco** **MICA TRIMMER**

CAPACITORS

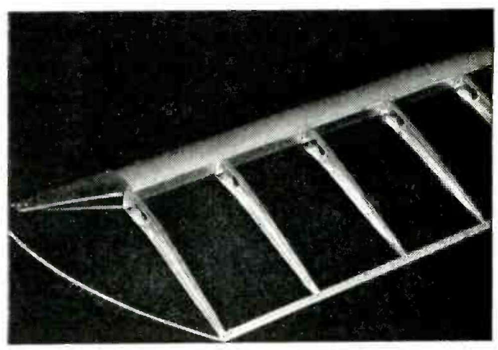
COMMON SENSE ASSEMBLY ENGINEERING



104 P-K Type "Z" Self-tapping Screws are furnished for assembling the fuselage, wings, cabane stabilizer and rudder of this Metaline Skyvahl Model Plane.



P-K binding head Type "Z" Screws fasten cabane to fuselage. Slots permit wing assembly to be moved back when model is changed over from "Class B" to "Class C", with heavier motor.



There are 15 P-K Self-tapping Type "Z" Screws in each wing structure, fastening spar, ribs, leading edge and tip securely together.

Model builders with an average amount of skill and ordinary household tools can put this nifty little plane together without any trouble, thanks to the simpler P-K fastening method.

Before starting production of this first all-metal model plane, the Vahl Engineering Company made an exhaustive study of assembly and found that P-K Self-tapping Screws eliminated the problems anticipated with more complicated fastenings.

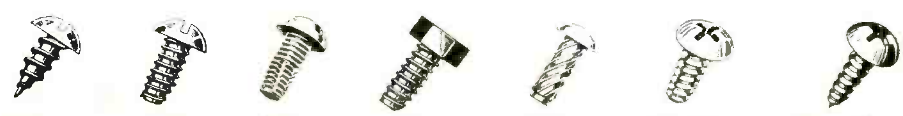
No tricky methods or special equipment are necessary. The model builder simply drills holes and drives the P-K Screws, which form their own threads, hold firmly.

The same P-K advantages of speed and simplicity have repeatedly saved large airplane manufacturers valuable time and labor . . . by eliminating tapping, bolting, riveting.

It's plain common sense to apply these P-K advantages in your product assembly, wherever possible. In 7 out of 10 jobs studied, P-K Screws permitted savings in time and labor, often from 30% to 50%. Call in a P-K assembly engineer and discuss your fastenings with him, or, send assembly details to us for recommendations. Write Parker-Kalon Corp., 200 Varick St., New York 14, N. Y.

Sold Only Through Accredited Distributors

P-K

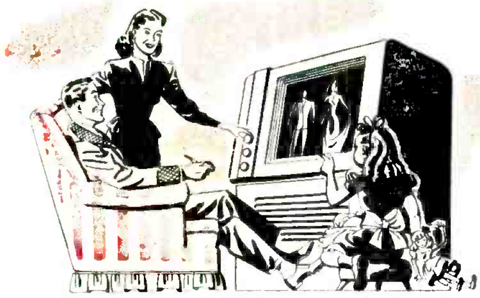


PARKER-KALON SELF-TAPPING SCREWS

FOR EVERY METAL AND PLASTIC ASSEMBLY

FEDERAL'S BALANCED HF CABLE KT-51

HAS THE RIGHT TWIST



for Peak Performance of FM and Television Receivers

HERE'S A NEW HF cable that will keep your FM and Television receivers working at peak performance—free from locally-induced interference, even in the most adverse locations. Where the performance of such costly equipment is at stake, it will pay you to specify Federal's KT 51—the finest high frequency lead-in cable available. More costly—but *worth* more!

The *twisted,* dual-conductor cable cancels any noise or signals not stopped by the double *braided shields* . . . because it's electrically balanced and stays that way in service, in any position. It's a rugged cable, too—remarkably resistant to abrasion, acids, alkalies, oils and greases, as well as smoky atmospheres and weather.

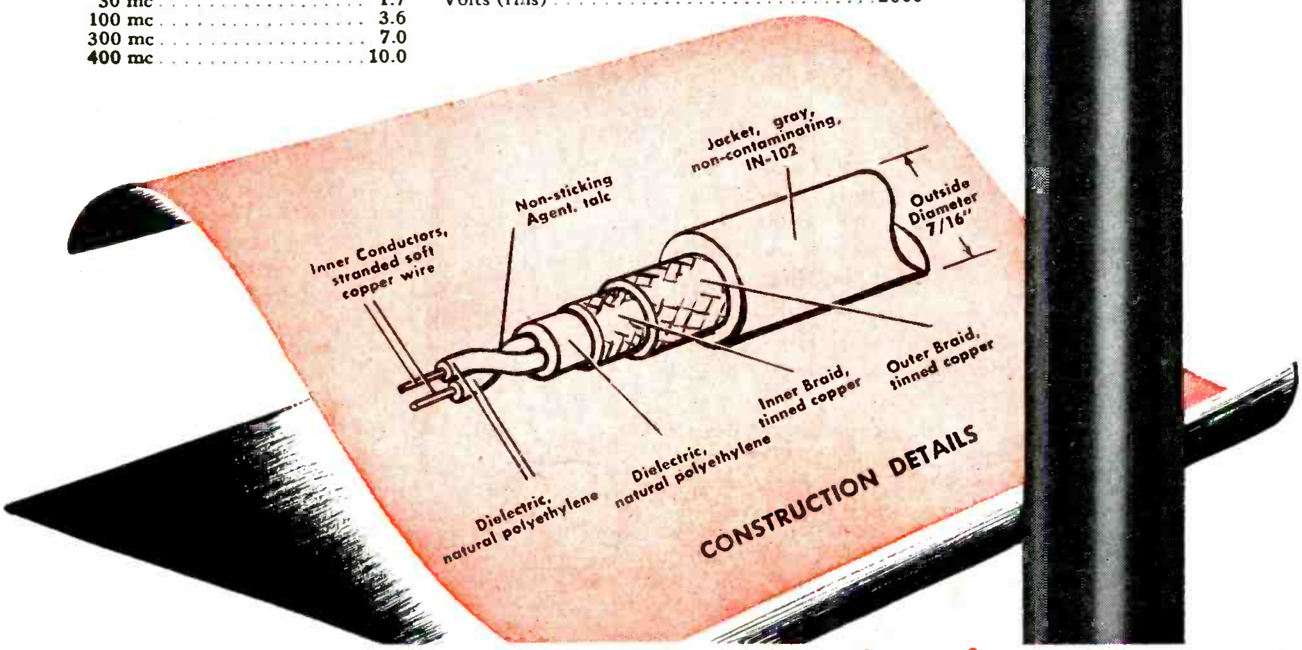
Don't let the lead-in wire be the "weak link" in otherwise perfect equipment. Be sure it's KT 51—the HF cable with the "right twist" to assure interference-free operation. For complete details, write to Dept. D-613.

ELECTRICAL CHARACTERISTICS

Nominal Attenuation (db/100 ft.)

Frequency	*Attenuation*
10 mc	0.9
30 mc	1.7
100 mc	3.6
300 mc	7.0
400 mc	10.0

Maximum Capacity Unbalance	1%
Nominal Characteristic Impedance (ohms)	95
Nominal Capacitance per ft. (uuf)	16
Volts (rms)	2000

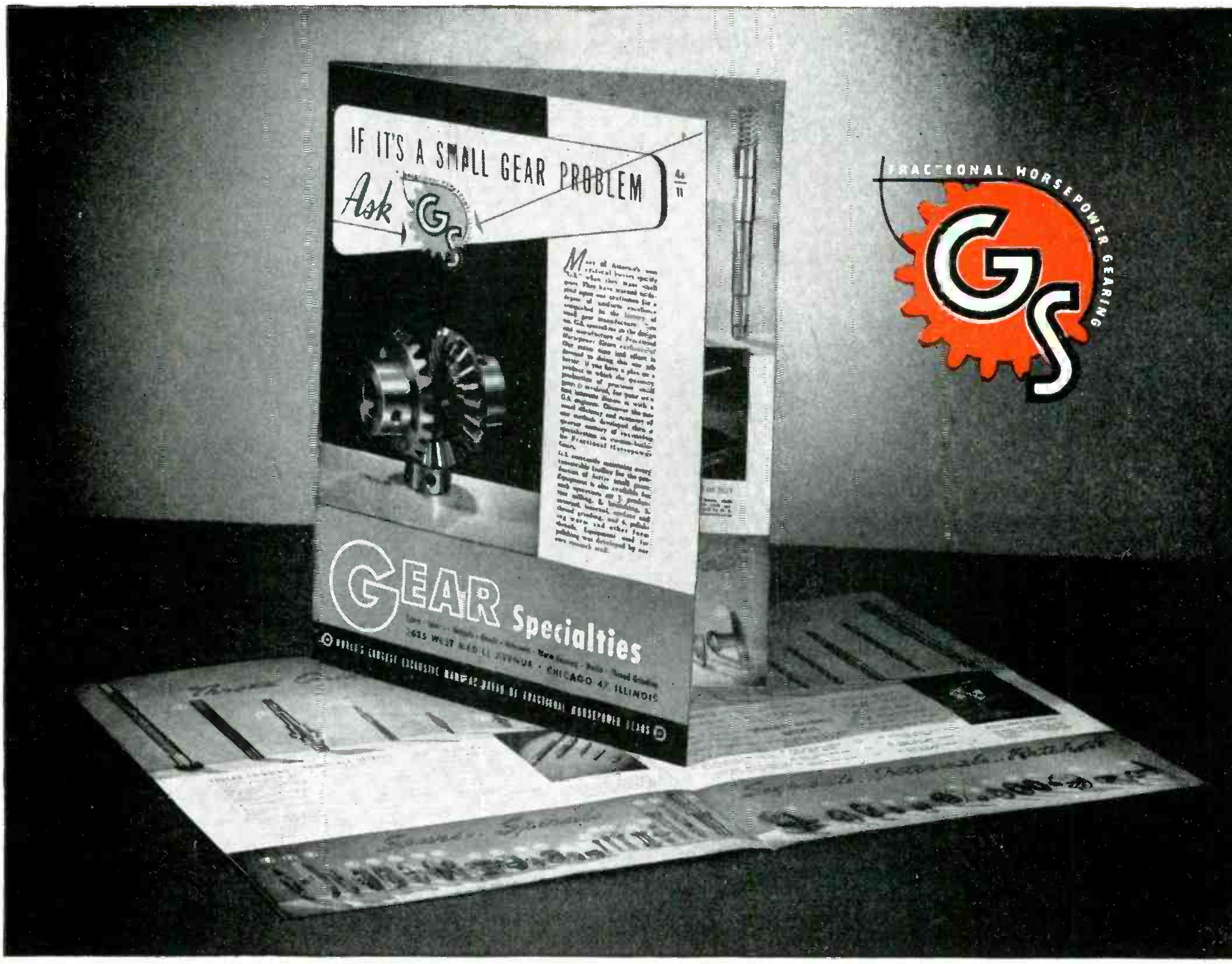


Federal Telephone and Radio Corporation

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

AN IT&T ASSOCIATE

Newark 1, New Jersey



SEND FOR OUR NEW 4-PAGE GEAR CATALOG

Small Gears are made in almost endless variety. Frequently their applications are entirely without precedent. This was especially true during the war. New principles, new design, new engineering, a different approach to power transmission problems . . all these things and more are often required to produce the greater efficiency and economy of G.S. Fractional Horsepower Gears. The G. S. Gear Catalog just printed, illustrates and describes many different types and applications of G. S. Small Gears. It offers valuable aid to *anyone* concerned with specifying Gears from 12 to 96 D.P. Just ask for a copy on your company stationery. No cost or obligation is involved.

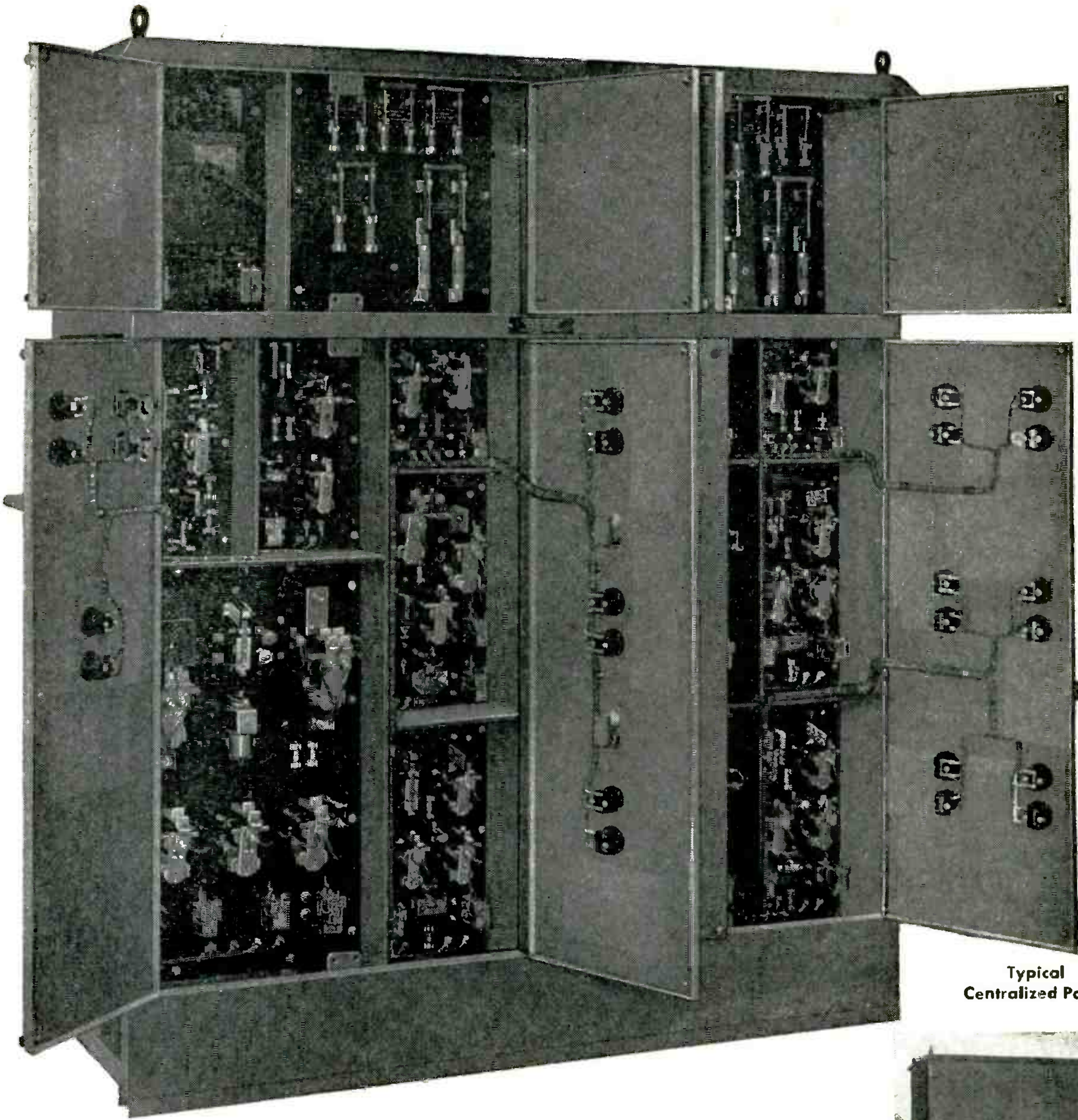
GEAR Specialties

Spurs • Spirals • Helicals • Bevels • Internals • Worm Gearing • Racks • Thread Grinding

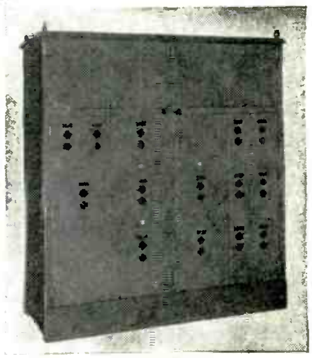
2635 WEST MEDILL AVENUE • CHICAGO 47, ILLINOIS

MEMBER OF AGMA

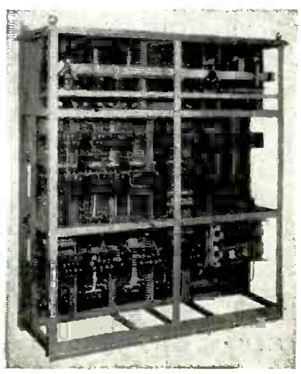
WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARS



Typical Centralized Panel



Front View



Rear View

WITH CENTRALIZED CONTROL ONE MAN IN ONE PLACE CONTROLS EVERYTHING

Convenience and accessibility of controls are but two of the many potent arguments for centralized control. Here are a few of the advantages:—

SAFETY of dead front enclosure with operation of all mechanisms from the front offers greatest protection to your operator.

SIMPLICITY of installation and wiring results in reduced costs.

SPACE SAVING with the single enclosure is accomplished. Frameworks and wall supports are not needed.

ENGINEERED CONTROL to meet your own requirements at little or nothing above the final cost of individual control units.

These are but a few of the reasons why alert engineers are specifying centralized control for modern plant installations.

Let us show you the benefits. A Ward Leonard engineer will gladly help you to select a centralized control to meet your exact needs.

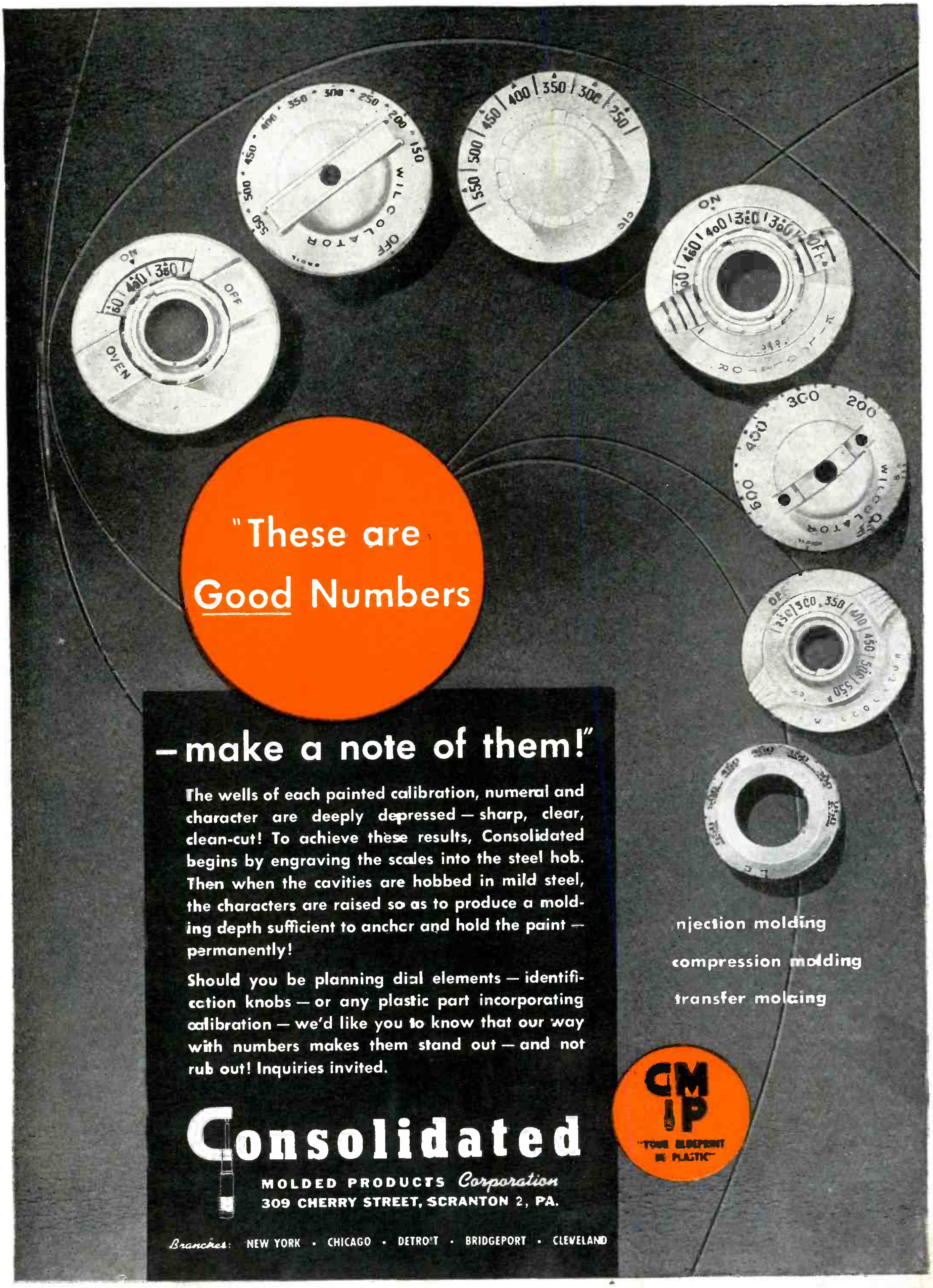
WARD LEONARD

RELAYS • RESISTORS • RHEOSTATS

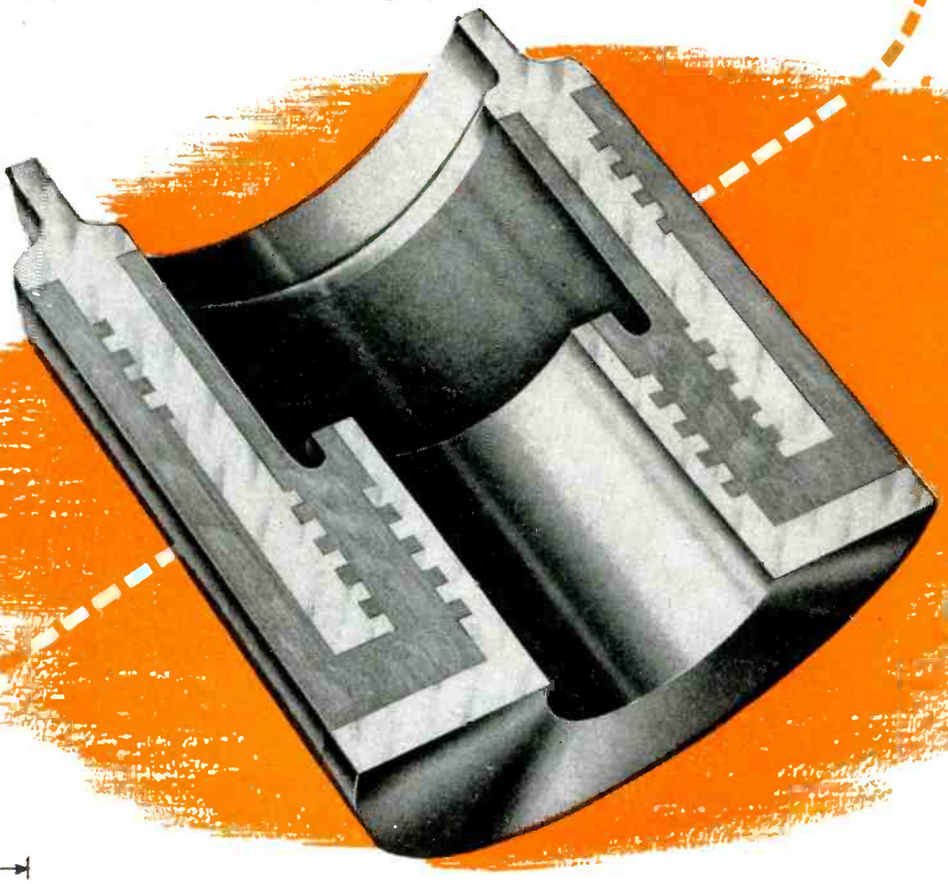
Electric control devices since 1892

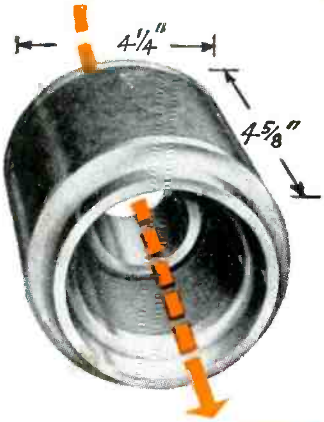
WARD LEONARD ELECTRIC COMPANY

32 SOUTH STREET, MOUNT VERNON, N.Y. • OFFICES IN PRINCIPAL CITIES


"These are Good Numbers
– make a note of them!"
The wells of each painted calibration, numeral and character are deeply depressed — sharp, clear, clean-cut! To achieve these results, Consolidated begins by engraving the scales into the steel hob. Then when the cavities are hobbed in mild steel, the characters are raised so as to produce a molding depth sufficient to anchor and hold the paint — permanently!
Should you be planning dial elements — identification knobs — or any plastic part incorporating calibration — we'd like you to know that our way with numbers makes them stand out — and not rub out! Inquiries invited.
injection molding
compression molding
transfer molding
CMP
"YOUR BLUEPRINT IN PLASTIC"
Consolidated
MOLDED PRODUCTS Corporation
309 CHERRY STREET, SCRANTON 2, PA.
Branches: NEW YORK · CHICAGO · DETROIT · BRIDGEPORT · CLEVELAND

Largest MYCALEX Part Ever Molded





This cross section of a MYCALEX-to-metal molded component part was made for one of the country's leading manufacturers, and is the result of close cooperation between the customer's and our own engineering staffs. It exemplifies a new development in the molding of MYCALEX 410 with metal to form a hermetic seal.

The objective was to take advantage of the low loss factor and other desirable properties of MYCALEX 410 to produce a rugged bushing assembly in a single molding operation.

A difficulty was presented by the extremely long and branched path which the MYCALEX 410 had to follow. Total charge of MYCALEX 410 was 7 pounds, while the metal weighed 6 pounds to make a total weight of 13 pounds.

The MYCALEX and metal were sealed into one closely-bonded integral part, held to extremely close dimensional tolerances.

For more than 27 years MYCALEX has met and surpassed the most exacting needs engineers have been able to devise from year to year. MYCALEX 410, together with our highly perfected methods of molding it, is the greatest advancement in this high frequency low loss insulation to date.

Our technical staff is at your service. What is your problem in low loss insulation?

SINCE 1919 MYCALEX THE INSULATOR
TRADE MARK REG. U. S. PAT. OFF.

MYCALEX CORPORATION OF AMERICA

"Owners of 'MYCALEX' Patents"

Plant and General Offices, CLIFTON, N. J. *Executive Offices,* 30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

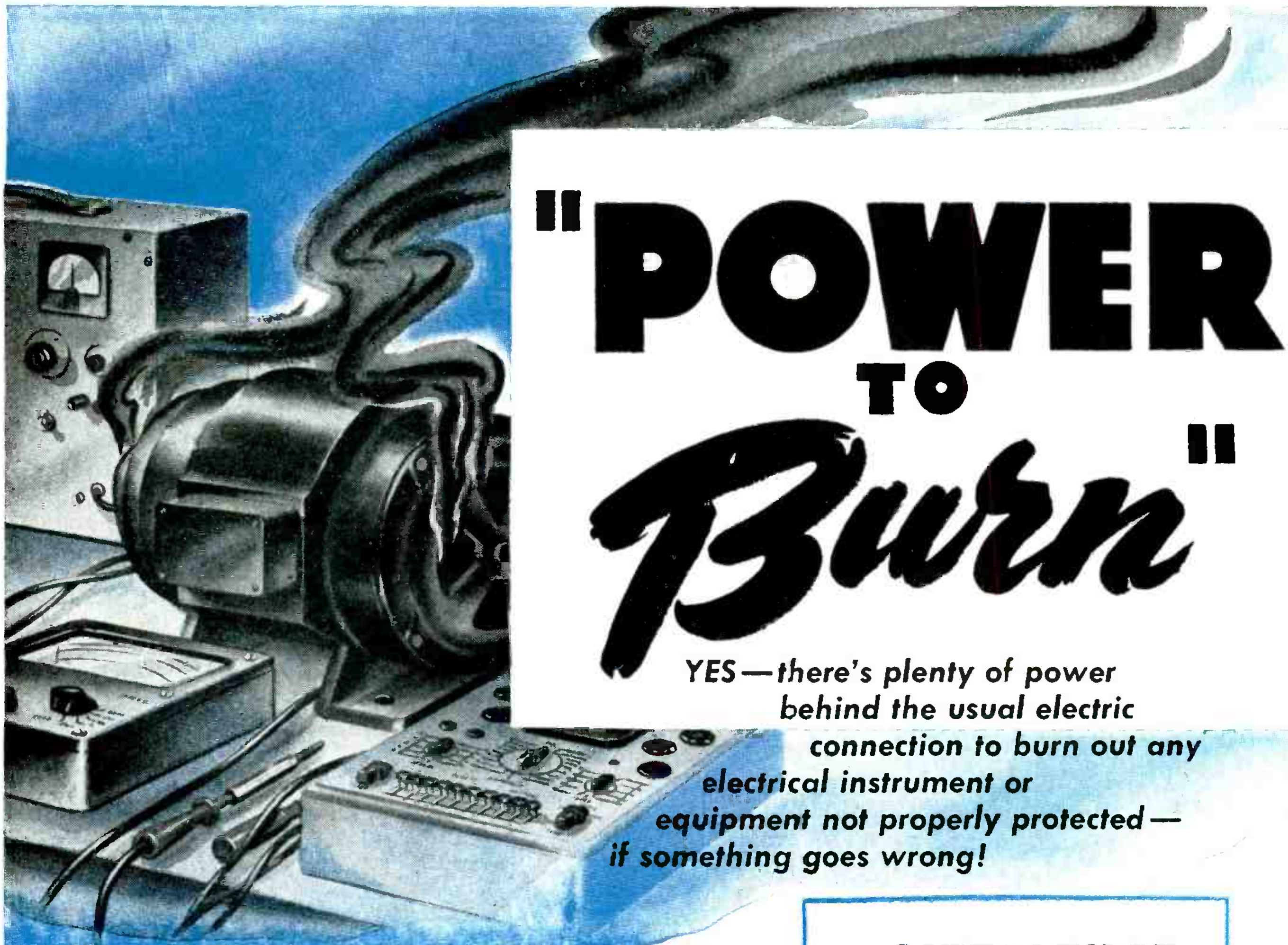
Continuously VARIABLE

CAPACITANCE "ON-THE-NOSE" FOR HIGH CURRENT, HIGH POWER ELECTRONIC CIRCUITS

The variable capacitance feature of Lapp Gas-Filled Condensers permits you to "tune-to-a-whisker," with power on, to get the most out of any high current, high power circuit. And once set, this gas-dielectric unit delivers uniformly—no "warm up," no change of capacitance with change in temperature. Non-deteriorating, too, the Lapp unit is truly puncture-proof and will outlast almost any other components of any circuit of which it is a part. In addition to the variable unit, there are adjustable units, continuously adjustable within their range but not designed for frequent "tuning dial" adjustment, and fixed capacitance units. Current ratings range up to 500 amperes R.M.S.; power ratings to 60 Kv peak load. Capacitance to 60,000 mmf. (for fixed units); to 16,000 mmf. (variable and adjustable units). Higher ratings on special design order.

Lapp

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



"POWER TO *Burn*"

YES—there's plenty of power behind the usual electric connection to burn out any electrical instrument or equipment not properly protected—if something goes wrong!

IF IT'S WORTH MAKING IT'S WORTH PROTECTING!

When a motor, instrument or other electrical equipment burns out, the user is prone to blame the manufacturer for not having provided adequate protection. It frequently means costly delays and replacement, or expensive repairs—all of which tends to create a bad impression.

Littelfuse precision-built fuses are so inexpensive that every manufacturer of such equipment can effectively protect his products and reputation at relatively small cost. They embody special features in engineering, design and construction which insure the exacting protection *necessary* for highly critical equipment, and *desirable* on all electrical devices.

A complete range of different types and sizes for instrument protection, fusing of small motors, radio and electronic circuits, automobile, aircraft and marine instruments, and all types of electrical equipment. Fuse mountings also available for an extensive range of applications. Write, phone or wire for prices and specifications.

LITTELFUSE *Plus* FEATURES!

Vibration-Proof. Littelfuse element twisted to 90 degrees most effectively braces the fuse element against severe vibration.

Non-Crystallizing. Littelfuse "Gooseneck" provides a spring-like formation at one end of the fuse element, which prevents crystallization due to repeated expansion and contraction. There is no cracking at the fusion point.

Locked Cap Assembly. Littelfuse "Locked Caps" assembled with non-corrosive fluxes prevent interior corrosion. No difficulty in removing fuse for identification and replacement, in all types of mountings after fuse is blown. Littelfuse "Locked Caps" always remain firmly in position.

FIRST IN CIRCUIT PROTECTION

LITTELFUSE *Incorporated*

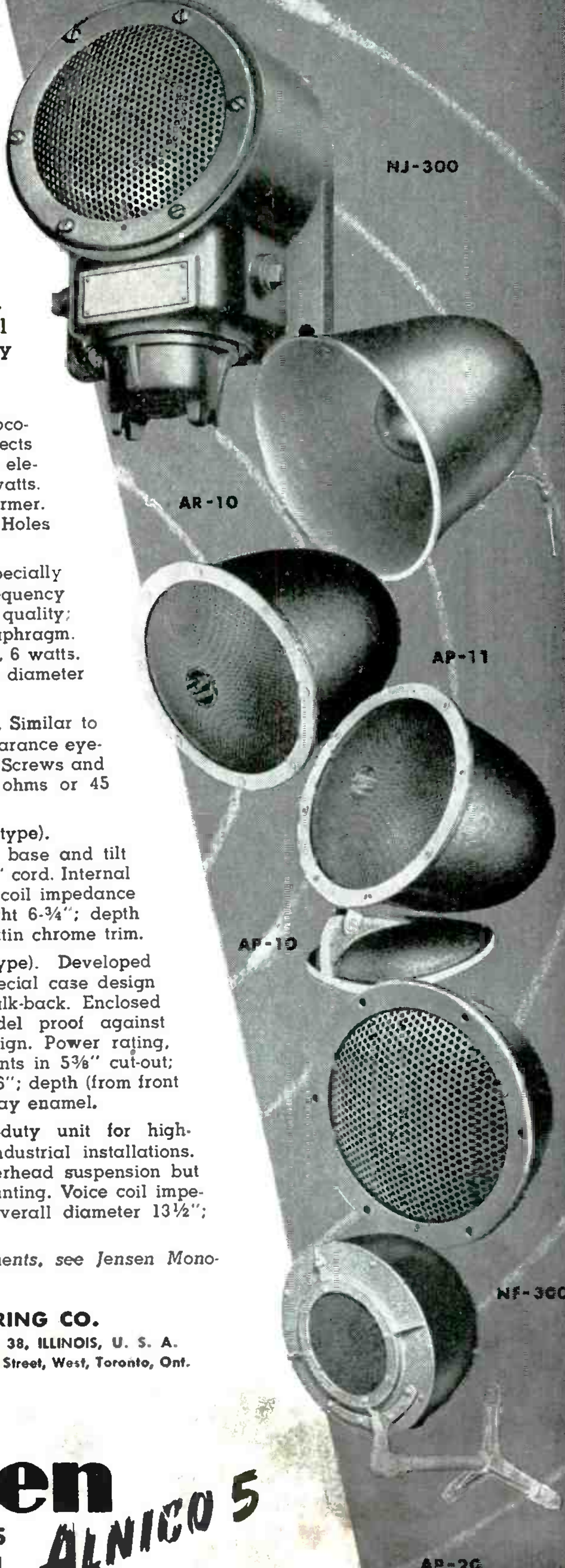
4757 RAVENSWOOD AVE. CHICAGO 40, U.S.A.

NITE-T-LITE • SWITCH-LITE • IGNITION-FRITZ • NEON INDICATORS • SWITCHES • CIRCUIT BREAKERS • FUSES, MOUNTINGS AND ACCESSORIES

Jensen *Speech Master* REPRODUCERS

...for clear, crisp, intelligible Speech* Reproduction

Designed especially for speech reproduction in intercommunication and public address applications, this Speech Master family of JENSEN Reproducers, delivers clean, sharp, understandable announcements and orders. Like all JENSEN products, these Speech Masters were completely engineered to do their job efficiently and well.



MODEL NJ-300 SPEECH MASTER (Railroad Type). PM design. Widely used in railroad intercommunication in locomotives, cabooses, signal towers and yards. Rugged case protects against shock and vibration; withstands dust, smoke and the elements. Voice coil impedance 12 ohms; power rating, 10 watts. Space provided inside case for 500-ohm impedance transformer. Overall height 11-3/4"; width 6-25/32"; depth 4-13/16". Holes provided in base for mounting in any position.

MODEL AR-10 SPEECH MASTER ***ALNICO 5*** design. Specially constructed reflex horn increases efficiency in mid-frequency range, giving added effectiveness and "punch" to speech quality; prevents direct access of rain and snow to speaker diaphragm. Voice coil impedance, 4 ohms and 45 ohms; power rating, 6 watts. Space provided inside for ½" x ½" transformer. Overall diameter 10"; depth 8". Complete with mounting bracket.

MODEL AP-11 SPEECH MASTER (Panel mounting). Similar to AP-10 but without base. Mounts in 4-27/64" cut-out; clearance eyelets for mounting screws. Depth 4½" from front panel. Screws and drilling template included. Voice coil impedance 4 ohms or 45 ohms; power rating, 5 watts.

MODEL AP-10 SPEECH MASTER (Desk or Wall type). PM design, desk or wall mounting. Complete with base and tilt adjustment. Double dustproofed. Rubber covered 36" cord. Internal mounting bracket for ½" x ½" transformer. Voice coil impedance 4 ohms or 45 ohms; power rating, 5 watts. Height 6-¾"; depth 5⅛"; diameter 5". Finish hammered gray with satin chrome trim.

MODEL NF-300 SPEECH MASTER (Navy Type). Developed for use as a loud speaker and microphone. Special case design over-rides wind and background noises for talk-back. Enclosed case and protective screen render this model proof against weather, dust and moisture ***ALNICO 5***-PM design. Power rating, 10 watts; voice coil impedance 12 ohms. Mounts in 5⅜" cut-out; six screw holes in rim. Overall diameter 6-7/16"; depth (from front of panel) 2-9/64". Finished in Munsel N4-5 gray enamel.

MODEL AP-20 SPEECH MASTER Heavy-duty unit for high-level paging and call systems in noisy industrial installations. PM design. Furnished with eyebolt for overhead suspension but available with stand for wall or table mounting. Voice coil impedance 8 ohms; power rating, 25 watts. Overall diameter 13½"; depth 9"

**For full discussion of Speech requirements, see Jensen Monograph No. 4.*

5 MONOGRAPHS AVAILABLE

If you haven't yet procured these five valuable technical booklets, order now—either from your dealer or direct—at 25¢ each.

1. Loud Speaker Frequency-Response Measurements
2. Impedance Matching and Power Distribution
3. Frequency Range in Music Reproduction
4. The Effective Reproduction of Speech
5. Horn Type Loud Speakers

25¢ each

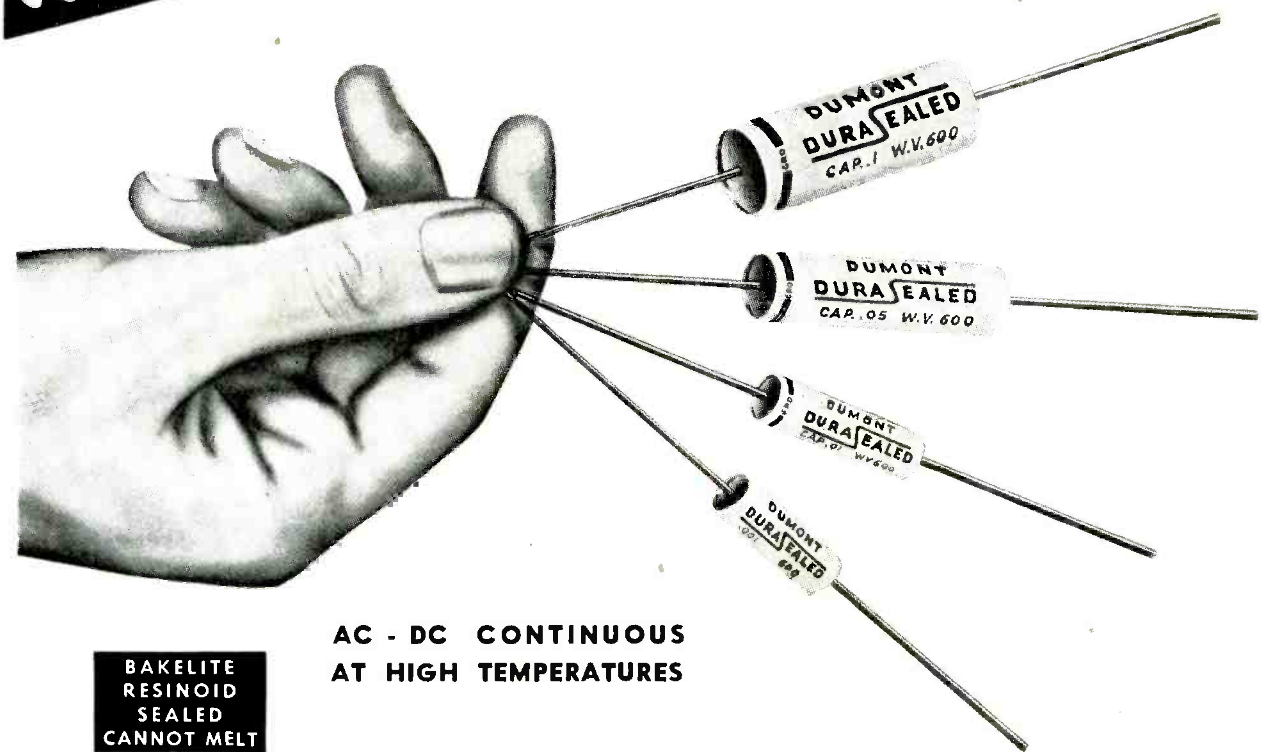
JENSEN MANUFACTURING CO.
6607 S. LARAMIE AVENUE, CHICAGO 38, ILLINOIS, U. S. A.
In Canada: J. R. Longstaffe, Ltd., 11 King Street, West, Toronto, Ont.

Jensen SPEAKERS WITH ALNICO 5

Specialists in Design and Manufacture of Acoustic Equipment

AT LAST!

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



AC - DC CONTINUOUS AT HIGH TEMPERATURES

PAT. PEND.

★ 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.

The Easy drafting Pencil Just as a superior instrument responds to the sensitive fingers of a master pianist—so do the true degrees of Typhonite Eldorado leads respond to the skilled fingers of a draftsman. Eldorado is the easy drawing pencil that puts harmony in all work. Let it work for *you!*

DIXON'S TYPHONITE

ELDORADO

PENCIL SALES DEPARTMENT, JOSEPH DIXON CRUCIBLE CO., JERSEY CITY 3, N. J.

www.americanradiohistory.com

New BEAM TETRODE *by* UNITED

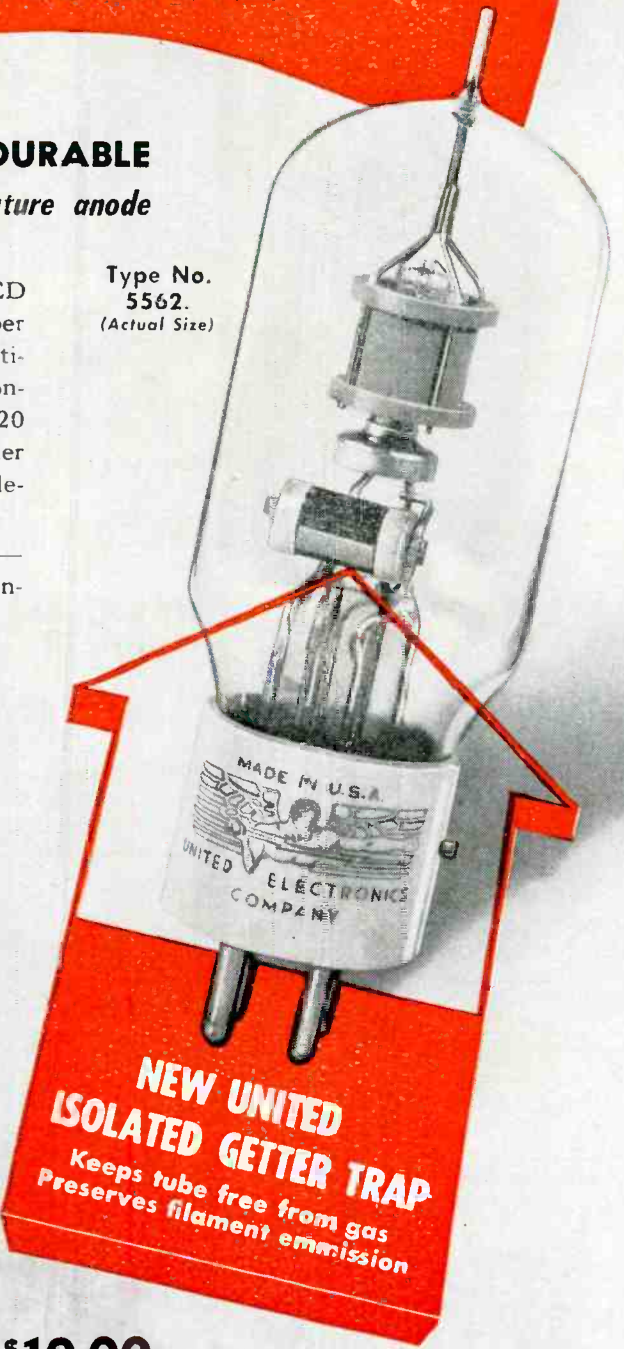
COMPACT • POWERFUL • DURABLE

with graphite, the real low temperature anode

DESIGNED for service longevity, UNITED type 5562 will prove to be a popular number on the VHF bands of the amateur, aeronautical, mobile, and emergency services. Conservatively rated at 175 watts input up to 120 megacycles. Authentic input ratings for higher frequencies will be announced after completion of further factory life tests.

Type 5562 has low drive characteristics—from 2 to 4.5 watts dependent upon plate input, frequency, and class of operation.

Type No. 5562. *(Actual Size)*



GENERAL CHARACTERISTICS		
Filament, 6.3 volts at 3.0 amps.		
Amplification factor	—	60
Transconductance	—	2500 micromhos
Direct Interelectrode capacitances		
Input to plate		.2 mmfds
Input		6.5 mmfds
Output		1.8 mmfds

MAXIMUM RATINGS	Class C Phone	Class C Telegraphy
D.C. Plate Voltage	1250	2000 volts
D.C. Grid Voltage (Grid # 1)	250	350 volts
D.C. Grid Voltage (Grid # 2)	350	400 volts
D.C. Plate Current	100	125 ma
D.C. Grid Current	20	20 ma
Plate Input	125	175 watts
Screen Input	8	8 watts
Plate Dissipation	35	45 watts

$10.00 ea.

UNITED

ELECTRONICS COMPANY

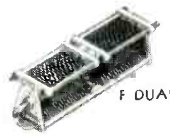
NEWARK, 2 NEW JERSEY

Transmitting Tubes EXCLUSIVELY Since 1934

Important advantages are yours with JOHNSON *condensers*

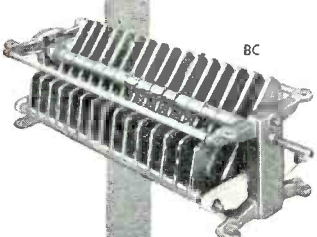
G

VP



F DUAL

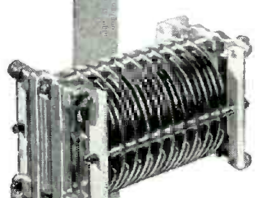
H DUAL



BC

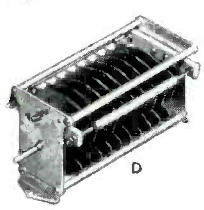
J

N

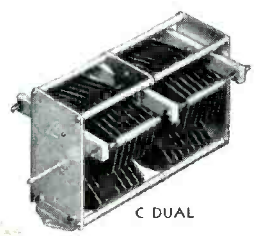


FBC

E



D



C DUAL

Many evidences of superiority in JOHNSON condensers reflect the twenty-three years of experience that has gone into them. Each type is carefully designed by electronic engineers for maximum circuit efficiency. A primary design objective at JOHNSON'S has been the accomodation of a greater number of specific requirements with a standard condenser or minor modification of a standard. JOHNSON'S search for better design and methods is continuous and employs first class engineering talent and equipment. Many developments, such as the new plate design mentioned below, not only bring increased efficiency but a saving in cost.

JOHNSON offers many standard types from which to choose with capacities to 10,000 mmf, voltage ratings to 30,000. See your distributor or write to Dept. D today

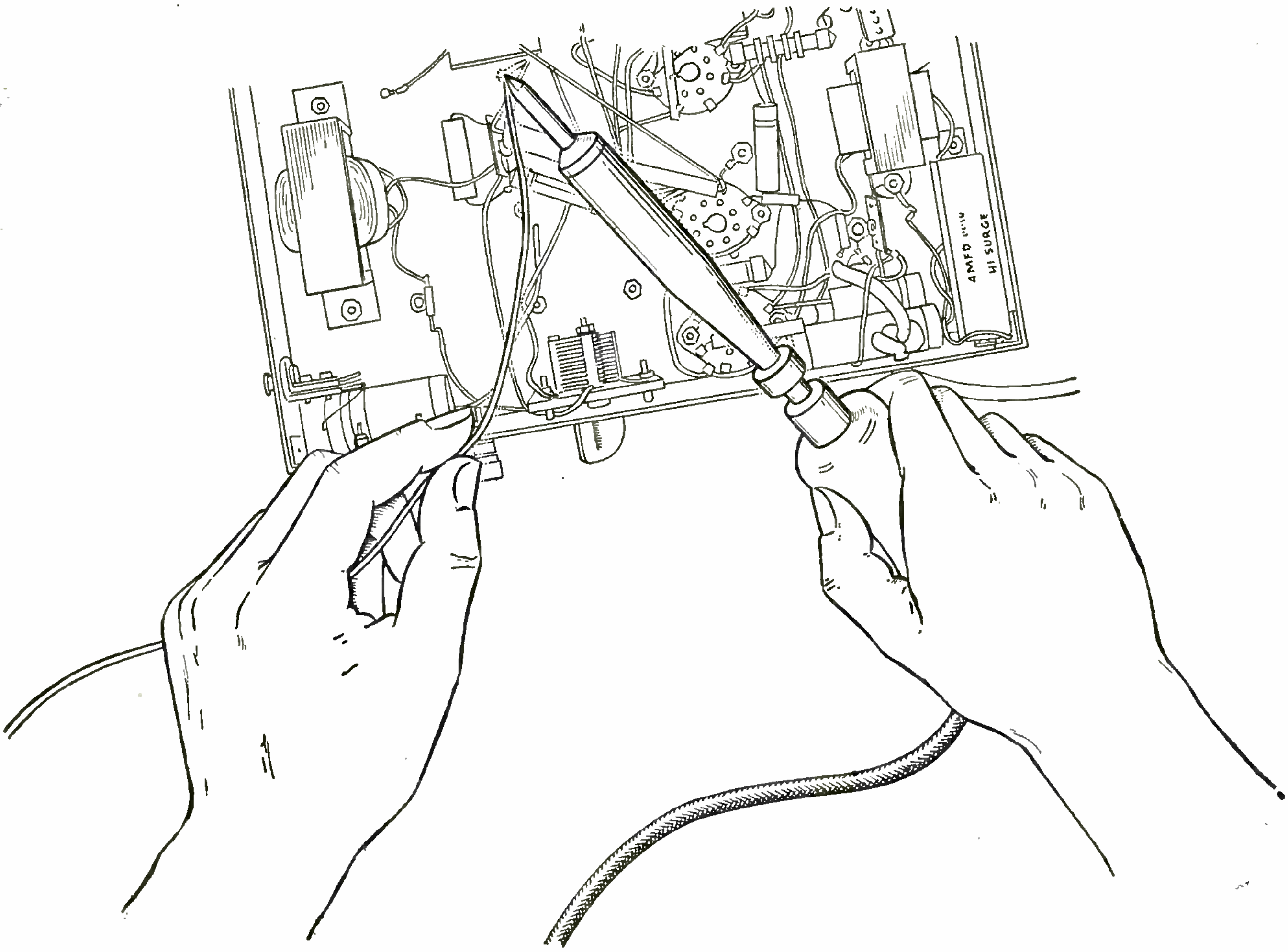
Plates for types A and B condensers are of the new heavy rounded edge design recently developed by JOHNSON engineers. Their higher breakdown voltage permits closer spacing, a shorter condenser, lower minimum, and less inductance at UHF. These features combined with new end frame design reduce weight to minimum, yet cost no more, in most cases less because of the saving in material.

JOHNSON
a famous name in Radio

Johnson products include

Condensers	Inductors	Sockets
R. F. Chokes	Q Antennas	Insulators
Connectors	Plugs & Jacks	Hardware
Pilot and Dial Lights	Broadcast Components	
Directional Antenna Equipment		

E. F. JOHNSON CO., WASECA, MINNESOTA



NOW READY: 3 NEW MODELS

SHERRON *Quality* LABORATORY INSTRUMENTS

SHERRON MULTIWAVE SHAPE GENERATOR

Designed to serve as a source of several wave shapes, and will prove very useful in the testing of amplifiers and associated equipment at audio and video frequencies. A regulated power supply is incorporated, which supplies plate and screen voltages for all stages.

SPECIFICATIONS:

OUTPUTS—Sine waves, square waves, positive pulses, negative pulses, and a trigger pulse. Impedance (output) 250 ohms for all voltages.

FREQ. RANGE—50 cycles to 50,000 cycles for all voltages continuously variable with a direct reading.

SQUARE WAVE—Rise time is less than .3 of a micro-second at the highest frequency and about .7 of a micro-second at the lowest frequency.

PULSES—Pulse width of both the positive and negative outputs is variable from about 1 to 75 micro-seconds.

POWER REQUIREMENTS—115 V., 60 cycle, 300 watts.

MODEL SE-512

SHERRON R.F. NULL DETECTOR

Visual indications permit this unit to be operated in noisy locations where aural indications may be useless. May be used as a signal generator to provide power at 1 MC, or as a sensitive detector at the same frequency. Both generator and detector are housed in the same cabinet.

SPECIFICATIONS:

FREQUENCY
1 MC

GENERATOR OUTPUT
0-5 volts

DETECTOR GAIN
500,000 plus

HARMONIC SUPPRESSION
2nd down more than 100 db

POWER REQUIREMENTS
115 volts, 60 cycle, 120 watts

MODEL SE-518

SHERRON D.C. VACUUM TUBE VOLTMETER-MICROAMMETER

Measures minute direct current and voltages on a new and different principle—a vast improvement over conventional methods. Converts electronically, the D.C. voltage to be measured to alternating voltages of a fixed frequency—amplifies, and then meters. An instrument of extremely high sensitivity. Can also be used as a megohmmeter with external voltage source.

SPECIFICATIONS:

VOLTMETER

RANGES—.015, .05, .15, .5, 1.5, 5, 15, 50, 150, 500, 1500 volts full scale.

INPUT IMPEDANCE—1 megohm on all ranges with exception of 1500V scale, where the impedance is 3 megohms. This gives a sensitivity of 68 megohms/volt on the lowest range.

MICROAMMETER

RANGES—.015, .05, .15, .5, 1.5, 5, 15, 50, 150, 500 microamps full scale.

VOLTAGE DROP—Maximum .15 volts. On lower ranges it drops to .045 volts.

OHMMETER: Resistance can be determined by measuring E & I from any external power supply. With 500 volts, 67,000 megohms, gives half scale reading on maximum range.

POWER REQUIREMENTS: 115 volts, 60 cycle, 175 watts.

MODEL SE-519

Sherron Electronics W2XDK

SHERRON ELECTRONICS COMPANY

Division of Sherron Metallic Corporation

1201 FLUSHING AVENUE, BROOKLYN 6, NEW YORK

West Coast Sales Office MECHANICS INSTITUTE BLDG., 57 Post St., San Francisco, Calif.

NEW EDITION OF FIBERGLAS ELECTRICAL INSULATION MATERIALS CATALOG

Just off the Press

Anyone concerned with insulation for electrical, radio, electronic or video applications can use the Fiberglas Electrical Insulation Materials Catalog to advantage.

It contains complete information about the many forms of Fiberglas Electrical Insulation Materials. Indicates where and how to use this material to obtain its many advantages.

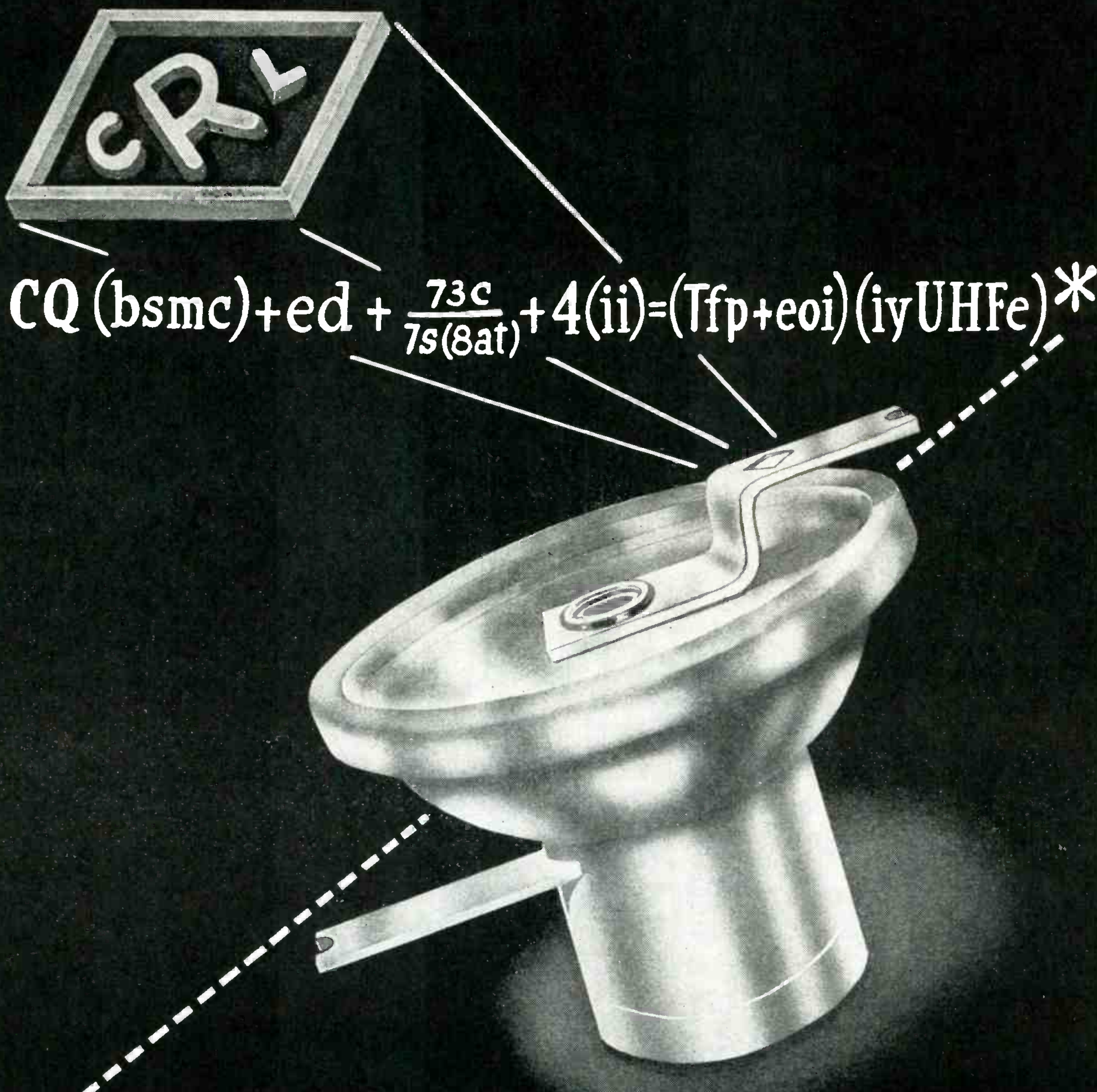
It describes the unique combination of electrically and mechanically important characteristics of Fiberglas, such as: resistance to high temperature, moisture and acid; favorable space factor and high tensile strength. It shows how the insulating impregnants increase the effectiveness of Fiberglas' inherent characteristics and add others such as high dielectric strength, insulation resistance and resistance to abrasion.

You will see why the use of this basic, inorganic, insulating material is increasing so rapidly—*why the swing is to Fiberglas.*

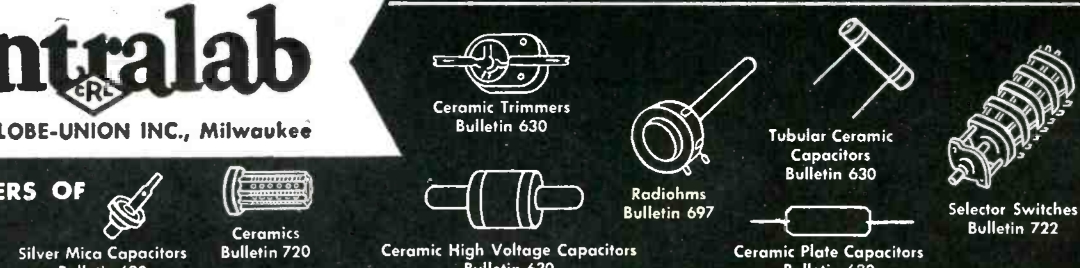
Be sure to have a copy of this new booklet in your file for ready reference. Write for copy today—there is no obligation. Owens-Corning Fiberglas Corporation, Dept. 860, Toledo 1, Ohio.

In Canada, Fiberglas Canada Ltd., Toronto, Ontario.

OWENS-CORNING
FIBERGLAS
T.M. REG. U.S. PAT. OFF.



CRL
CQ (bsmc)+ed + 73c/7s(8at) +4(ii)=(Tfp+eoi)(iyUHFe)*



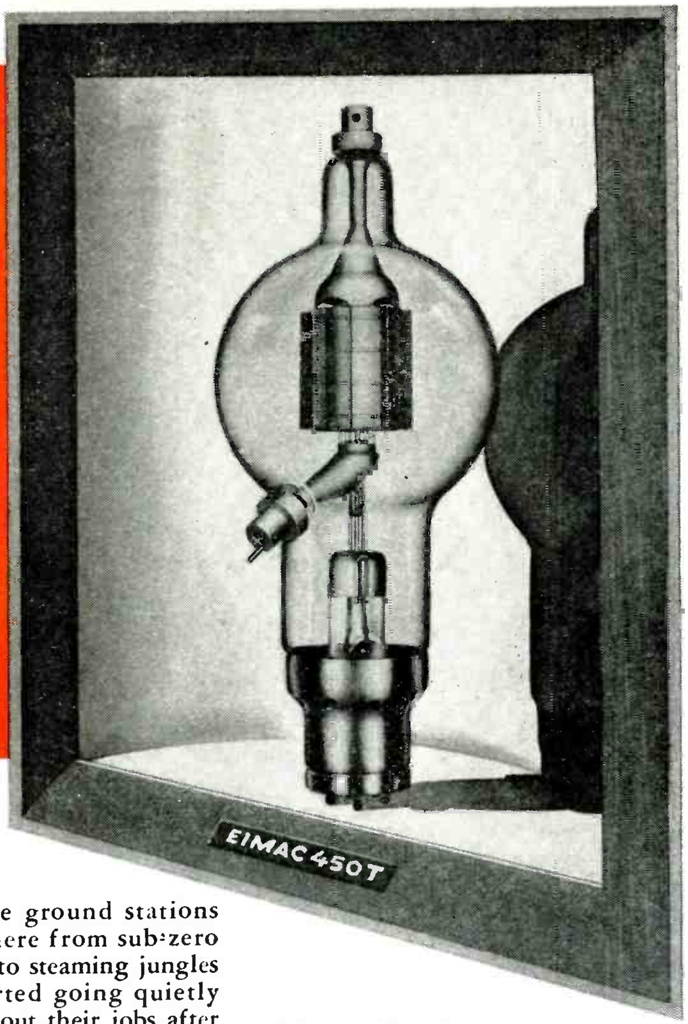
Silver Mica Capacitors
Bulletin 630
Ceramics
Bulletin 720
Ceramic Trimmers
Bulletin 630
Ceramic High Voltage Capacitors
Bulletin 630
Radiohms
Bulletin 697
Tubular Ceramic Capacitors
Bulletin 630
Ceramic Plate Capacitors
Bulletin 630
Selector Switches
Bulletin 722

FOR AN HONORED PLACE IN THE HALL OF FAME

Perhaps no other single transmitting tube has such a great and rightful claim to fame as has the Eimac 450T triode.

This tube, one of the original members of the Eimac family, has consistently established records for plus performance in some of the world's most gruelling applications.

Long before the war the Eimac 450T established a high standard of dependability and performance in the ground stations of leading commercial airlines. Because of their outstanding dependability and inherently superior capabilities, these tubes were snapped up for wartime duty in many vital applications.

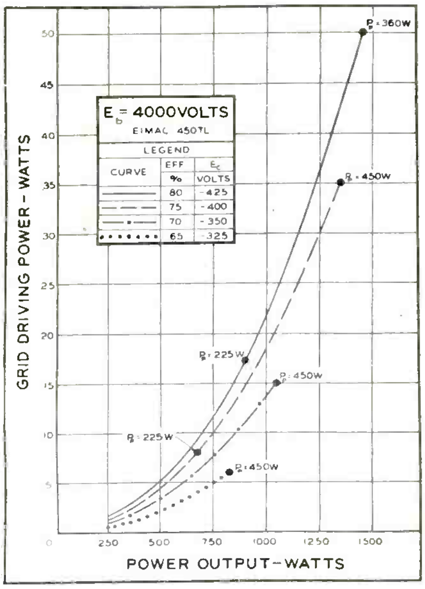


UNUSUAL VERSATILITY

The Eimac 450T is perfectly suited to a wide variety of uses as a modulator, oscillator, or amplifier. It is available as a high-mu (450TH) or low-mu (450TL) type. In every capacity, the Eimac 450T is tops in its power range; stable, rugged, and above all, proven over years of successful use.

LONG DEPENDABLE LIFE

When the first Eimac 450T's were installed in several major broadcasting stations, operators consistently reported better than 15,000 hours of service, top-notch performance. They were astounded to see such a compact tube do a giant's job. Eimac 450T's in airline ground stations located everywhere from sub-zero mountain passes to steaming jungles have been reported going quietly and efficiently about their jobs after 20,000 hours on the air!



PERFORMANCE PLUS

Performance is, after all, the ultimate criterion of electron tubes. The unusual capabilities and low interelectrode capacitances of the Eimac 450T are two of the reasons for its widespread use in 1 Kw to 5 Kw stations at frequencies up to 60 Mc. And even at frequencies up to 150 Mc, the 450T triode will provide a useful output.

HIGH POWER-GAIN

In a class B audio amplifier, a pair of Eimac 450TL's will provide 2200 watts plate power output with a driving power of but 15 watts! Or, in a class-C application, a *single* Eimac 450TL will provide an r-f plate power output of 1800 watts with but 42 watts driving power.

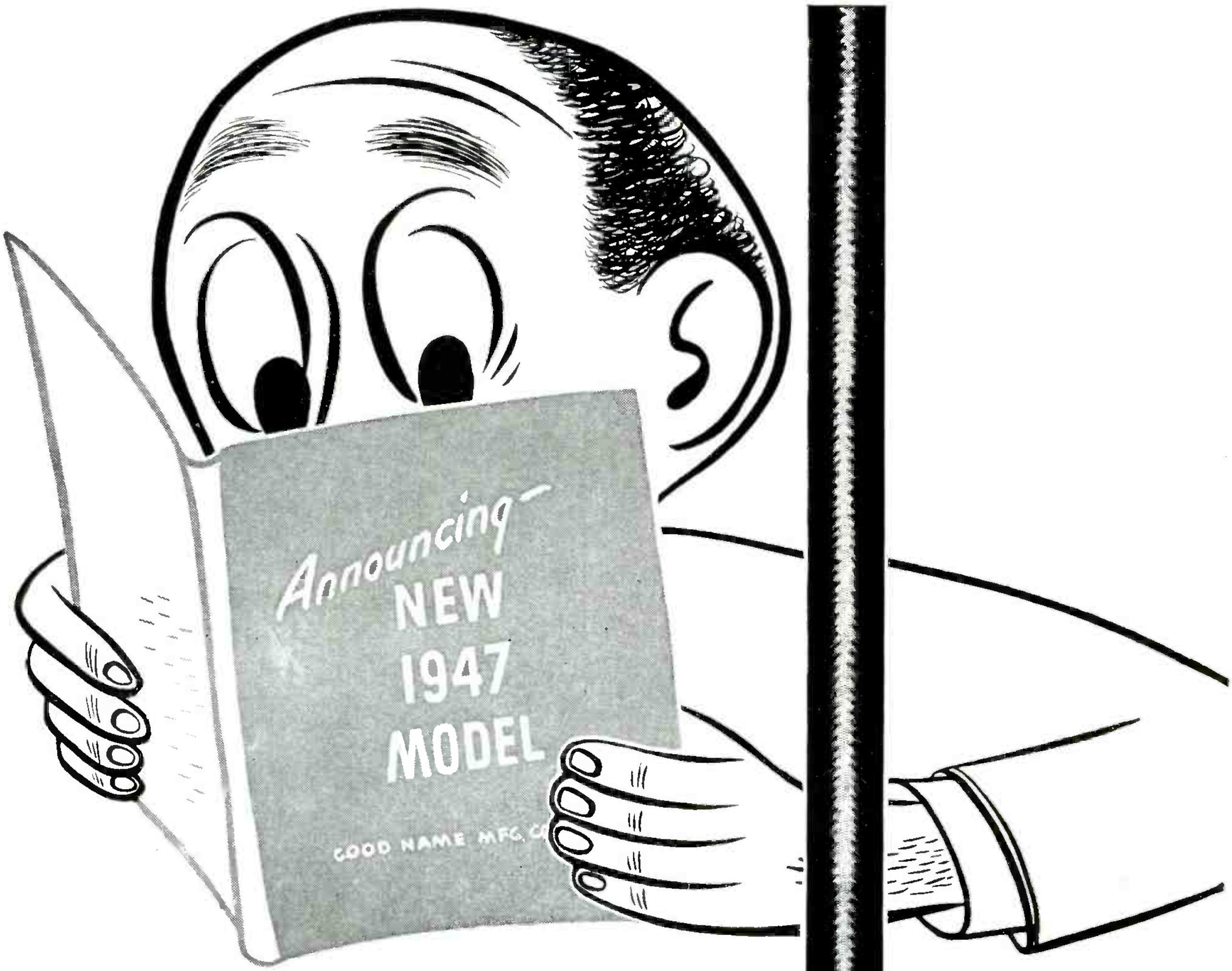
POST-WAR IMPROVEMENTS

The 450T, proven before war and during war, stands today as a greater tube than ever before. Post-war developments, the result of steady, intensive research in Eimac's laboratory, has brought to today's 450T new electrodes for higher thermionic efficiencies and even longer life.

With these facts in mind, it's easy to see why the Eimac 450T is accepted over any other triode of like rating. This veteran tube has stood the acid test of time and rugged duty around the world. Today a still better 450T awaits your order. Inquire!

EITEL-McCULLOUGH, INC.
1305E San Mateo Ave., San Bruno, Calif.
Export Agents:
Frazar and Hansen, 301 Clay St., San Francisco 11, Calif.

Follow the Leaders to
Eimac REG. U. S. PAT. OFF.
TUBES
THE COUNTERSIGN OF DEPENDABILITY IN ANY ELECTRONIC EQUIPMENT

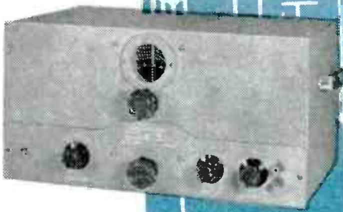

Announcing—
NEW
1947
MODEL
GOOD NAME MFG.

LABORATORY INSTRUMENTS FOR SPEED AND ACCURACY

201B AF OSCILLATOR

Meets every requirement for speed, ease of operation, accuracy and purity of wave form in FM and other fields where high fidelity is important.

Frequency range from 20 Cps to 20 Kc. Up to 3 watts power into 600 ohm resistive load with distortion of less than 1%. (Distortion not more than ½% at 1 watt output.) Frequency control is accurately obtained by direct or a 6-1 vernier tuning over a large illuminated, no-parallax dial. Price $190.00 FOB Palo Alto.



330B DISTORTION ANALYZER

Unusually valuable for measurement through the audio spectrum in broadcast, laboratory or production problems. Measures "total" distortion at any frequency from 20 Cps to 20,000 Cps, and will accurately make noise measurement of voltages as small as 100 microvolts. Linear r-f detector makes possible measurement direct from modulated r-f carrier. May be used as voltmeter for measuring voltage level, power output, amplifier gain; or serves as high-gain, wide-band stabilized amplifier with maximum gain of 75 db. Price $375.00 FOB Palo Alto.

One year of -hp- achievement

In one single year since the war's end, -*hp*- has brought you five important new precision instruments. All are now in use in laboratories, factories, electrical and electronic installations around the world. Each represents a vital contribution to the field of electrical measurement. Each is an example of how -*hp*- engineering anticipates the rapid strides of modern science.

Soon -*hp*- will announce significant new instruments to further broaden the field of electrical measurement. Meantime we are now able to make immediate delivery on most -*hp*- instruments. Send your order now!

HEWLETT-PACKARD COMPANY
1304A PAGE MILL ROAD • PALO ALTO, CALIFORNIA

410A VACUUM TUBE VOLTMETER

Measures voltage over wide frequency range (from audio to microwave regions) at high impedance. High input impedance and low shunt capacity makes possible testing video and VHF amplifier circuits without disturbing circuit under test. *ac measurements:* Six ranges, full-scale readings from 1 to 300 volts. Input impedance 6 megohms in parallel with 1.3 $\mu\mu$fd. Frequency response 20 Cps to 700 Mc, ±1 db. *dc measurements:* Seven ranges, full-scale readings from 1 to 1000 volts. Input impedance 100 megohms, all ranges. *Resistance measurements:* Seven ranges, mid-scale readings, 10 ohms to 10 megohms. Price $210.00 FOB Palo Alto.

450A AMPLIFIER

A stable, wide-band, general purpose laboratory instrument. 40 db or 20 db gain of unusual stability, low phase shift. Frequency response flat within ½ db between 10 and 1,000,000 cycles. Input impedance 1 megohm shunted by 15 $\mu\mu$fd. Internal impedance less than 150 ohms over entire range. Fully operated from 115 volts, 60 cycles AC power supply. Can be used with 400A Vacuum Tube Voltmeter to measure voltages as low as 50 microvolts. Price $125.00 FOB Palo Alto.

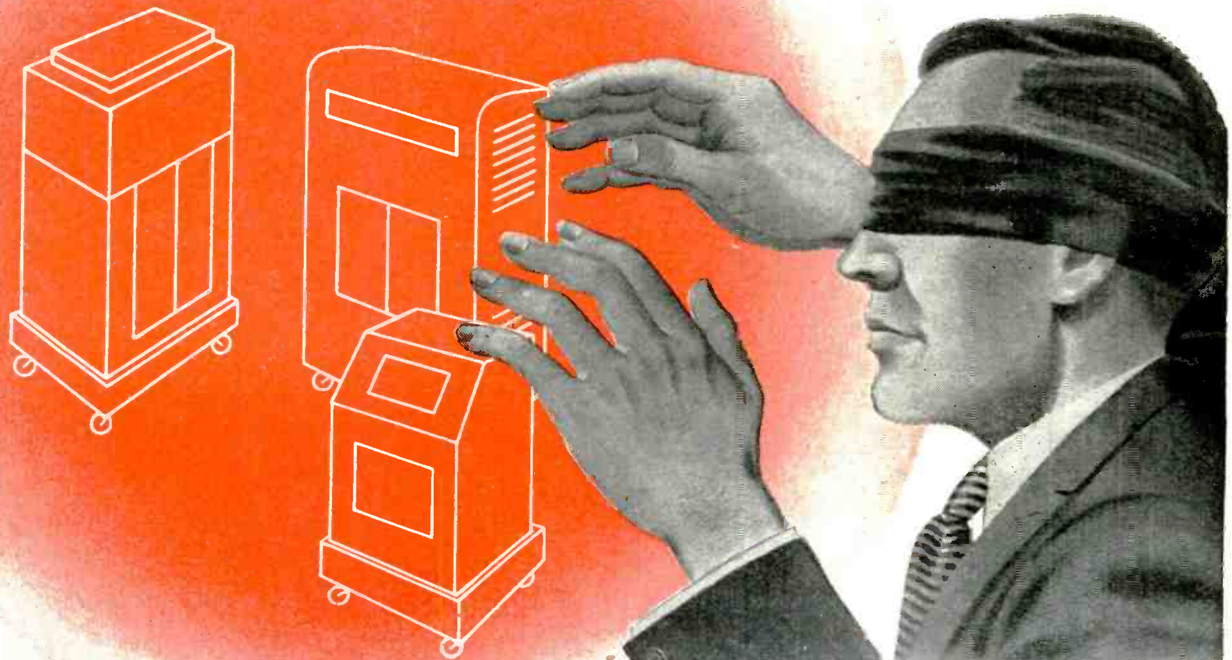
710A POWER SUPPLY

Ideal power supply for general, laboratory, or production use. Delivers any required voltage between 180 and 360 volts, with approximately 1% variation for output currents of from 0 to 75 ma. Maximum current 100 ma. Line voltage variation of ±10% causes less than 1% change in output voltage. Total noise and hum output is less than .005 volts. Supplies up to 5 amps at 6.3 volts ac for heating filaments. Either positive or negative terminal may be grounded. Price $75.00 FOB Palo Alto.

Power Supplies • Frequency Standards • Amplifiers • Electronic Tachometers Frequency Meters • UHF Signal Generators • Square Wave Generators

Noise and Distortion Analyzers • Audio Signal Generators • Attenuators Audio Frequency Oscillators • Wave Analyzers • Vacuum Tube Voltmeters

Don't buy an electronic heater *blindly*



INSIST ON PROOF BY TRIAL

Do you do 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 and 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.

Scientific Electric Electronic Heaters are made in the following range of power; 3—5—7½—8—10—12½—15—18—25—40—60—80—100—250 KW —and range of frequency up to 300 Megacycles depending on power required.

Scientific Electric

DIVISION OF
"S" Corrugated Quenched Gap Co., 107 Monroe St., Garfield, N. J.

ISOLATED IN A LITTLE WORLD ALL ITS OWN

. . . with

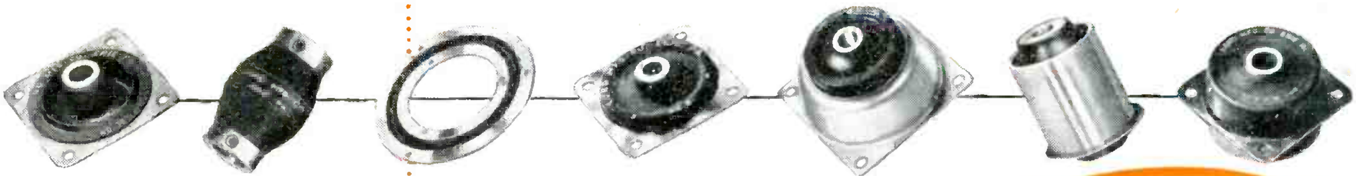
LORD
SHEAR TYPE
Bonded Rubber
MOUNTINGS

METER INSTALLED
WITH MOUNTING

AN accurate meter is a sensitive mechanism, and a sensitive mechanism is also a delicate mechanism. It can't stand the buffetings of vibration, and continue its normal functioning. Yet some of the most important services that meters render must be rendered in the midst of chaotic disturbances.

The Lord Meter Mount creates a new environment, an environment of peace and quiet in the midst of turbulent vibration, for the sensitive and delicate instrument, a little world of its own that is limited by the soft circular cushion of rubber that surrounds it. It goes on quietly registering speed, or altitude, or temperature, or amperes, with self-possessed efficiency.

In a generation of pioneering vibration control we have solved thousands of vibration problems which have come to us. The problem which is new to you may be old to us, with the data in our files and the product in our line to meet it. If it's a new problem, remember that every problem was new when we started. We'll find a solution, and if necessary we'll make a new product to put it into effect.



Every genuine Lord Mounting carries the name "LORD" embossed in the rubber or in raised letters on the forgings.

IT TAKES BONDED RUBBER *In Shear* TO ABSORB VIBRATION

LORD MANUFACTURING COMPANY

ERIE, PENNSYLVANIA

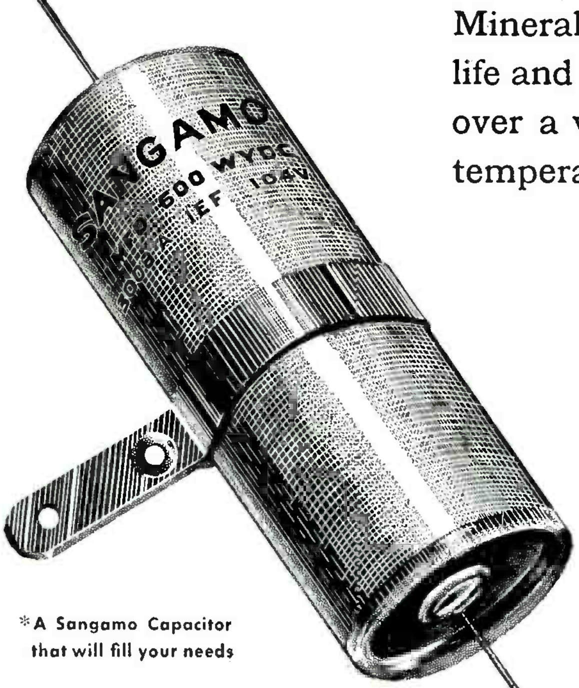
SALES REPRESENTATIVES
NEW YORK - - 280 MADISON AVE.
CHICAGO - 520 N. MICHIGAN AVE.
DETROIT - - 7310 WOODWARD AVE.
BURBANK, CAL. - 245 E. OLIVE AVE.
CANADIAN REPRESENTATIVES
RAILWAY & POWER ENGINEERING CORP., LTD.
TORONTO, CANADA

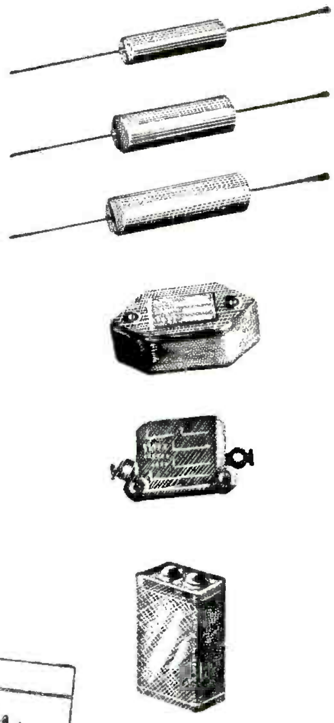
Originators of Shear Type Bonded Rubber Mountings

JACK OF ALL TRADES*

SANGAMO METAL-CASED MINERAL OIL PAPER CAPACITORS

Mineral oil filled to assure longer life and more stable performance over a wider range of operating temperatures.



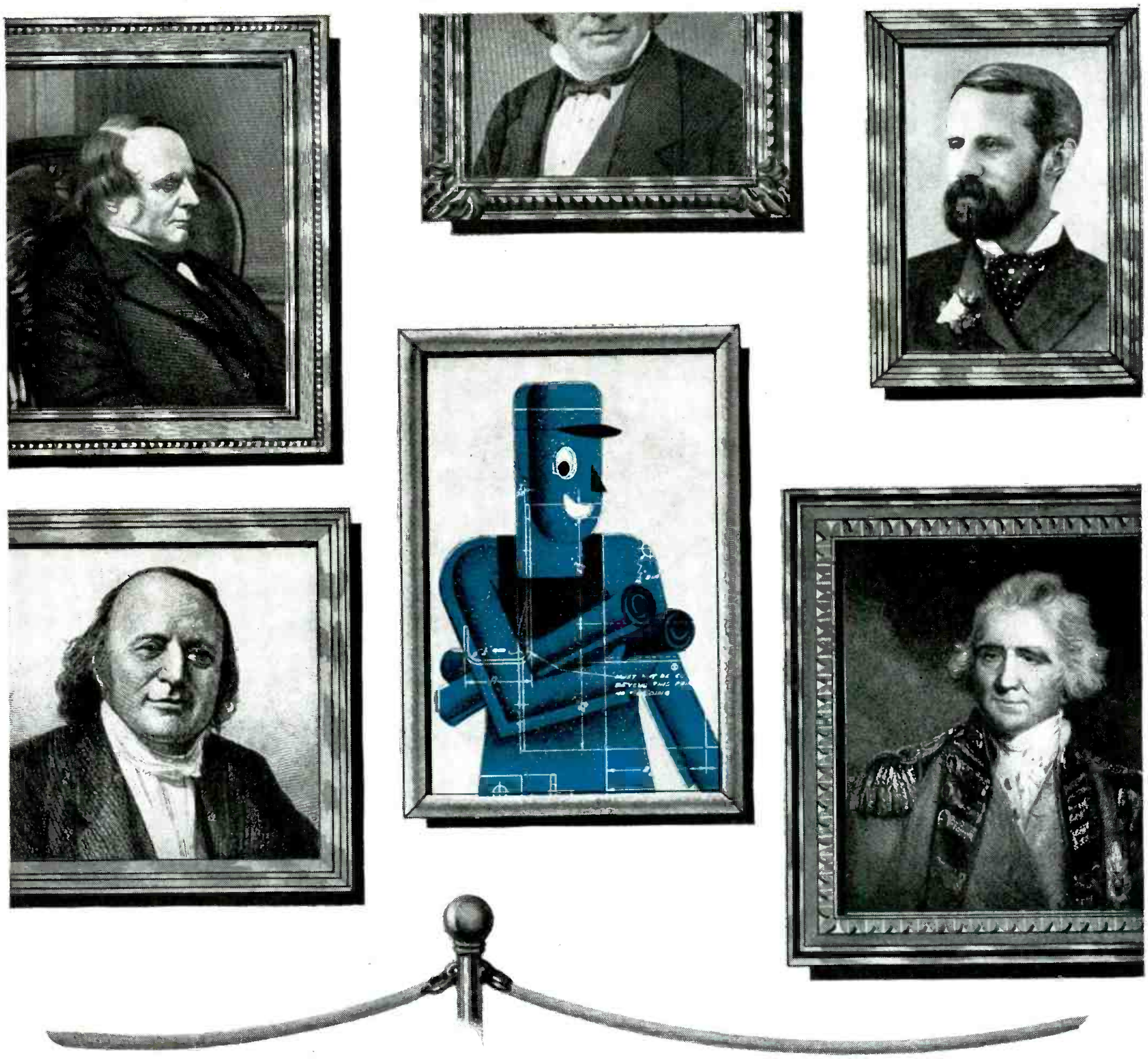


*A Sangamo Capacitor that will fill your needs

Sangamo Types 20 and 21 Capacitors have attained extreme popularity with their users because of their excellent by-pass and coupling qualities. Vacuum impregnated and filled with the highest grade of mineral oil, their capacity is stable from 55°C below to 85°C above zero. Capacitors are available within the range of 200 to 2000 volts working.

Write for the new Sangamo Capacitor Catalog which contains complete information for your use

SANGAMO ELECTRIC COMPANY
SPRINGFIELD • ILLINOIS



GOOD COMPANY

WE'RE not pretending we belong in any Gallery of the Great. It's just our way of calling attention to the fact that a manufacturing organization, as well as a famous personage, can have character and individuality.

Through the years the Karp organization has become known as a good company to do business with — a company with a likeable personality — a company that understands and practices cooperative service.

Because our experience and craftsmanship in sheet metal fabrication mean good business for our customers, our services are preferred by many of the "great names" in American industry. We're extremely proud of the outstanding firms we serve.

They like our work. They like the sound value our work represents. They find their relations with us helpful and pleasing.

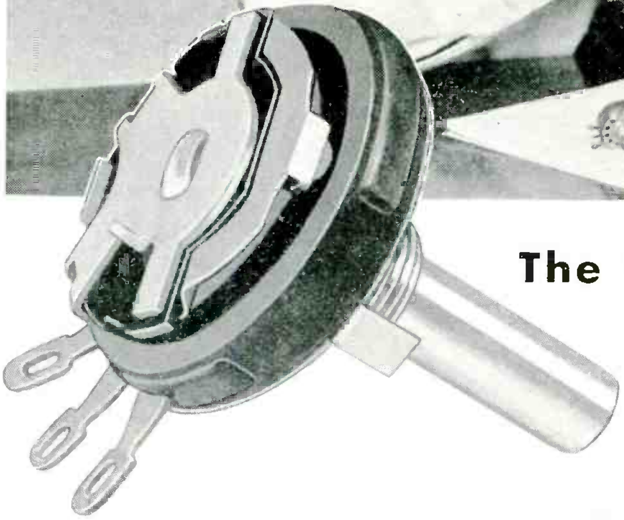
If you are not already on our list of customers, let's get acquainted. Consult us for superior craftsmanship in cabinets, housings, chassis, racks, boxes, enclosures or any type of sheet metal fabrication.

WRITE FOR OUR NEW CATALOG.

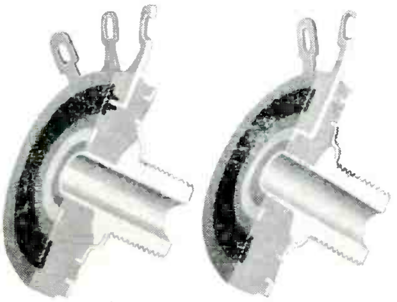
KARP METAL PRODUCTS CO., INC.

Custom Craftsmen in Sheet Metal

124 — 30th STREET, BROOKLYN 32, N. Y.



The resistor element is molded as a single unit, with insulation, terminals, face plate, and threaded bushing. There are no rivets, welded or soldered connections.



During manufacture, the resistance may be varied over its length to provide any resistance-rotation curve. After molding, heat, cold, moisture, or hard use cannot affect it.

The Bradleyometer Resistor is solid-molded and thick ... not just sprayed film

The heart of an adjustable composition rheostat or potentiometer... like the Type J Bradleyometer ... is the resistor element. If it is a fragile, sprayed film, it cannot hold up satisfactorily under frequent operation, rapid climatic changes, or overload. But if it is a thick, solid-molded ring . . . as in the Type J Bradleyometer... it has long, trouble-free life built into it. And its 2-watt rating has a big safety factor, too.

Type J Bradleyometers can be furnished in single, dual, or triple unit construction. Built-in switch is optional. Let us send you specifications.

Allen-Bradley Company, 110 W. Greenfield Ave., Milwaukee 4, Wis.

A·B

ALLEN-BRADLEY

FIXED & ADJUSTABLE RADIO RESISTORS

QUALITY

More Than Relays... It's CLARE Reputation They Hold In Their Hands!

● Relays are no side line with Clare. Precise, "custom-built" relays are our stock in trade.

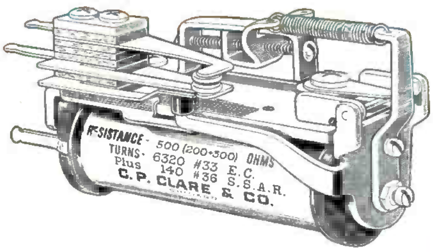
Through these trained fingers in Clare's modern test laboratory pass every Clare "Custom-Built" Relay to make sure that each fulfills the customer's requirements exactly. Operate and release current . . . contact sequence . . . contact pressure . . . coil resistance . . . high-voltage insulation . . . every detail must check.

This painstaking testing of the manufacture and precise adjustment of each relay is one reason why thousands of users of Clare "Custom-Built" Relays count on them for applications where ordinary relays won't do.

Clare "custom-building" means that the proper combination of various Clare features may be built into a standard frame so as to provide a relay ideal for the specific requirement. This makes possible a flexibility of design and construction which gives unusual operating reliability even under severe conditions of temperature, humidity, atmospheric pressure or vibration.

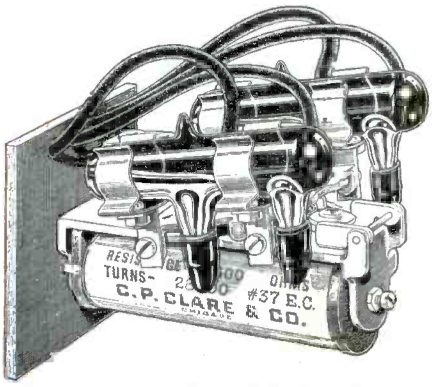
See your nearest Clare sales engineer. They are located in principal cities to work with you in the development of "custom-built" relays to meet your most unusual relay requirements. Let them show what Clare "custom-building" can mean to you. Do you have the new Clare Engineering Data Book? If not, send for your copy today. Address: C. P. Clare & Company, 4719 West Sunnyside Ave., Chicago 30, Ill. Cable Address: CLARELAY.

In Canada: Canadian Line Material Ltd., Toronto 13



Clare Micro-Adjustment Relay—This Clare Micro-Adjustment Relay is capable of unusually precise adjustments for marginal, close differential operation. It is for use in applications where extremely accurate adjustment is required.

The armature tension is adjusted by tightening or loosening the spring which is attached to a post at the armature end of the relay.



Clare Mercury Contact Relay—Shown above is a Clare Type "M2" Mercury contact relay with glass enclosed contacts. The mercury contact is mounted on a tilt table attached to the heelpiece of the relay. These relays must be mounted horizontally. Clare also provides Mercury contact relays with Bakelite enclosed contacts and with metal contacts.

CLARE RELAYS

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

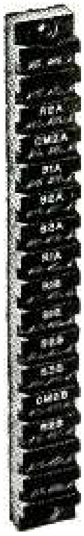
Post-formed Lamicoid laminated plastic used by RCA as an antenna case and insulating piece.

POST-FORMED LAMICOID...THE CASE FOR RCA VICTOR RADIO ANTENNAE

RCA-Victor uses a post-formed Lamicoid laminated plastic part, on which is stamped the RCA trade name, as an *insulating part*, and a case for the internal antenna on their 66BX Globetrotter—the portable radio.

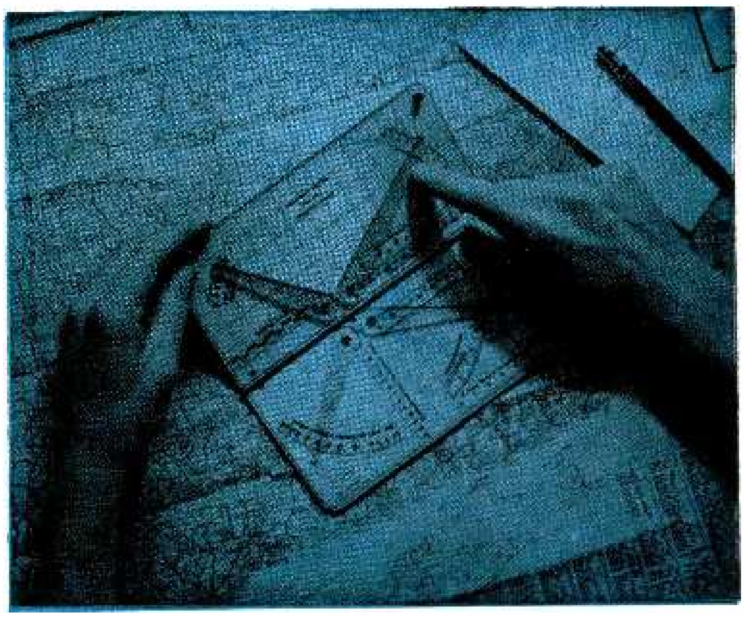
Whatever *your* uses and requirements may be for a laminated plastic insulating material for electric and electronic equipment, we can supply you with Lamicoid because it is available in so many grades and types. Coil forms, panel boards, charts, signs, gears, machine parts and many other insulating or structural pieces can be made of Lamicoid to *exact* specifications.

Lamicoid has high dielectric strength,



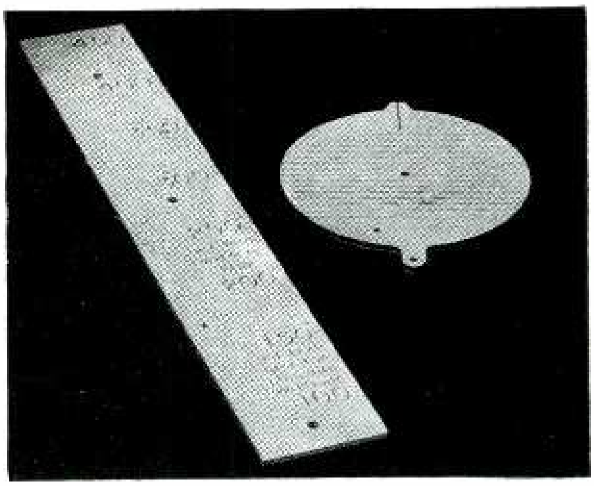
Lamicoid used on this terminal block can be machined, sawed, drilled and easily printed for circuit identification. Lamicoid sheets are obtainable with rubber for terminal connections that must be sealed against moisture and various liquids.

Mechanical Calculator—which utilizes graphic Lamicoid. This type of Lamicoid is widely used for wiring diagrams, instrument panels, flasher and elevator signals, etc.

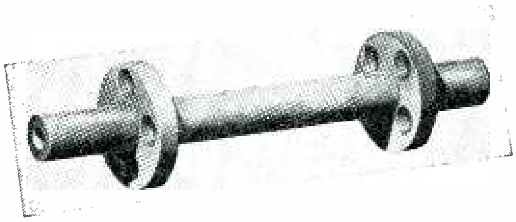


high mechanical (compressive) strength, is suitable for both high and low-voltage, and low power factors—and is staple under varying atmospheric conditions. Lamicoid is available in sheets, rods and tube forms . . . and made with different resin binders to meet specific operating conditions.

Mica Insulator Company is headquarters for all types of insulating materials, backed by half a century of practical experience which dates from the very beginning of electrical insulation. That's why you can always be sure of receiving from Mica engineers honest and impartial suggestions as to the best solution to your insulating problems. Write.



Example of how graphic Lamicoid can be used as an insulating material and as an indicating medium. Available in translucent, opaque, rigid or flexible, translucent engraving or fluorescent graphic for name plates, signs, charts, diagrams.



This coil form is made of canvas-back Lamicoid. Let the Mica Insulator Company, with over 50 years of practical experience suggest the types of Lamicoid best suited to the exact requirements of *your* product.

MICA *Insulator* COMPANY

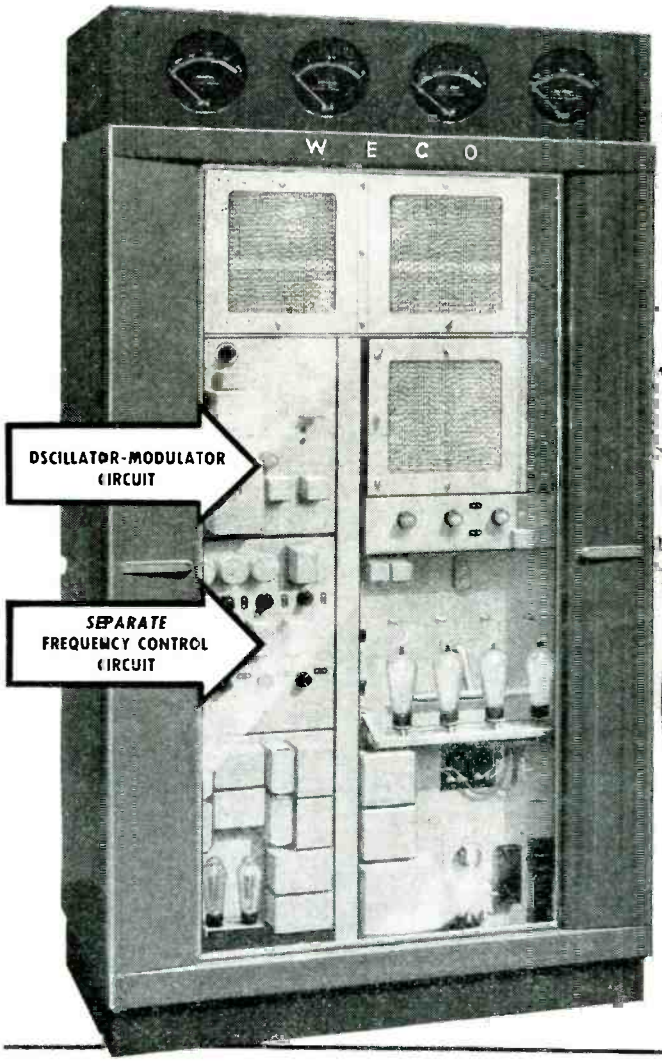
Dept. 22, Schenectady 1, New York

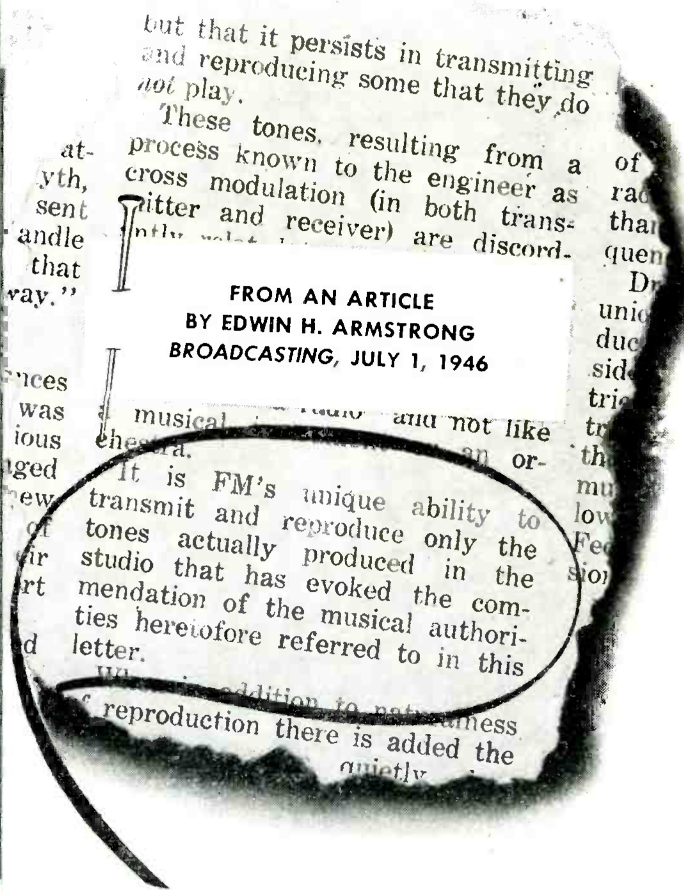
SALES OFFICES: Boston: 285 Columbus Avenue; Chicago: 600 West Van Buren Street; Cincinnati: 3403 Hazelwood Avenue; Cleveland: 1276 West 3rd Street; Detroit: Book Building; New York: 200 Varick Street; St. Louis: 455 Paul Brown Building; Philadelphia: 1119 Real Estate Trust Building; Rochester: 817 Commerce Building; Western Fiberglas Supply, Ltd., 739 Bryant Street, San Francisco 7; 937 South Grand Avenue, Los Angeles 15.

FABRICATORS: Lamicoid Fabricators, Inc., 3600 Potomac Avenue, Chicago, Ill.; Insulating Fabricators, Inc., 69 Grove Street, Watertown, Mass.; Insulating Fabricators, Inc., 12 East 12th Street, New York City; Bakoring, Inc., 1020 Houston Avenue, Houston 10, Texas.

Important FM news

for Broadcast Managers . . . Engineers . . . Listeners




but that it persists in transmitting and reproducing some that they do not play.

These tones, resulting from a process known to the engineer as cross modulation (in both transmitter and receiver) are discord-

FROM AN ARTICLE
BY EDWIN H. ARMSTRONG
BROADCASTING, JULY 1, 1946

musical ... and not like orchestra.

It is FM's unique ability to transmit and reproduce only the tones actually produced in the studio that has evoked the commendation of the musical authorities heretofore referred to in this letter.

... reproduction there is added the ...

IT is low cross modulation (intermodulation), as Major Armstrong points out, which allows FM to reproduce only the notes actually played and thus achieve such naturalness of tone.

Western Electric's Synchronized FM transmitters are unique in FM broadcasting because of their *unusually low intermodulation products*—achieved by a complete separation of the oscillator-modulator circuit from the frequency control circuit.

For other important features of Western Electric's complete new line of FM transmitters, contact your nearest Graybar Broadcast Equipment Representative, or write to Graybar Electric Company, 420 Lexington Avenue, New York 17, N.Y.

Unexcelled Performance of Western Electric FM Transmitters

Audio Frequency Response		±0.25 DB from 30 to 15,000 cycles
Harmonic distortion — for	±75 KC swing	Less than 0.5% from 30 to 15,000 cycles
— for	±100 KC swing	Less than 0.75% from 30 to 15,000 cycles
Intermodulation— — for	*±75 KC swing*	*Less than 0.5% for 80% 50 cycles and 20% 1000 cycles; less than 1.0% for 80% 50 cycles and 20% 7000 cycles*
FM noise level		65 DB below ±75 KC swing
AM noise level		50 DB below 100% amplitude modulation
Carrier Frequency stability		Less than 2000 cycles deviation (no crystal heater)

Western Electric

— QUALITY COUNTS —

Western Electric — Distributed by Graybar — Offices in 92 principal cities

Accurately detects sources of wear, strain and noise . . . . .

The TELEVISO
MODEL 11-B
VIBROMETER

● The Televiso Model 11-B Vibrometer electronically measures the vibration characteristics of any moving surface instantly and accurately. Unnecessary wear, strain and noise no longer need be tolerated in industrial machinery, and in the integral parts of products.

The Vibrometer is an invaluable design aid. It prevents breakdowns, locates trouble, speeds production, reduces rejects.

It is particularly useful in measuring the vibration in motors, gears, bearings, rotors, fans, propellers, presses, aircraft structures, stokers, etc. Ninety-five percent of all vibration measurements needed by industry are covered.

All three types of vibration are registered on a calibrated meter scale: *displacement,* where the vibration may be felt but not seen; *velocity,* where the vibration is minute; *acceleration,* where the vibrating surface is small.

Consisting of an integrated, amplified vacuum tube voltmeter with a cable-attached piezo-electric Rochelle salt crystal search prod; the Vibrometer is equipped with interchangeable fittings which permit innumerable applications.

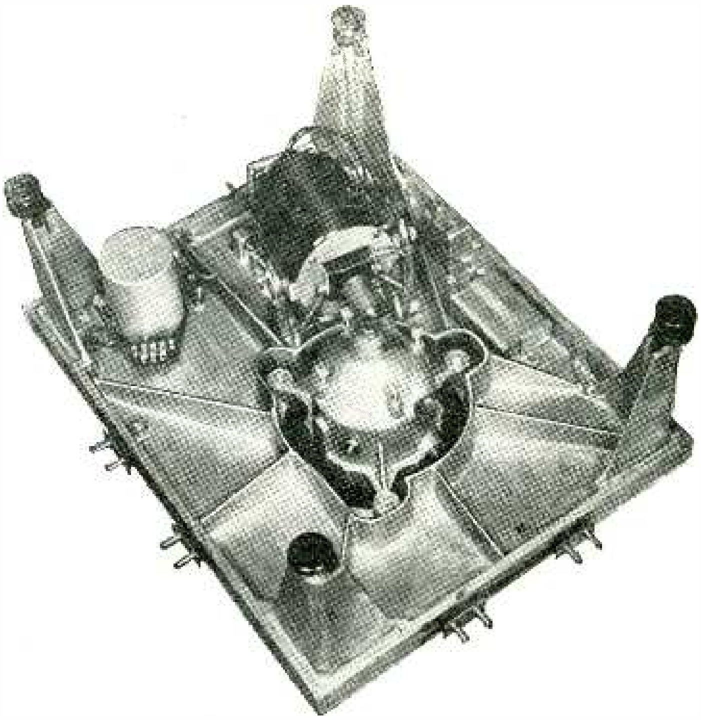
Sturdily constructed and portable, the Vibrometer is practical for field, laboratory and production use. Operation is simple. Write today for complete technical data.

Specifications

Operation:	105-125 volt, 50-60 cycle, power.
Frequency Response with Search Prod Plugged in:	5-2500 cps., uniform within 2%. Correction graph to 2 cps. can be supplied.
Weight:	31 pounds.
Size:	17″ high, 12″ deep, 11½″ wide, 10° slope.
Displacement Range:	5 ranges, 0-.01″, 0-.03″, 0-.1″, 0-.3″, 0-1″ in RMS displacement.
Velocity Range:	5 ranges (in inches per second), 0-1, 0-3, 0-10, 0-30, 0-100.
Acceleration Range:	5 ranges (in inches per second per second), 0-100, 0-300, 0-1000, 0-3000, 0-10,000.
Output Jack:	Available at rear of Vibrometer for use with phones, oscillograph, wave analyzer, or recording devices.
Construction:	All aluminum mechanical components housed in a solid oak, copper lined cabinet. The black, wrinkle-finish panel is engraved.
Guaranty:	The Vibrometer is guaranteed for two years.

Televiso PRODUCTS CO.
7466 IRVING PARK ROAD
CHICAGO 34, ILLINOIS

Console STABILITY



Unit 539 Portable Recorder

...for professional portable recorders!

Once again, Fairchild takes the lead in improved sound equipment design—*for even finer performance*. This time it's the new cast panel and motor mount for the Unit 539 Portable Recorder, shown above.

By replacing the former lightweight panel with a sturdy, ribbed casting with integrally cast legs, Fairchild brings console stability to professional portable recorders. The full weight of the recorder mechanism is supported independently of the trunk. The entire mechanism can be removed as a unit, if desired, and leveled up on its own four legs on a bench for operations or mechanical adjustment.

Here again, Fairchild is thinking ahead in terms of increasingly higher standards of performance for both AM and FM broadcasting and professional recording by adding vibration-free performance to already attained wide dynamic range, minimum distortion content, wide frequency range and split-second timing.

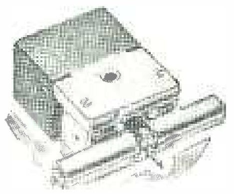
Unit 539 Portable Recorder, mounted in a trunk for portability, is designed to meet and exceed professional specifications for direct lateral recording and reproduction of sound on discs up to 16″ at 33.3 rpm and 78 rpm. It is complete with cable and connectors for attachment to Fairchild Unit 540 and 295 Amplifier-Equalizers.

Where double turntable or continuous recording and direct playback are required, a second identical Unit 539 Recorder can be connected to a Unit 540 or 295 Amplifier-Equalizer.

SOUND EQUIPMENT

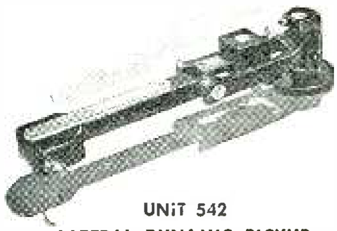
FCI *Fairchild* CAMERA AND INSTRUMENT CORPORATION

FOR IMPROVED PERFORMANCE



UNIT 541
MAGNETIC CUTTERHEAD

Earlier FAIRCHILD portable models and many other types of recorder-playbacks will give vastly improved performance if equipped with an improved Fairchild Pickup and Cutterhead. For complete information address: 88-06 Van Wyck Boulevard, Jamaica 1, N. Y.



UNIT 542
LATERAL DYNAMIC PICKUP

SYLVANIA NEWS

CIRCUIT ENGINEERING EDITION

NOV. *Prepared by* **SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa.** 1946

SYLVANIA COMMERCIAL ENGINEERING DIVISION AIDS IN PRODUCING EFFICIENT SET CIRCUITS

Views of Sylvania Electric's renowned Commercial Engineering Department. Here, new discoveries from Sylvania's laboratories are built into the latest products.

Helping to engineer the best possible radio circuits for many set manufacturers is one of the numerous achievements of Sylvania's famous Commercial Engineering Department.

Time and again circuits found to be unnecessarily complicated were simplified and made even *more efficient* through the work carried on here.

HELP — SHARE A MEAL EVERY DAY

For nearly twenty years Sylvania's Commercial Engineering Department has contributed to the advancement of circuit design as well as to the development of a great variety of electronic and lighting products.

SOME PRODUCTS OF SYLVANIA ENGINEERING RESEARCH

- Radio receiving tubes, such as the famous Lock-In.
- Miniature radio receiving tubes, including the tiny T-3.
- 1.4 volt battery tubes.
- 150 ma. line of 6.3 volt tubes.
- Radio transmitting tubes.
- Cathode ray tubes.
- Pirani tubes.
- Silicon Crystal Diodes.
- 1N34 and 1N35 Germanium Crystals.
- Electroflash Tubes and Units.
- Radio tube parts.
- Fluorescent lamps.

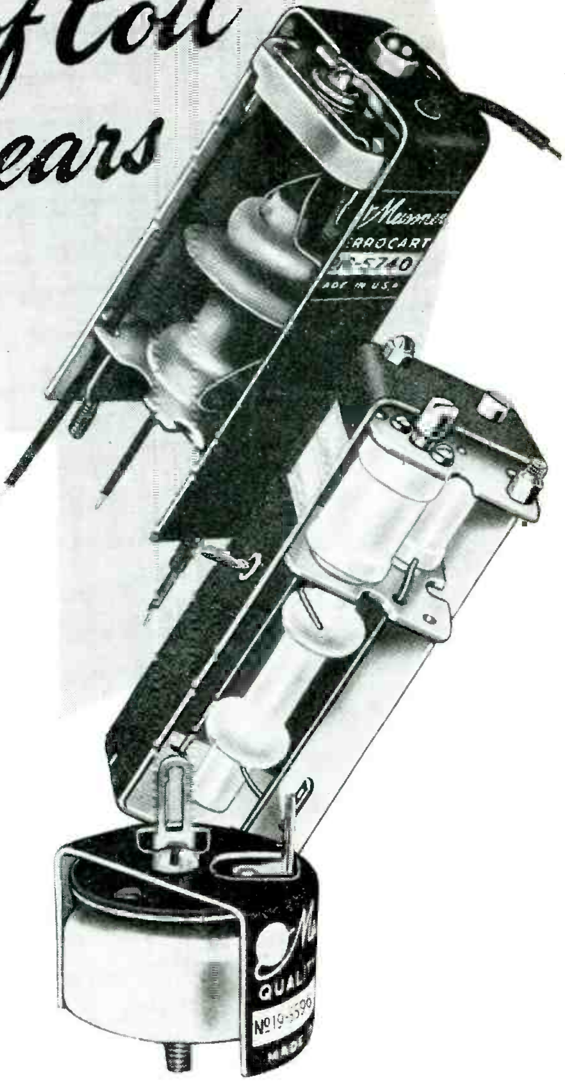
SYLVANIA ELECTRIC

Emporium, Pa.

MAKERS OF RADIO TUBES; CATHODE RAY TUBES; ELECTRONIC DEVICES; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES; ELECTRIC LIGHT BULBS

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.

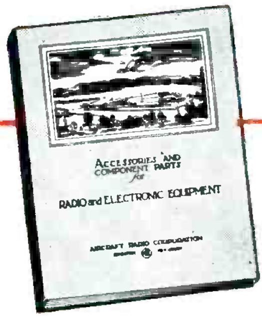
936 N. MICHIGAN AVENUE · CHICAGO 11, ILLINOIS

Recently released from Army-Navy classification, this equipment, formerly known as the TS-223/AP, is now being produced by Aircraft Radio Corporation as the A.R.C. Test Set, Type H-10.

This highly specialized test equipment is used primarily for the measurement of radar receiver sensitivity, frequency and band width; and transmitter power and frequency, in the 24,000 Mc. band. Other field or laboratory measurements possible with this equipment include testing of type 2K50 r-f oscillator tubes and measurement of radar receiver recovery time.

The heart of the A.R.C. Test Set, the 24,000 Mc. wavemeter and attenuator, is available separately, if desired.

For full information on A.R.C. microwave accessories and component parts, write



NOW AVAILABLE: free, illustrated catalog of A.R.C. Radio and Electronic Component Parts and Accessories

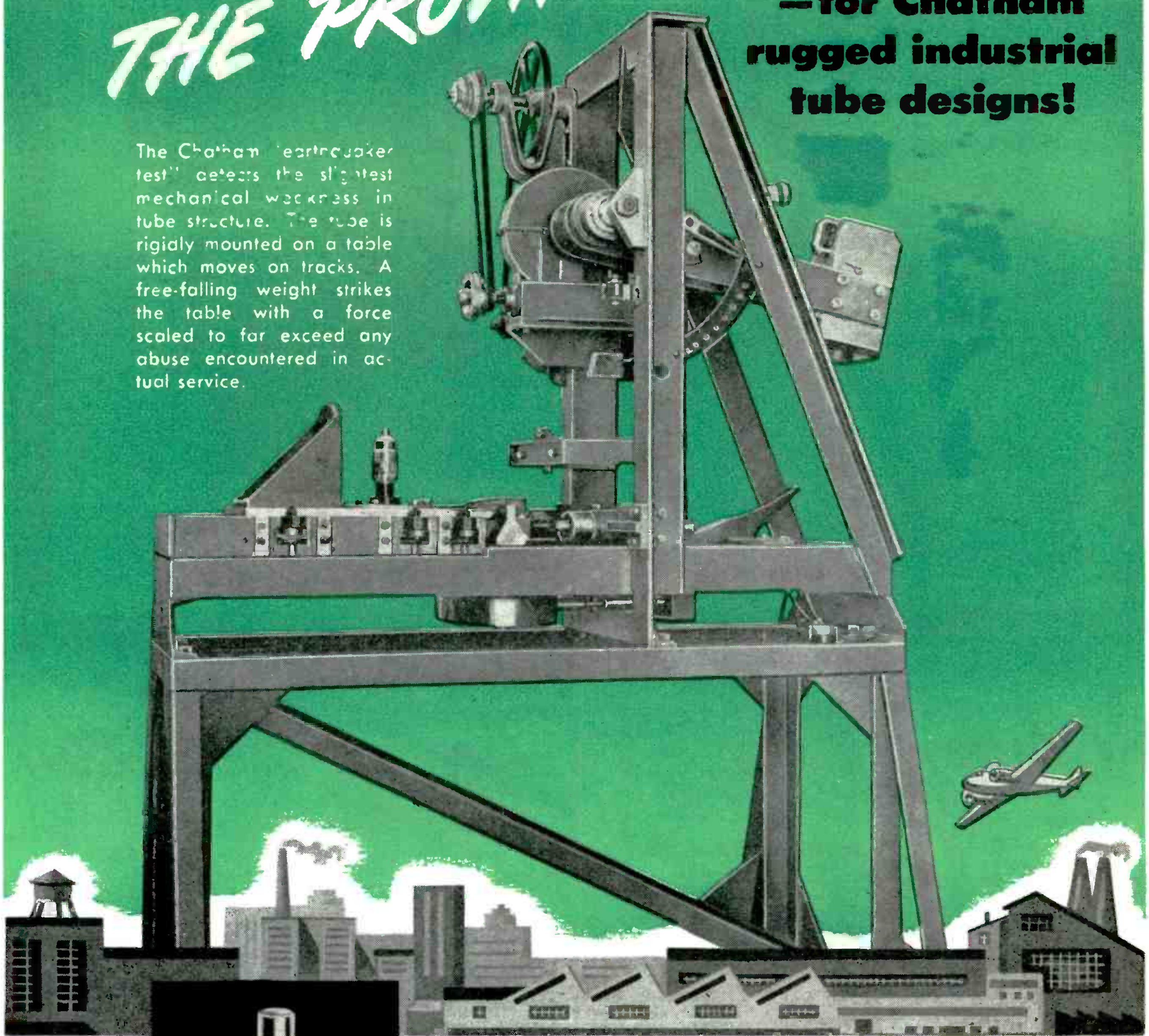
ARMY NAVY — CONTRACTORS SINCE 1929 TO THE ARMY AND THE NAVY

AIRCRAFT RADIO CORPORATION

BOONTON, NEW JERSEY

This high impact shock machine is THE PROVING GROUND —for Chatham rugged industrial tube designs!

The Chatham "earthquaker test" detects the slightest mechanical weakness in tube structure. The tube is rigidly mounted on a table which moves on tracks. A free-falling weight strikes the table with a force scaled to far exceed any abuse encountered in actual service.



INERT GAS RECTIFIERS

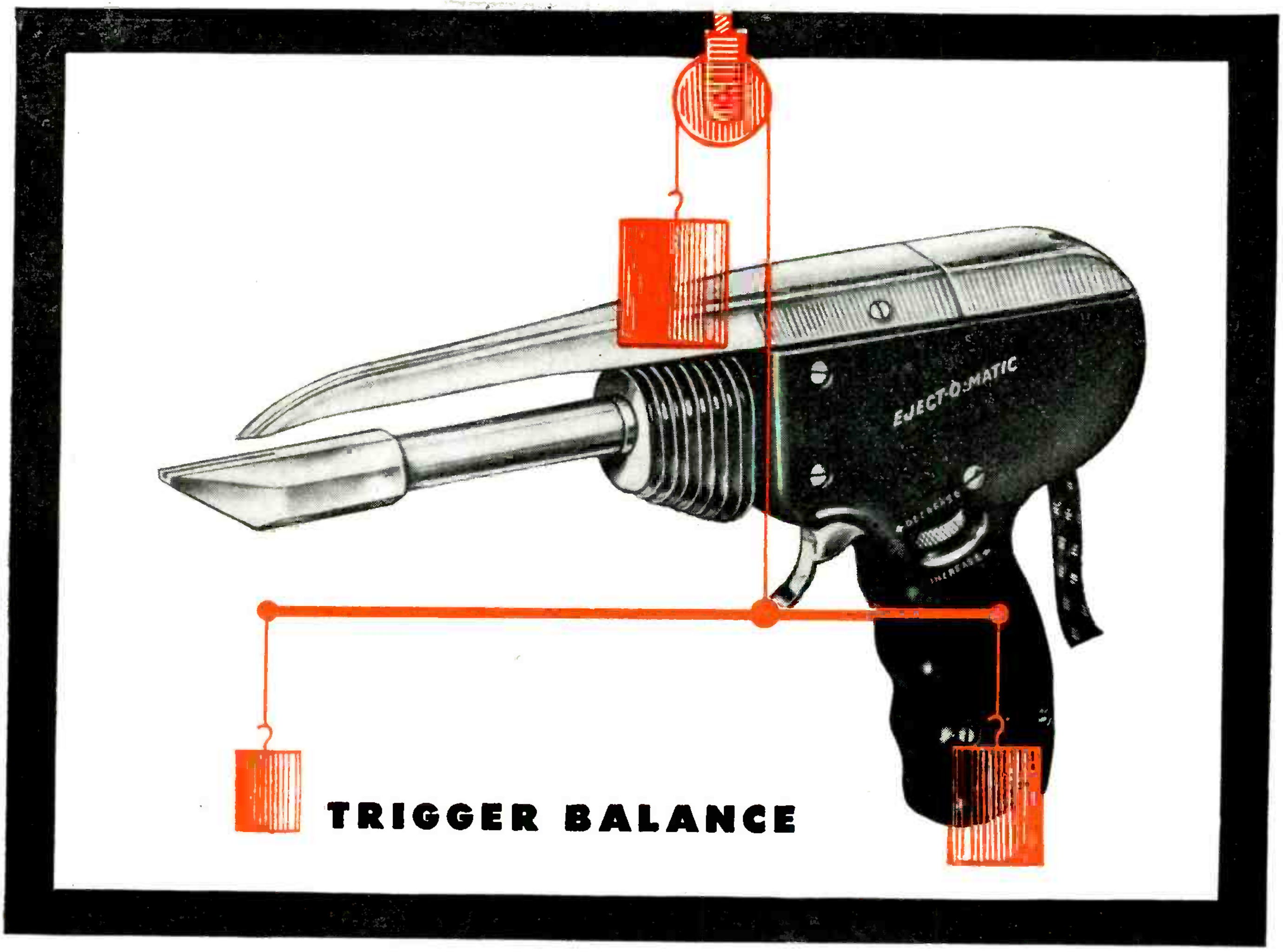
CHATHAM Xenon rectifier and thyratrons perform perfectly under wide extremes of ambient temperature without blowers, thermostats or other auxiliaries to maintain bulb temperature. They are recommended for industrial, airborne and other installations where reliability is a prime consideration.

Chatham engineering and design research far surpasses ordinary methods and procedure in pre-detecting and analyzing electronic rectifier tube characteristics under severe operating conditions. Vibration, shock and other mechanical abuse—the usual "death knell" for tubes in heavy industrial applications—are dealt with in the blueprint stage of manufacture.

For example, CHATHAM is one of the few manufacturers equipped to subject their tubes to this positive test of stamina. For this reason, we suggest that users of rectifiers, thyratrons and spécial types check their needs with CHATHAM engineers—particularly where severe operating conditions are involved. Simply call or write on company letterhead. There is no obligation for this CHATHAM service.

CHATHAM ELECTRONICS

475 WASHINGTON STREET, NEWARK 2, NEW JERSEY



Reduces fatigue factor—speeds production

Light weight, and non-tiring balance are built-in features of the Eject-O-Matic. This modern soldering tool weighs only 20 ounces fully loaded with a 4-ounce reel of solder. The center of gravity is located near the trigger. The molded, pistol-grip handle fits the hand snugly, and the fatigue factor is reduced to minimum. Eject-O-Matic can be used for hours without tiring the operator! And actual industrial tests prove that it speeds up production — nearly doubles the output per operator.

Eject-O-Matic is available in 50, 75 and 100 watt models — 150 and 175 watt models in production soon.

WEIGH THESE ADVANTAGES

Automatic Feed

Micrometer Control of amount of solder ejected

Automatic Retracting Feature

Cooling Fins dissipate excess heat

Drop-forged, Non-corrosive Tip Safety, Utility Base

Model 19-S *(illustrated)* with base—retails at $18.95

Individually packed. Shipping wt. per carton of 12 units, approx. 42 lbs.
Send for literature

AUTOMATIC-FEED SOLDERING TOOL
EJECT-O-MATIC
HOUSES · MEASURES · EJECTS THE SOLDER

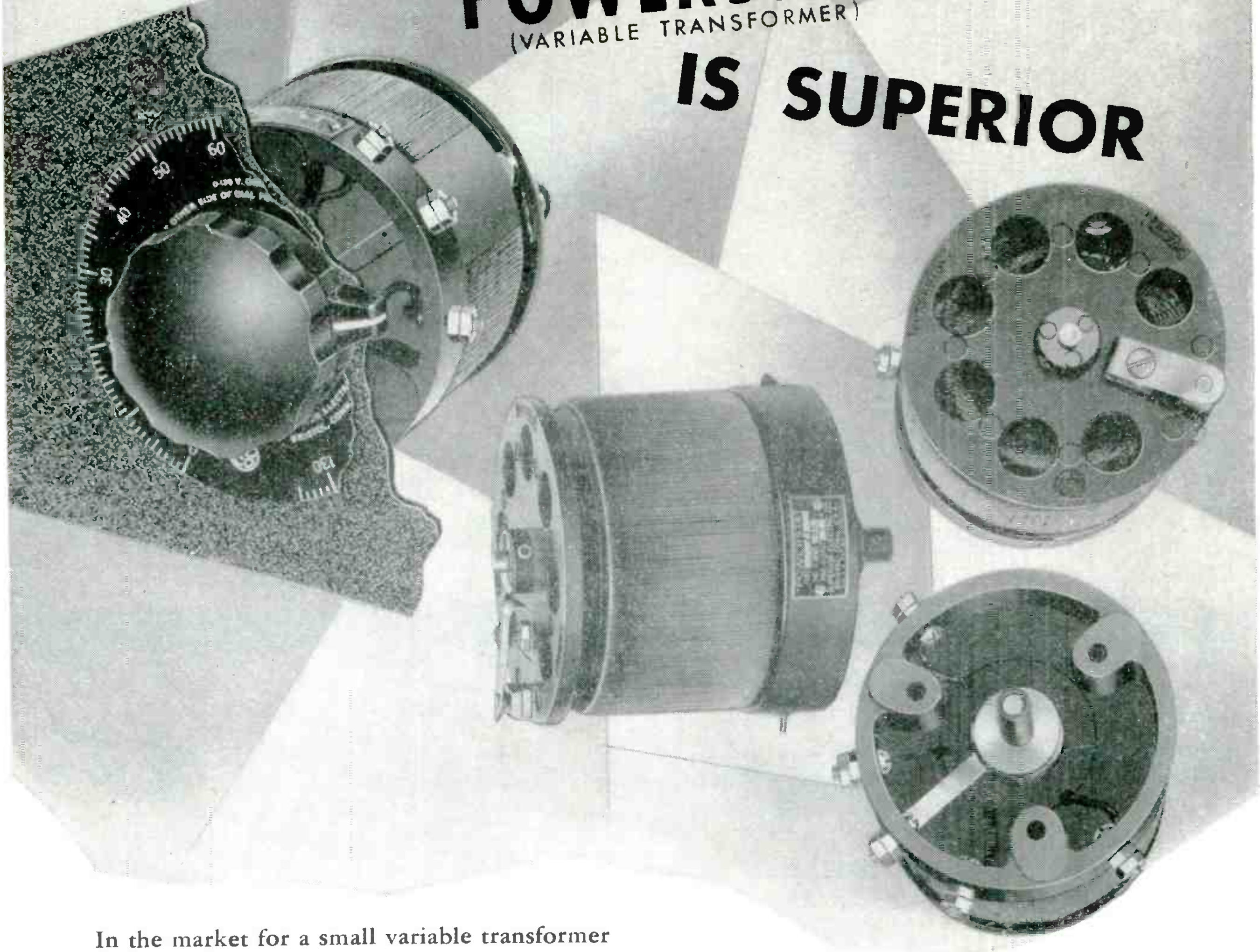
MULTI-PRODUCTS TOOL COMPANY, 123 SUSSEX AVENUE, NEWARK 4, NEW JERSEY

FROM ANY ANGLE..

POWERSTAT TYPE 20

(VARIABLE TRANSFORMER)

IS SUPERIOR



In the market for a small variable transformer of about ½ KVA capacity? To be more specific . . . INPUT — 115 volts, 50/60 cycles, 1 phase. OUTPUT — 0-135 volts or 0-115 volts, 3.0 amperes.

Take a look at POWERSTAT type 20.

Viewed from any angle it qualifies as a superior voltage controller.

QUALITY ANGLE . . . The mechanical construction is extremely rugged yet this POWERSTAT is unusually compact for the rating.

Mounting holes are located on a 1¼ inch radius.

Excellent regulation, smooth control, high efficiency are only a few of its desirable electrical features.

VERSATILITY ANGLE . . . Type 20 can be connected to provide increasing voltage with either clockwise or counterclockwise rotation. Terminals permit clip-lead or solder connections.

COST ANGLE . . . Highest valuation yet lowest price per rated ampere output of any similar type variable transformer.

Other angles regarding type 20 will be cheerfully discussed by SECO sales-engineers. . . *Consult us NOW!*

Send for Bulletin 150 LE

THE SUPERIOR ELECTRIC COMPANY

711 LAUREL STREET BRISTOL, CONNECTICUT, U. S. A.

*** RICHARDSON MEANS *Versatility* IN PLASTICS**

Don't Look Now—But Here it Comes!

What's the mystery . . . here *what* comes? Chances are, it's a problem in plastics. We get them every day. It may involve an insulating part for an electrical application, or a non-corrosive part for chemistry. It might turn out to be a quieter streetcar bearing, collector rings on a power shovel, or thread advancing reels for textile applications. Whatever it is . . . Richardson *versatility* will soon have it solved.

For here you deal with practical people in an old, established firm whose sole business is plastics; where diversified equipment and adequate research, design and engineering personnel have been established to provide you with the complete plastics service you like . . . but seldom find.

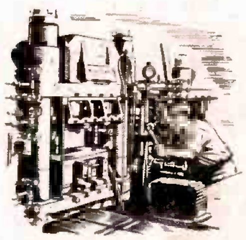
INSUROK *Precision Plastics*

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

***DESIGNING**
. . . Artistic visualization. Creative engineering. Practical planning for efficient plastics production.

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

***LAMINATING**
. . . Sheets, rods, tubes. Standard NEMA grades; over 700 special grades.



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

The RICHARDSON COMPANY

Sales Headquarters: MELROSE PARK, ILL. FOUNDED 1858 LOCKLAND, CINCINNATI 15, OHIO

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

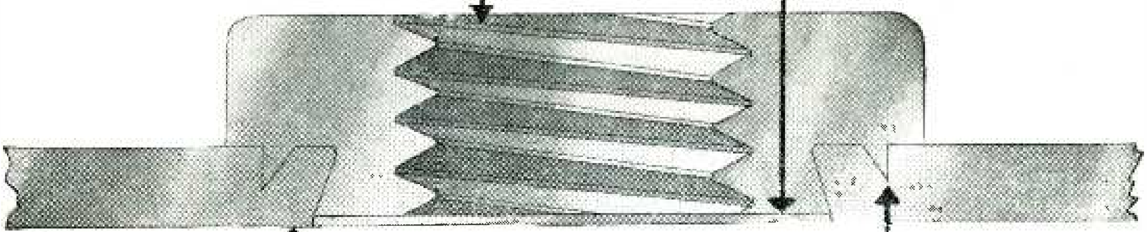
NEW!

Self-Clinching Fastener

PROVIDES LOAD-CARRYING THREADS IN THIN STEEL, ALUMINUM, COPPER OR BRASS SHEET!

1 *Provides load-carrying threads in thin steel, aluminum, copper, or brass sheet!*

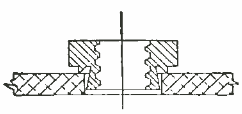
2 *Shank length can be equal or less than thickness of sheet!*



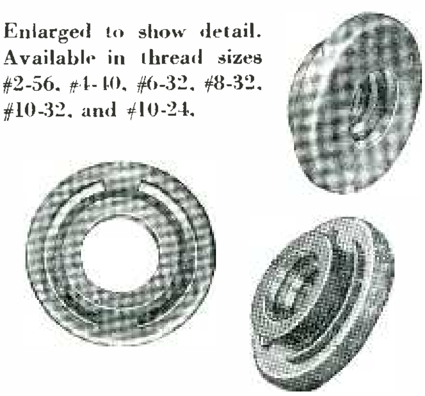
3 *Countersinking of hole not necessary. Reverse side of sheet remains flush!*

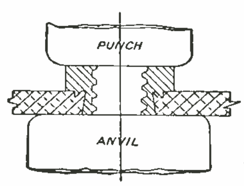
4 *Ring clinches fastener and prevents turning.*

PEM Self-Clinching Fasteners solve assembly problems involving steel, aluminum, copper, or brass sheet. Because no special tools are required, PEM Self-Clinching Fasteners save time, labor, and weight; mean faster, more simplified clinching. Use the coupon to get complete information.



Enlarged to show detail. Available in thread sizes #2-56, #4-40, #6-32, #8-32, #10-32, and #10-24.





IT'S THIS EASY! Punch straight hole, insert fastener in sheet, and apply pressure to head of fastener.

PEM

PENN ENGINEERING & MANUFACTURING CORP.
SOUTH MAIN STREET, DOYLESTOWN, PA.

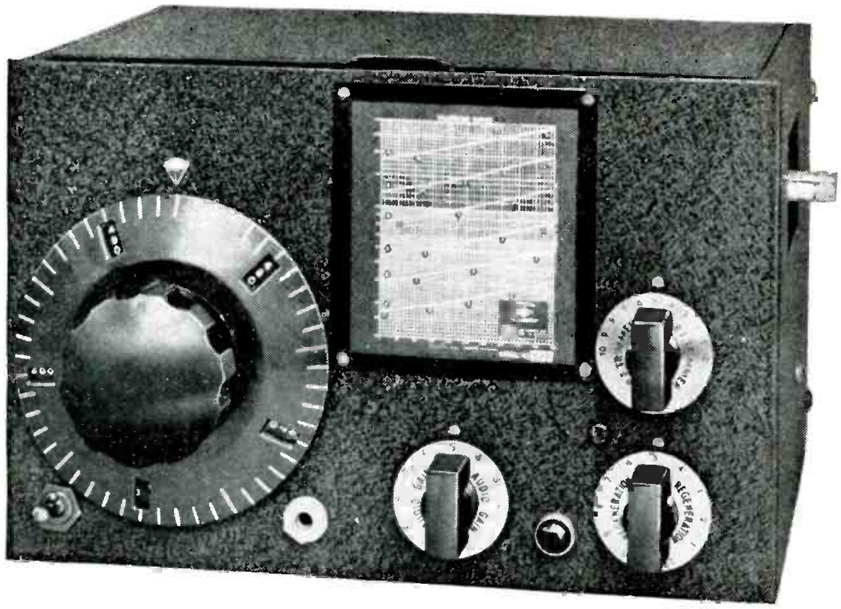
PENN ENGINEERING & MANUFACTURING CORP.
SOUTH MAIN STREET, DOYLESTOWN, PA.

Please send me complete information about the new PEM Self-Clinching Fastener.

NAME ____________________

COMPANY ____________________

ADDRESS ____________________



THE 1-10A

The ONE-TEN-A is a complete redesign of the ONE-TEN, retaining all the proven design features of the older model but with improved performance and smoothness of control.

For many years the ONE-TEN has been the "standard" receiver for work in the range from one to ten meters. Although many advances in high frequency technique have been made since this little receiver was first introduced, it has easily held its place in the affections of experienced amateurs by its consistent dependability under actual operating conditions and its high usable sensitivity.

The new ONE-TEN-A inherits the fine qualities of its predecessor brought up to date by a complete restudy of circuit, mechanical arrangement and constructional details.

The ONE-TEN-A is a fine receiver.

NATIONAL COMPANY, INC., MALDEN, MASS.

RUGGED*

Light-weight — Resilient
NATIONAL
VULCANIZED FIBRE
protects against shock and strain ... in products or plant equipment

If it's a *rugged* material you want to protect your products or plant equipment against shock and strain —you're sure of getting it in tough, durable National Vulcanized Fibre!

One of the strongest materials per unit weight known, this versatile, hard vulcanized fibre can "take it" in every way. Resilient and light in weight (about half that of aluminum), it has outstanding impact, tensile and dielectric strength . . . is extremely resistant to wear and abrasion . . . and is machined and formed easily, economically. You get all this and toughness, too, in National Vulcanized Fibre.

To be sure of improved performance for your products or plant equipment, let a trained National engineer show you how this rugged material can be readily adapted to your production. Write for information.

*Trunks must be built to "take" the hard knocks to which they're subjected. That's why so many of them —including U. S. Army foot lockers —are made of *rugged* National Vulcanized Trunk Fibre.

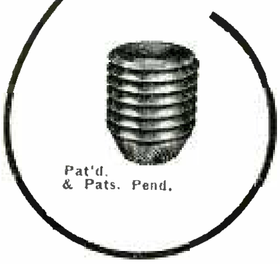
NATIONAL VULCANIZED FIBRE COMPANY

Wilmington 99, Delaware *Offices in Principal Cities*

SEE OUR CATALOG IN SWEET'S

But we have little things too

Pat'd. & Pats. Pend.



Pat'd. & Pats. Pend.

"Unbrako" Self-Locking Set Screws DO come in #0 size—with all the quality, accuracy and strength of the big #1" size.

"Unbrako" Socket Set Screws with the knurled Cup-Point are *Self-Lockers*—because the *knurled point digs in and holds firm* . . . regardless of the most chattering vibration. The tiny size of these screws—with their almost microscopic knurling has made them invaluable to manufacturers in Electronics, Electrical and Radio Industries.

Made with the accuracy and skill for which "Unbrako" products are famous, these "Unbrako" Socket Set Screws with knurled cup-point are outstanding for accuracy, hardness and strength.

"Unbrako" and "Hallowell" products sold entirely through distributors.

You can't screw socket screws in or out without a socket hex wrench,—so why not get our #25 or #50 "Hallowell" Key Kit which contains most all hex bits.

UNBRAKO

Reg. U. S. Pat. Off.

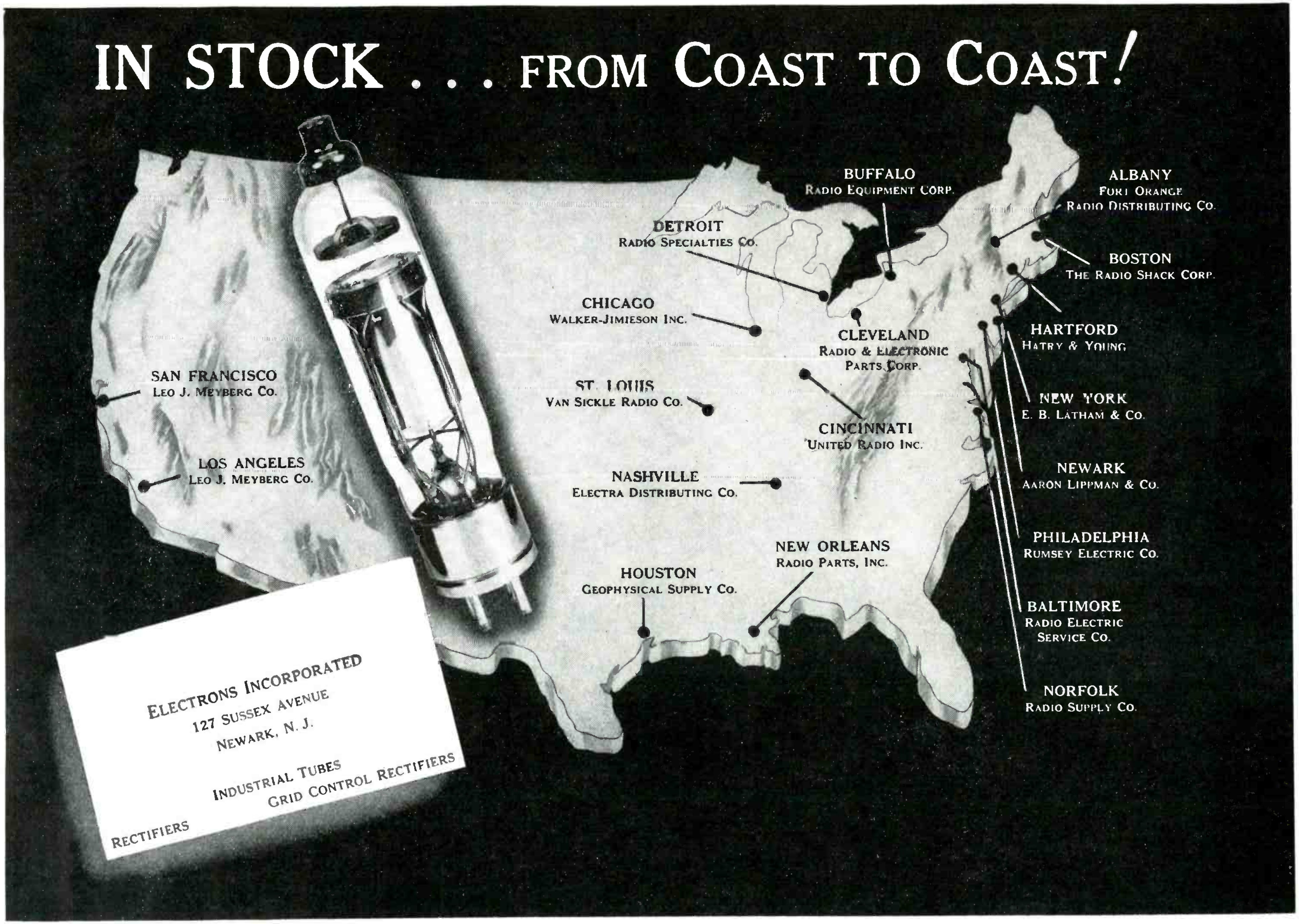
Knurling of Socket Screws originated with "Unbrako" in 1934.

OVER 43 YEARS IN BUSINESS

STANDARD PRESSED STEEL CO.

JENKINTOWN, PENN., BOX 596

BRANCHES: BOSTON • CHICAGO • DETROIT • INDIANAPOLIS • ST. LOUIS • SAN FRANCISCO


IN STOCK . . . FROM COAST TO COAST!
BUFFALO
RADIO EQUIPMENT CORP.
ALBANY
FORT ORANGE
RADIO DISTRIBUTING CO.
DETROIT
RADIO SPECIALTIES CO.
BOSTON
THE RADIO SHACK CORP.
CHICAGO
WALKER-JIMIESON INC.
HARTFORD
HATRY & YOUNG
CLEVELAND
RADIO & ELECTRONIC
PARTS CORP.
SAN FRANCISCO
LEO J. MEYBERG CO.
ST. LOUIS
VAN SICKLE RADIO CO.
NEW YORK
E. B. LATHAM & CO.
CINCINNATI
UNITED RADIO INC.
LOS ANGELES
LEO J. MEYBERG CO.
NASHVILLE
ELECTRA DISTRIBUTING CO.
NEWARK
AARON LIPPMAN & CO.
PHILADELPHIA
RUMSEY ELECTRIC CO.
NEW ORLEANS
RADIO PARTS, INC.
HOUSTON
GEOPHYSICAL SUPPLY CO.
BALTIMORE
RADIO ELECTRIC
SERVICE CO.
NORFOLK
RADIO SUPPLY CO.
ELECTRONS INCORPORATED
127 SUSSEX AVENUE
NEWARK, N. J.
INDUSTRIAL TUBES
GRID CONTROL RECTIFIERS
RECTIFIERS

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

AMERICAN PHILLIPS SCREWS are "FIRST MATES" Cost-wise

...BOTH TO BOAT-BUILDERS AND OWNERS

In shipyards (as in automobile plants, refrigerator factories — *or what's yours?*) American Phillips Screws deliver these special savings: Swift, sure-handed handling. Automatically straight driving. Protected, unspoiled work-surfaces. More and better work done far more easily. All of which translate into TOTAL TIME-SAVINGS AS HIGH AS 50%!

And American Phillips savings reach straight through to the buyer of the boat. For these screws resist corrosion, withstand vibration, remove screw-driving from his maintenance work, help to keep his craft always trim, tight, and shipshape.

You can steer by this: American Phillips Screws are profitable not only production-wise. They're potent sales promotion, as a mark of quality construction . . . and they're sound sales-protection, too. *You* can get these same production and sales advantages in American Phillips Screws in any type or metal (see below) for any fastening requirement. Write.

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

AMERICAN PHILLIPS *Screws*

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

THE POWER YOU want is in this package!

POWR-PAKT MOTORS

Alliance Powr-Pakt Motors will open and close valves, switches, operate toys and motion displays, actuate parts in business and vending machines, and can be used as component power sources in electronic control systems.

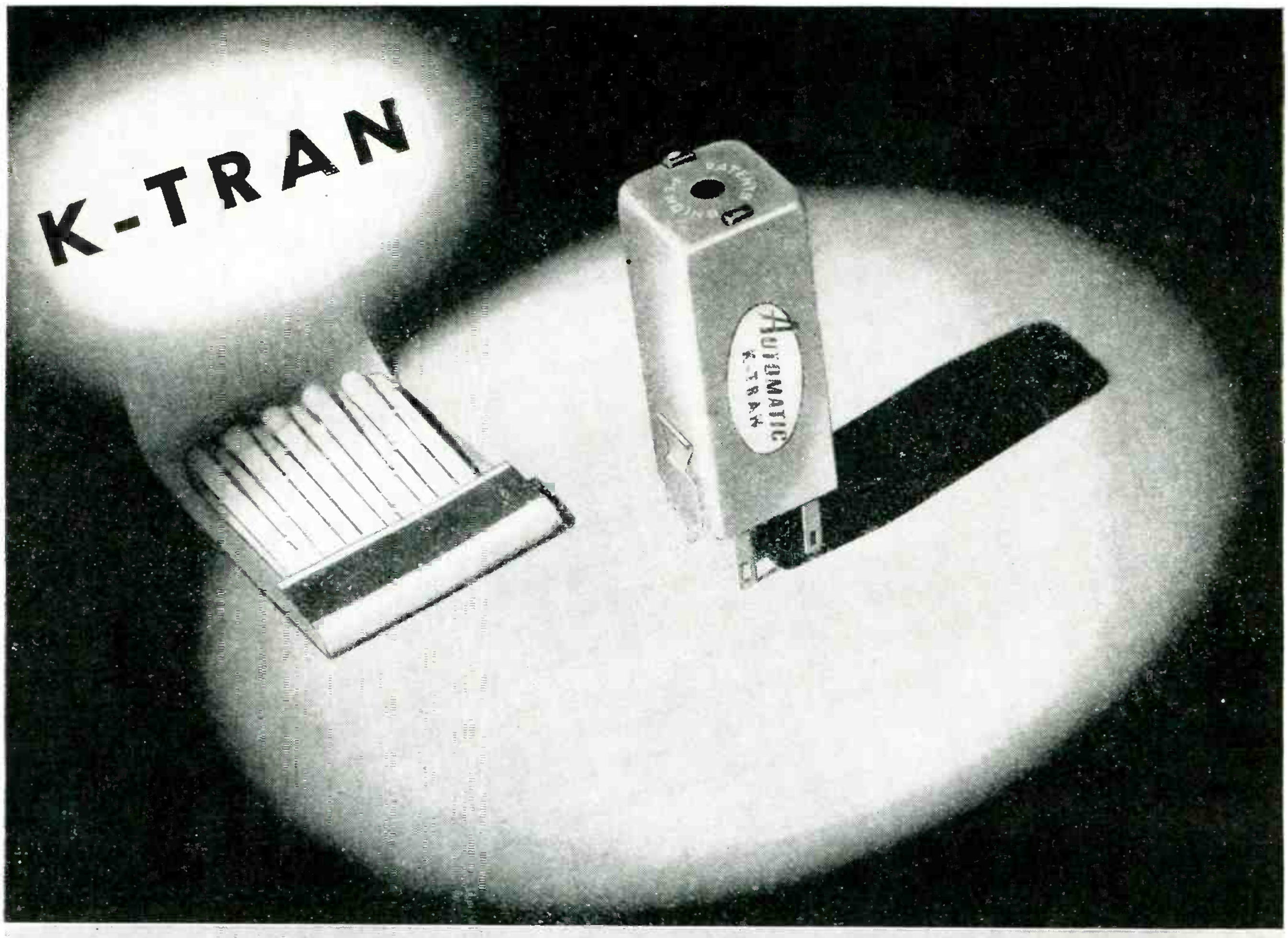
The Model 80 Phonomotor has been the outstanding favorite of manufacturers and jobbers who want a power source that's smooth, quiet, and time-tested. This is the No. 1 motor for driving turntables and record changers!

For original equipment and replacement, the leading radio manufacturers and jobbers of radio parts *rely* on Alliance Phonomotors and Powr-Pakt Motors to drive their turntables, record changers, recording and tuning devices.

Alliance Motors are mass produced, precision built, and low in cost. Besides Phonomotors, Alliance makes a wide range of small motors designed to meet the special demands of small loads. Write!

WHEN YOU DESIGN—KEEP alliance MOTORS IN MIND

ALLIANCE MANUFACTURING COMPANY • ALLIANCE, OHIO



MODERN!

THE K-TRAN is very small.

THE K-TRAN equals the performance of old style I.F. Transformers many times its size.

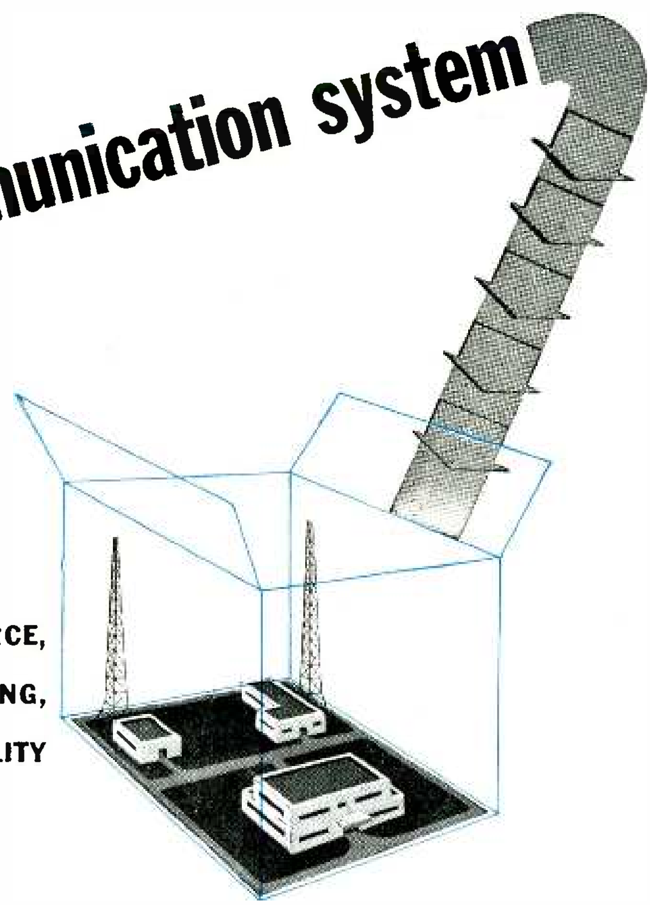
THE K-TRAN is standard. At 455 KC or 265 KC, four types meet practically every need, eliminating the need for many different numbers.

AUTOMATIC MANUFACTURING CORPORATION

MASS PRODUCTION COILS & MICA TRIMMER CONDENSERS

900 PASSAIC AVE. EAST NEWARK, N. J.

one source
one contract
one "packaged" communication system



. . . FROM ONE WORLD-RENOWNED SOURCE, YOU CAN OBTAIN ANALYSIS, ENGINEERING, MANUFACTURING AND INSTALLATION ABILITY

BUILDING A COMPLETE communication system to meet your particular needs is a job for experts. Unless all units in the system are properly integrated, the end result may prove unsatisfactory and costly.

In spite of the fact no two communication problems are identical, Press Wireless—with their world-wide operating and manufacturing experience—can engineer a combination of standardized units to do your job. Obviously, such a procedure results in greater efficiency, lower cost.

After thorough analysis, and this means much more than "desk work", PW will present recommendations for your "packaged" communication system—all units of which are designed and built to work together. Such a system will be complete from soil analysis to antenna tower, even to equipment housing where necessary. Thus, you will be able to obtain all the factors of a successful communication system from *one source*, under *one contract*. Press Wireless Mfg. Corp., Executive Offices, 1475 Broadway, New York 18, N.Y. USA

UNITS IN THE PW "PACKAGE"

RADIO-TELEGRAPH
AND TELEPHONE TRANSMITTERS
FREQUENCY SHIFT
RADIO-PHOTO
COMMUNICATION RECEIVERS
PLUS
ASSOCIATED TERMINAL
EQUIPMENT

Your installation is engineered from any combination of the above standardized PW units

PRESS WIRELESS

First in "Packaged" Communications Equipment

At 225 miles...13,000 feet **VHF reception** **good**

reports American Overseas Airlines...

VHF TEST FLIGHT

Engineering Report

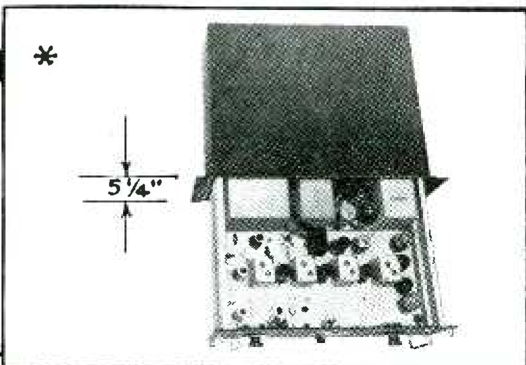
Crew: Capt. Robert Ditsworth
Comm. Engr. Reprs. J. E. Mac Dowell
H. S. Keen

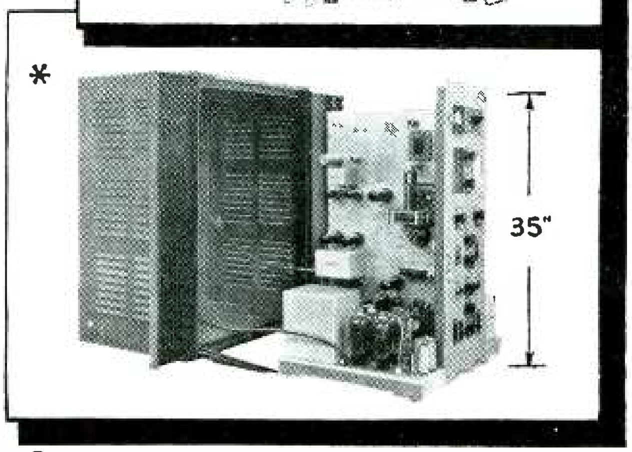
Aircraft NC 90421
Date 8/20/46

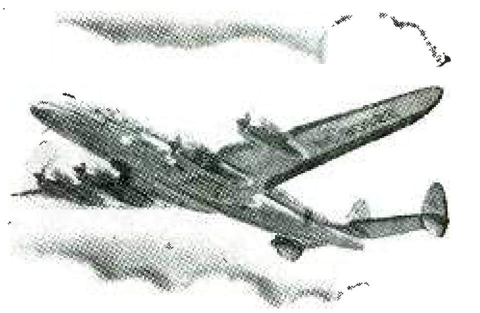
Time Off: 11:30 EST (AM)
Return : 4:30 EST (PM)

The purpose of this report is to transmit the results of a test flight made by members of the communications engineering department to gather data for an analysis of the range and quality of the VHF installation at LaGuardia.

*Transmitter: Radio Receptor TV-50A Output Power - 50 watts
*Receiver : Radio Receptor RV-1A
Antenna : Ground Plane - located atop Marine Terminal, LaGuardia Field
Frequency : 123.3 Meg.







EXHAUSTIVE VHF tests made from an American Overseas Airlines "Flagship" show conclusively the consistent results produced by Radio Receptor VHF installation at LaGuardia Field—over considerable distances as well as on short-range low-level work. Here are the highlights of test results:

"NO FAILURE OR STATIC . . ." On a descent from 13,000 feet to CFR through heavy cumulus overcast—at a distance over 150 miles—accurate ground checks were possible at all times. "NO FAILURE OR STATIC WAS ENCOUNTERED."

". . . GOOD COMMUNICATION WAS MAINTAINED" At a 5,000-foot altitude a full 360° check on a ten-mile radius produced good communication with no low spots in reception. West of the station a descent was made to 1,000 feet. At this altitude New York City buildings obstructed a line-of-sight signal ". . . BUT GOOD COMMUNICATION WAS MAINTAINED."

"HIGHLY SATISFACTORY" Readable communication with LaGuardia Field was maintained over a route covering Long Island and lower New England to a distance of 225 miles. At this distance the Flagship at 13,000 feet received transmissions from the Radio Receptor installation with an R5-S5 signal. From these results American Overseas Airways concludes—"THE INSTALLATION IS HIGHLY SATISFACTORY FOR ITS PURPOSES."

Radio Receptor VHF equipment and navigational aids for all airport and airline ground installations have records of dependability throughout the world. For complete results of the test above or for more information about Radio Receptor equipment, write today.

Ⓢ1940

Please send me the bulletins checked: Dept. C-9

- ☐ "Packaged Radio Station RSV-1" (VHF)
- ☐ "Packaged Radio Station RSL-1" (low frequency)
- ☐ LF Transmitter (Bulletin No. 5009)
- ☐ HF Receiver (Bulletin No. 5008)
- ☐ VHF Receiver (Bulletin No. 5007A)
- ☐ VHF Transmitter (Bulletin No. 5006)
- ☐ "Highways of the Air" (the story of airway radio)

Name__________

Position__________

Company__________

Address__________

City__________ State__________

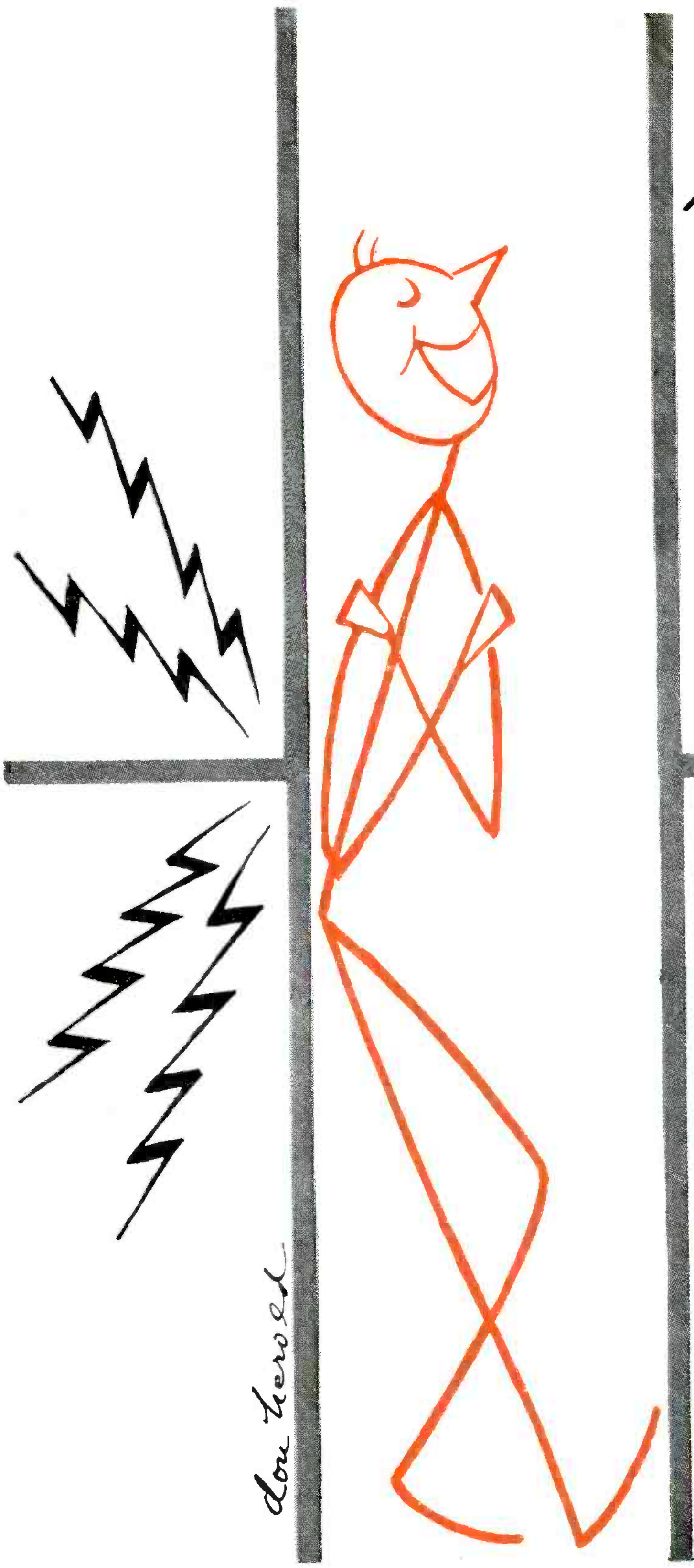
Communications Division

RADIO RECEPTOR CO., INC.

Since 1922 in Radio and Electronics

251 West 19th Street
New York 11, N.Y.

Export Representatives: RCA International Division, New York



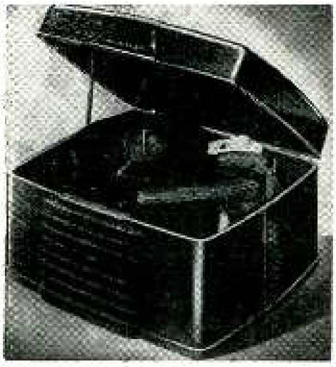
You can't shock us!

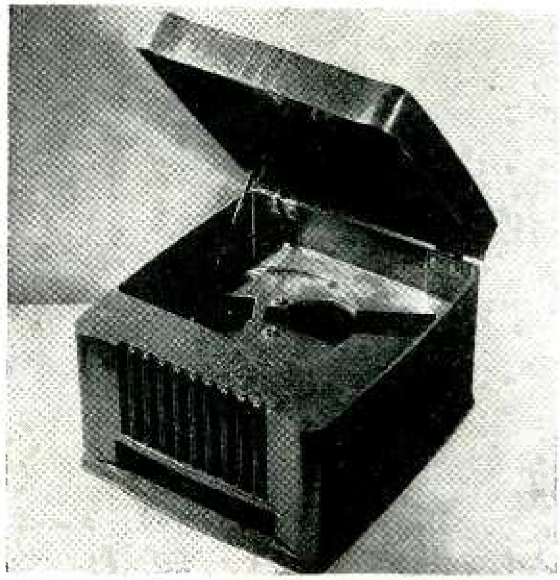
For many years, the Schweitzer Paper Co. has been a leader in the manufacture of thin gauge insulating papers for capacitors, coils, transformers, and other equipment where top quality and performance are so necessary. Your requirements, regardless of how exacting, will not shock us for our specialty has been the production of thin gauge insulating papers ranging in thickness from .0002″ to .004″ to meet the most stringent requirements.

SCHWEITZER PAPER CO.

182 Cornelison Ave., Jersey City, N. J.
Plants: Jersey City, Mt. Holly Springs, Pa.
Research Laboratories: Chrysler Bldg. New York, N. Y.

SPECIALISTS IN THIN GAUGE INSULATING PAPERS





INTERESTED IN LARGE PLASTIC PIECES?

Dispelling the time-worn theory that large molded plastic pieces are impractical and uneconomical, these Admiral phonograph and radio-phonograph cabinets effectively demonstrate that large products as well as small can be molded of Durez phenolic plastics.

The bigger cabinet (right) when assembled contains a five-tube radio and automatic record player. The molded Durez body weighs 9½ pounds and the cover 3½ pounds. This makes a total cabinet weight of only 13 pounds.

Radio Frequency Preheat

Compression-molded in a 400-ton press, the special Durez compound used in this larger unit is preheated by radio frequency. This modern method of production facilitates the molding operation considerably and results in the strong, attractive cabinet shown.

The smaller unit, Admiral's automatic record player, is also molded of Durez but in a 300-ton press.

Why Plastics?

The progressive Admiral Corporation experimented and found that for top quality cabinets of this type—having light weight and an integral, lustrous finish, plastics were better suited than any other material.

Why Phenolic Plastics?

The excellent moldability, impact strength, eye-appealing finish, and the non-resonance of phenolic plastics proved the decisive factors in the choice of these most-versatile-of-all-plastics.

Why Durez Phenolic Plastics?

As specialists in the production of phenolic plastics for the past quarter century, the Durez staff have developed more than 300 multi-propertied Durez phenolic molding compounds from which to select the plastic that precisely fits the job.

Write for Free Booklet

"Machining Data on Phenolic Plastics" is an informative manual which covers all the standard machining operations encountered in the average plant. Write for your free copy. No obligation, of course. Durez Plastics & Chemicals, Inc., 811 Walck Road, North Tonawanda, New York. *Export Agents: Omni Products Corporation 40 East 34th Street, New York 16, N. Y.*

DUREZ

PHENOLIC RESINS — MOLDING COMPOUNDS — INDUSTRIAL RESINS — OIL SOLUBLE RESINS

PLASTICS THAT FIT THE JOB

WHAT'S YOUR VIEW POINT

on indicating instruments?

FOR CLOSE-UP READING . . .

LOOK AT THIS MB PRECISION MINIATURE

ANY INSTRUMENT WORTH INSTALLING should be easy to read . . . but from its *working distance.* There's no need to specify bulky instruments with long-range readability when readings are made at arm's length.

In MB miniatures, you get the *smallest, lightest instruments of this type made!* You save not only on space and weight, but on cost. At a reasonable price, you assure an indicating job done with practical precision. For though miniature in size, MB instruments have large-meter accuracy (within ±2% at every point). They have a high torque-to-coil-weight ratio . . . a good measure of sensitive, speedy response and long life. In fact, because they've *standard size* sapphire bearings and steel pivots supporting just a "wisp" of coil weight, MB instruments wear indefinitely!

We'll be glad to cooperate on any adaptations needed for your applications, and have an MB engineer work out the details with you. Write for full information, and our new catalog that describes the complete line of MB instruments.

THE MB MANUFACTURING COMPANY, INC.
331 East Street, New Haven 11, Conn.

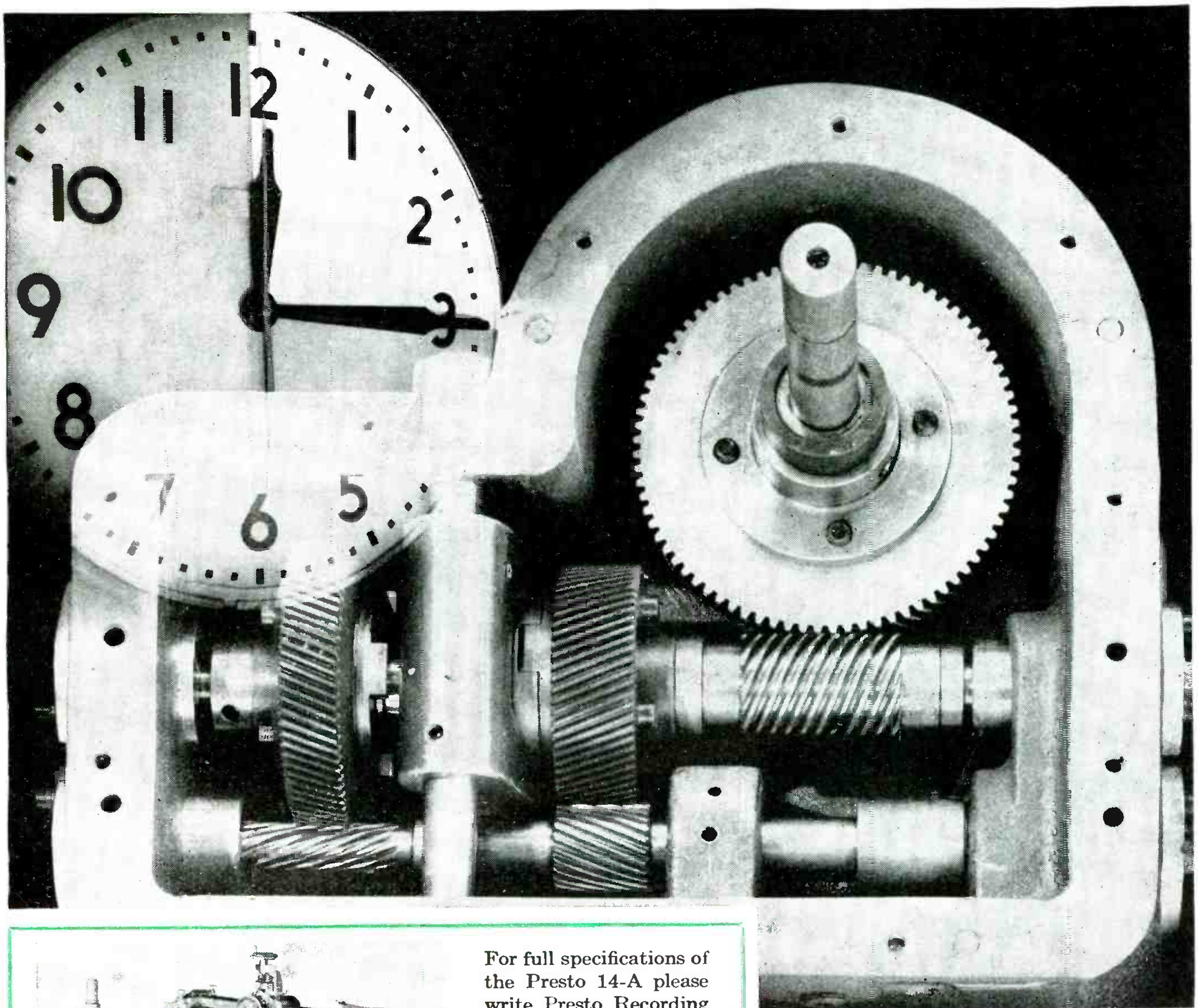
INSTRUMENT DIVISION

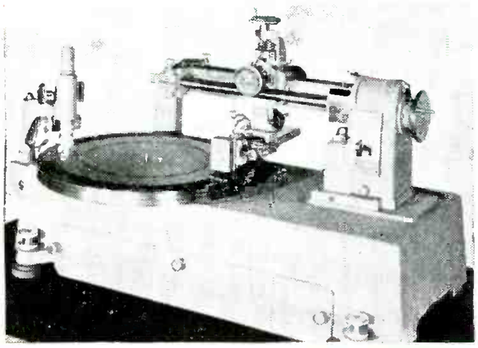
MINIATURE ELECTRICAL INSTRUMENTS FOR ANY PURPOSE

Playback Time =
15 Minutes ± Zero

▶ Directly gear-driven at both 78.26 and 33.33 rpm by a synchronous motor, the playing time of recordings made on the Presto 14-A corresponds to the original program time with split-second accuracy. The only deviation in speed may be due to variations in power supply frequency which seldom exceed 0.1%. Rotational flutter and background noise from mechanical sources are at an absolute minimum.

▶ The Presto 14-A represents a major advancement in the design of recording turntables, having all of the performance characteristics demanded by experienced engineers. Illustrated below is the new 14-A gear drive.





For full specifications of the Presto 14-A please write Presto Recording Corporation, 242 West 55th Street, New York 19, N.Y. To insure future delivery within a reasonable time, we suggest you place your order on our priority list since orders are considerably in advance of production.

PRESTO

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


Symbol of Capacitor Quality
SOLAR
Solar Manufacturing Corporation
GENERAL OFFICES: 285 MADISON AVENUE, NEW YORK 17, N. Y.
PLANTS AT CHICAGO, ILL.; NORTH BERGEN AND BAYONNE, N. J.
PAPER, MICA AND ELECTROLYTIC CAPACITORS FOR THE ELECTRICAL AND ELECTRONIC INDUSTRIES

DEPRESSION IN '47?

...controls can bring one

IT IS CONVENTIONAL for the American business man, who values freedom, to protest against government regulation. On this account, many people who do not know the facts in detail are inclined to discount current business protests against the post-war application of wartime economic controls. This is particularly true since in his report for the third quarter of this year, the Director of War Mobilization and Reconversion implied that business is in fine health by remarking that "business profits, after taxes, are at the highest point in history."

In complaining about government controls, however, the American business man is not crying wolf. These controls were an essential war weapon. Now, however, they are contributing decidedly to a twisting and distorting of the American economy in a degree which, if not soon corrected, may well start production and employment down the toboggan.

One general indication of how badly twisted our economic system has become is found in the wide disparities in the amounts by which different groups of prices have increased. Since 1941, for example, farm prices have advanced an average of about 125%. Industrial prices, more tightly controlled than any other group except rents, have increased only about 32%. Meanwhile, straight time hourly earnings of industrial workers have gone up about 60% and the cost of living about 43%.

The advances of individual prices within these groups have also varied enormously. Among industrial prices, that of finished steel has gone up only about 14% since 1941, while lumber has gone up over 50%. Hourly wage rates in the women's garment industry have gone up 116%, while those in the brewing industry have gone up only 33%. That share of the cost of living due to rent has gone up only 4%, while that due to the cost of clothing has gone up over 60%.

Well, What Of It?

At least four things of major importance:

1. Production, under the influence of price control, has been heavily concentrated in some lines to the neglect of others. Result—unbalanced production, unbalanced inventories, and a serious cut in the flow of goods to consumers.

2. More or less uniform post V-J Day wage increases, promoted by the federal government, have imposed a far more serious cost problem on some industries than on others. This is particularly true of some of the most basic industries.

3. While, as a whole, "business profits, after taxes, are at the highest point in history" (due in part to a temporary excess profit tax rebate arrangement) there are enormous disparities in the profits of different industries. Some key industries are making little or no profits.

4. **If not corrected, the distortion of prices, wages and production, which has resulted in such a wide disparity of profits, can contribute decisively to a major business upset.**

The most striking example of the distortion of production by controls was, of course, that provided by a metropolitan meat famine at a time when beef cattle crowded the ranges. This has now been recognized. But there are many other distortions. Abundance of sports clothes, acute shortage of more essential clothing made from the same kind of cloth. Successive shortages of critically important products like baling wire and nails as the price lid on steel is jiggled first this direction and then that.

Some of these distortions of production are due to material shortages. But a major contributor is uneven application of controls, and the total removal of some while others are held firm. Among the results are bulging inventories of partially completed assemblies and shut-downs while waiting for parts.

Wage Complications

While price controls, unevenly applied, have shunted production first this way and then that, the federal government has further complicated the situation by promoting uniform wage rate increases without regard to varying capacities to pay them. The greatest single contribution to this distortion was made by the President himself. In the course of unsuccessfully trying to mediate the dispute over steel wages last January he recommended a wage rate increase of 18½ cents an hour. Immediately that increase was accepted by organized labor as par for the first round of wage adjustments, having the sanction of the White House itself. The game then became to beat par.

But the capacity of different industries to pay wage increases varied greatly. During the war some had hiked their pay much more than others. Moreover, in some industries wages are a much larger element of total cost than in others. In 1939 (last year for which figures are available) wages ranged all the way from 2½% of total sales in cigarette manufacturing to 34.3% in hosiery manufacturing and 65.2% (for wages and salaries combined) in soft coal mining.

Under these circumstances, some industries were far less able to meet a uniform wage increase than others. Nonetheless, many of them had uniform wage increases imposed upon them. Then the price lid was held firm. This, coupled with material shortages and production difficulties which also choked output, squeezed the profit right out of those industries.

A Study In Contrasts

Some of the most important industries are making little or no profits while they bump along on a production volume which fails to meet consumer needs and prevents attainment of maximum efficiency. The automobile industry affords one conspicuous example. Another is electrical manufacturing, and rail equipment is yet a third. All of them are crucially important. Many other lines of business, of course, are extremely profitable. For example, the profits of a group of large retail stores were 150% higher during the first half of this year than they were a year ago; the profits of a group of motion picture companies were up 140%.

In the meantime, the workers in some of those low-profit industries are in no bed of roses. The increase in the cost of living since 1941 is now outstripping the increase in the hourly wage rate of workers in a number of industries, where wage rates have not risen as much as the average. On a weekly basis, a shorter work week, with less overtime, has combined with the recent upsurge in consumer prices, to place the living standards of some of these workers below the wartime level.

Such circumstances obviously create pressure in the ranks of these workers for another round of wage increases. But as long as the profit remains squeezed out of their industries wage increases, if any, must be translated either into higher prices, or, if the government sits tight on the price lid, into losses which will discourage production and ultimately cost workers their jobs.

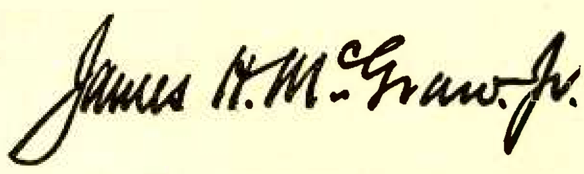
What To Do?

Salvation both for the workers and for employers in the relatively profitless section, a peculiarly important group of industries, must be looked for primarily by increasing productivity, thereby decreasing the cost per unit. Part of this higher productivity can come only from individual efforts of the workers themselves. Another part can come from an elimination of bottlenecks in materials and parts which prevent the labor force from working most efficiently. Only by greater output per man-hour can workers and management solve their common problem.

Until productivity has been thus increased, it is hard to think how the federal government could do a greater disservice both to labor and to industry than to repeat its performance of promoting a uniform national wage increase. With the present distortion of the national economy, some industries might again take such an advance in their stride. With many others it would raise even greater havoc.

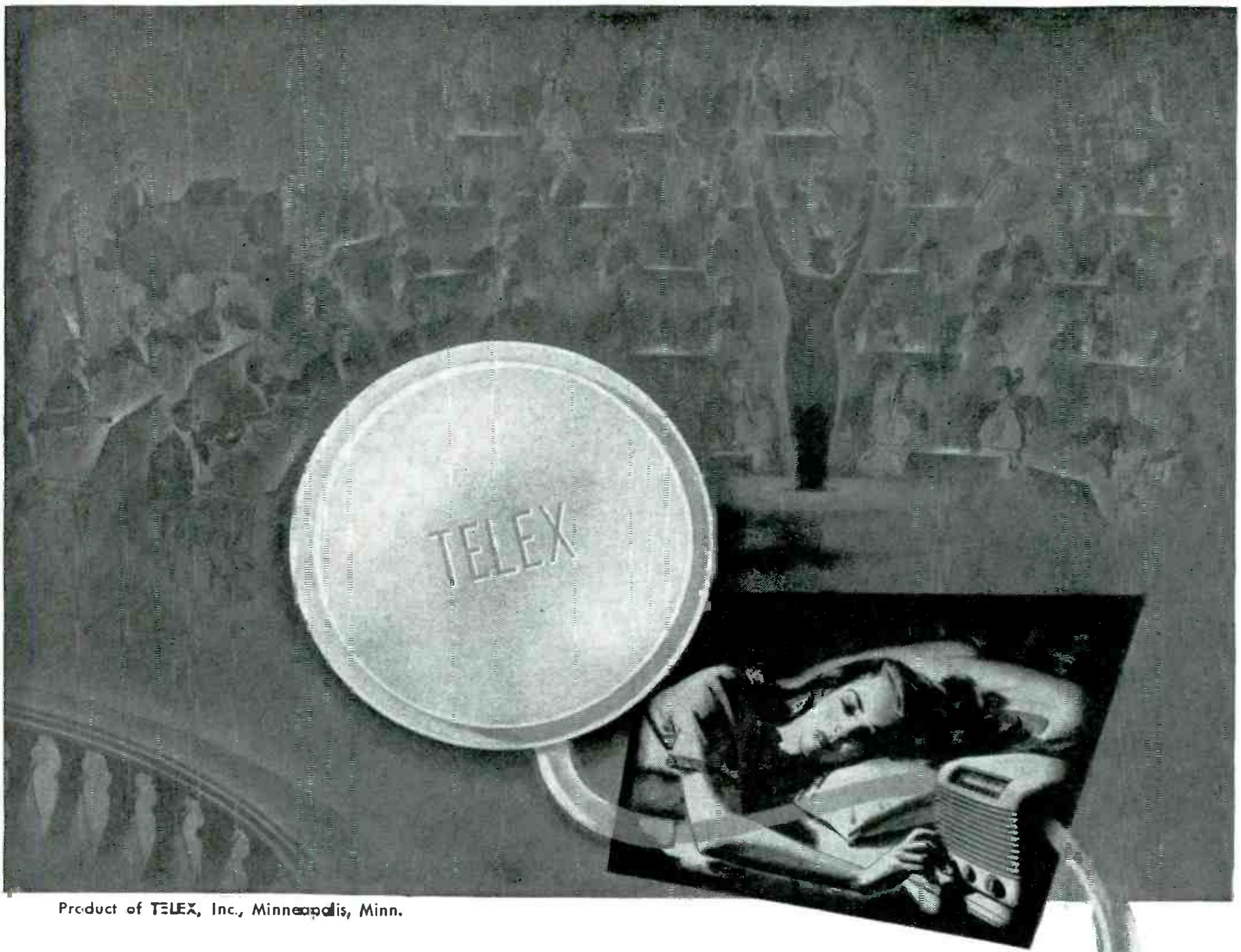
While avoiding like the plague promotion of another uniform wage adjustment, the federal government must make it a primary objective to relieve distortions caused by the uneven application of other controls, primarily price control. Nature has given a lift to the elimination of distortions by providing bumper grain crops which should in time reduce that staggering disparity between a 125% increase in farm prices and a 32% increase in industrial prices. But that process must be speeded as a matter of conscious policy. No element of such a policy is more important than expediting the decontrol of industrial prices. Such a course is clearly essential to achieve that balance in the production of materials and parts required for maximum output.

Business and labor both want a sustained prosperity in which all will share. Sustained prosperity can be achieved only if we eliminate the distortions in wages, prices and profits which now restrain so much vital production.



President McGraw-Hill Publishing Company, Inc.

THIS IS THE 52ND OF A SERIES



Product of TELEX, Inc., Minneapolis, Minn.

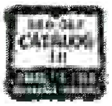
TELEX tells an impressive PLASKON story

The TELEX under-pillow speaker is a new and extremely rugged electro-magnetic sound generating unit. It is designed for normal sound reproduction when placed under a pillow, or as a personal radio soft speaker not requiring headphones. Thousands already are in use in hospitals, hotels, homes, Pullman cars, bus lines, air lines and other places where soft, high-fidelity radio reproduction is desired.

The TELEX under-pillow speaker is an ideal application of Plaskon, using almost every one of the many advantages of this versatile plastic material. The beautiful, rich-looking case is strong and shockproof, not easily damaged, and adequately protects the enclosed electrical mechanism. The vibrating sound-generating surface is inductively coupled to the electro-magnetic structure. The absence of cemented connections assures clear, rattle-free performance throughout the life of the instrument. The hermetically sealed, continuous housing makes it impossible for the user to tinker or tamper with the operating elements.

Plaskon Molded Color makes this TELEX unit warm and friendly to the touch. The gleaming, colorful, non-porous surface will not tarnish, check or corrode. It is impervious to the action of oils, greases, alcohol, acetone and other common solvents.

Plaskon materials have distinctive features that give them wide-spread application in the electrical, cosmetic, drug, garment and many other industrial fields. We shall be glad to help you adapt the many advantages of these versatile materials to your manufacturing and merchandising needs. Write for free illustrated book on Plaskon plastics.



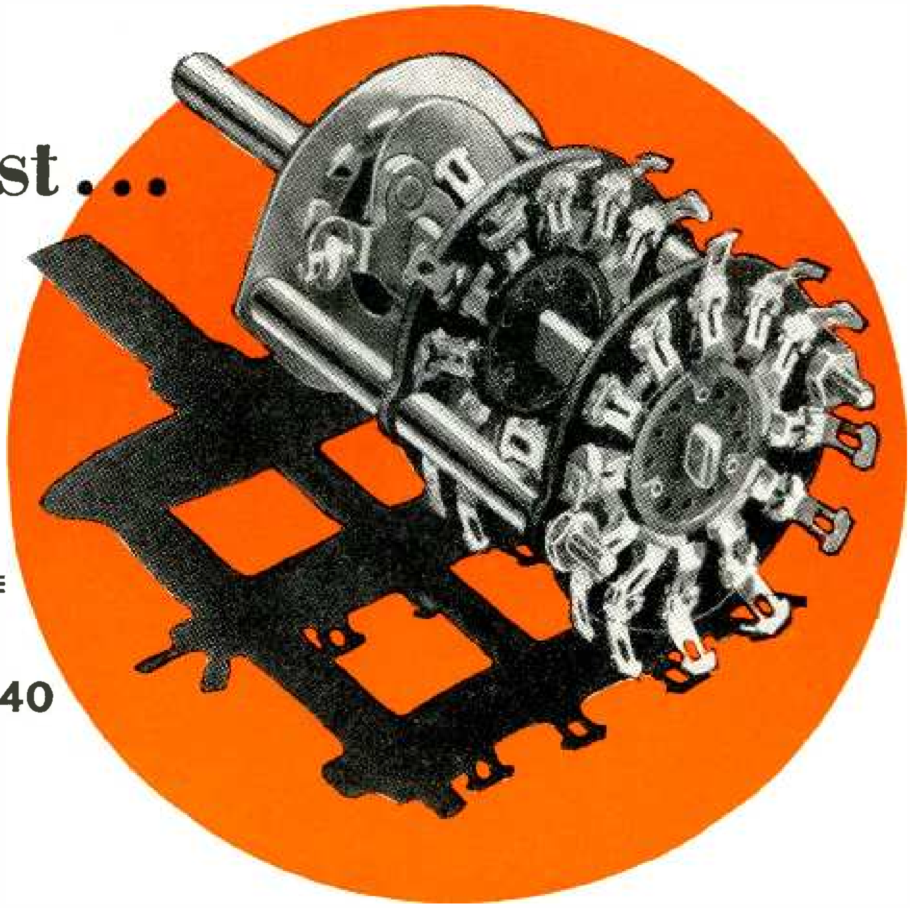
PLASKON

TRADE MARK REGISTERED

MOLDED COLOR

PLASKON DIVISION • LIBBEY • OWENS • FORD GLASS CO. • 2136 Sylvan Ave., Toledo, O. • Canadian Agent: Canadian Industries, Ltd., Montreal, P. Q.

Built to Last...

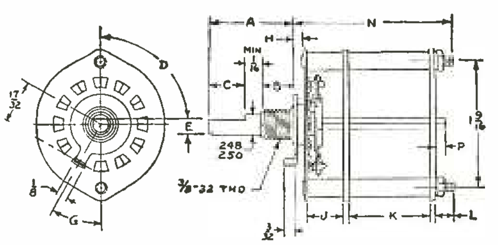


MULTIPLE SECTION SWITCH
RS-40

...With Unlimited Circuit Possibilities

Ask for RS Specification-Layout Sheets

Printed on thin paper to permit blueprinting, these sectional drawings indicate standard and optional dimensions—make it easy for you to order pre-production samples of RS switches built to meet your requirements exactly. Ask your nearest Mallory Field Representative or write direct for a supply.



FRONT VIEW OF INDEX PLATE   ELEVATION VIEW OF RS SWITCH

"BUILT TO LAST" tells only part of the story of this Mallory switch which combines compact design with remarkable circuit flexibility.

It's designed specifically for radio receivers where higher-torque, snap indexing is essential. And in common with other members of the Mallory RS line, it has these additional features:

New, heavier staples and stapling technique, insuring tight terminals . . . New stator design improves rotor and contact alignment . . . Double wiping contacts . . . Silver-to-silver contacts . . . Indium-treated, silver plated rotor segments.

Sound like a switch that fits your product? Then write today for RS Switch Data Folders and Specification Sheets. If special problems are involved, Mallory engineers are ready to help. Standard Mallory switches may be readily obtained from your Mallory Distributor.

P.R. MALLORY & CO. Inc.
MALLORY SWITCHES
(INDUSTRIAL AND ELECTRONIC)

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

CROSS TALK

▶ **D. G. F.** . . . As part of a plan conceived before the war and delayed in coming to proper fruition because of the war, Donald G. Fink becomes Editor of ELECTRONICS on November 15.

Mr. Fink came to the editorial staff in 1934 from MIT where, after graduation in communication engineering, he had put in a year of research in the departments of geology and electrical engineering. During the succeeding years he became Associate and then Managing Editor. Loaned to the Radiation Laboratory shortly after its formation, he had much to do with the development of loran and the location of stations in the European and Asiatic war theaters. In the office of the Secretary of War under E. L. Bowles his electronic background was put to good use in the development of electronic aids to aviation. Returning to the staff late in 1945 as Executive Editor, he was soon asked by the Navy to go to Bikini on a special job, coming back to this country in September of this year after a four-months jaunt into the Pacific.

During Mr. Fink's years on the staff his interest in television resulted in the design and construction of receivers later described in ELECTRONICS, in service with the National Television Systems Committee, and later with the Radio Technical Planning Board. Two of his four books, "Principles of Television Engineering" and "Television Standards and Practice," stemmed from this interest.

Mr. Fink's taking over the full responsibility for directing the editorial activities of ELECTRONICS relieves the present editor of that more-than-full time job, a prospect which alternately looked bright and then dark as the vagaries of the war dictated.

After 16 years on the job, the present editor looks with much favor upon younger shoulders taking on the task of seeing that the magazine is, as always, at the top in its service to the technical side of a young and vigorous industry. He is happy to be able to continue with it as Consulting Editor, maintaining his office with the staff and continuing the many friendships which nearly twenty-five years of technical publishing have formed. In addition, there are certain jobs which can be undertaken only by a man free from direct daily responsibility for the operation of the paper. From time to time the results of such activities will find their way into the editorial pages.

▶ **CODE** . . . Rummaging around the editorial office recently, on a clean-up campaign, the first book in which manuscript records were kept was found. The first entry, dated June 1, 1931, was for a manuscript entitled Super-Midget Radio Transmitter, by James A. Code, Jr., Captain, U. S. Army. Not long ago the author of this article retired from the army after a distinguished career, most recently as Assistant Chief Signal Officer. Major General Code is now vice president of the Automatic Electric Company, Chicago, where he is playing a new, but none the less important, role in the communications business.

In a recent letter to the editor, General Code expressed very clearly the importance of maintaining the spirit — as well as the funds — for research in our military and naval departments:—

"Most of our military and naval expenditures in time of peace are like fire insurance premiums — we hope that we may never need to get any benefit from them. Funds put into research and development form one outstanding exception to this rule; they pay dividends in peace or war, and without regard to the military objectives of the projects to which the funds are applied; one might almost say in spite of those objectives. For military and civilian engineering are so closely allied that one cannot advance without pulling the other with it. The military side automatically falls heir to civilian advances. It, therefore, applies its funds to projects which seem to have no civilian application, or where the goal seems so remote that commercial companies cannot take the risks involved. That was the way the Signal Corps got its first operating radar equipment in 1937, when the commercial companies did not want to touch the project, yet the civilian byproducts alone have more than justified every cent of the cost. That is the way it will always be. That is why, whatever else we do to our military and naval establishment, we must not skimp their development funds, for those funds pay dividends in money, in security, and in human lives."

ELECTRONICS AT BIKINI

TABLE I

Electronic Equipment Exposed to the Bikini Bombs

Type	*Test Able*	*Test Baker*
Fire-control radars	48	46
Surface-search radars	66	64
Air-search and airborne radars	85	68
Radar repeaters	100	97
Radar countermeasures equipment	36	36
Radar and radio beacons	7	7
IFF equipment	277	237
Radio transmitters	251	222
Radio receivers	813	720
Antennas	10	10
Radio transmitter - receivers	498	525
Sonar echo-ranging equipment	40	40
Sonar echo-sounding equipment	78	61
Loran navigation equipment	37	36
Communications auxiliary equipment	1069	1013
Teletype equipment	5	—
Test equipment	288	274
Telephone. intercommunication	123	70
Radio direction - finding equipment	4	3
Total	3835	3529

Telemetering, radio and radar monitoring, television and stratovision measured effects of atomic bombs, while 3,800 electronic equipments were exposed on target ships. First published details of Crossroads electronics program

By **DONALD G. FINK**
Executive Editor, Electronics

and

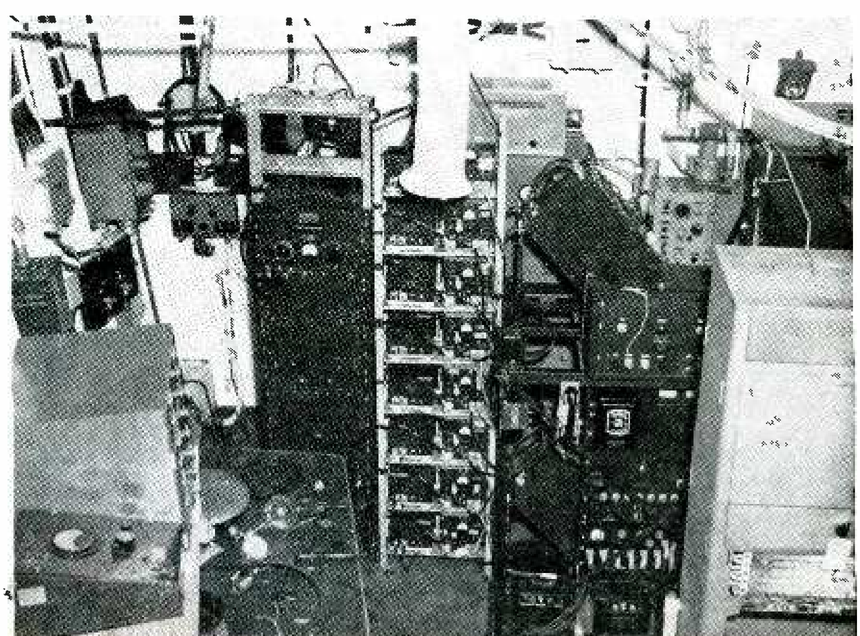
CAPT. CHRISTIAN L. ENGLEMAN, U.S.N.
Electronics Coordinating Officer Joint Task Force One

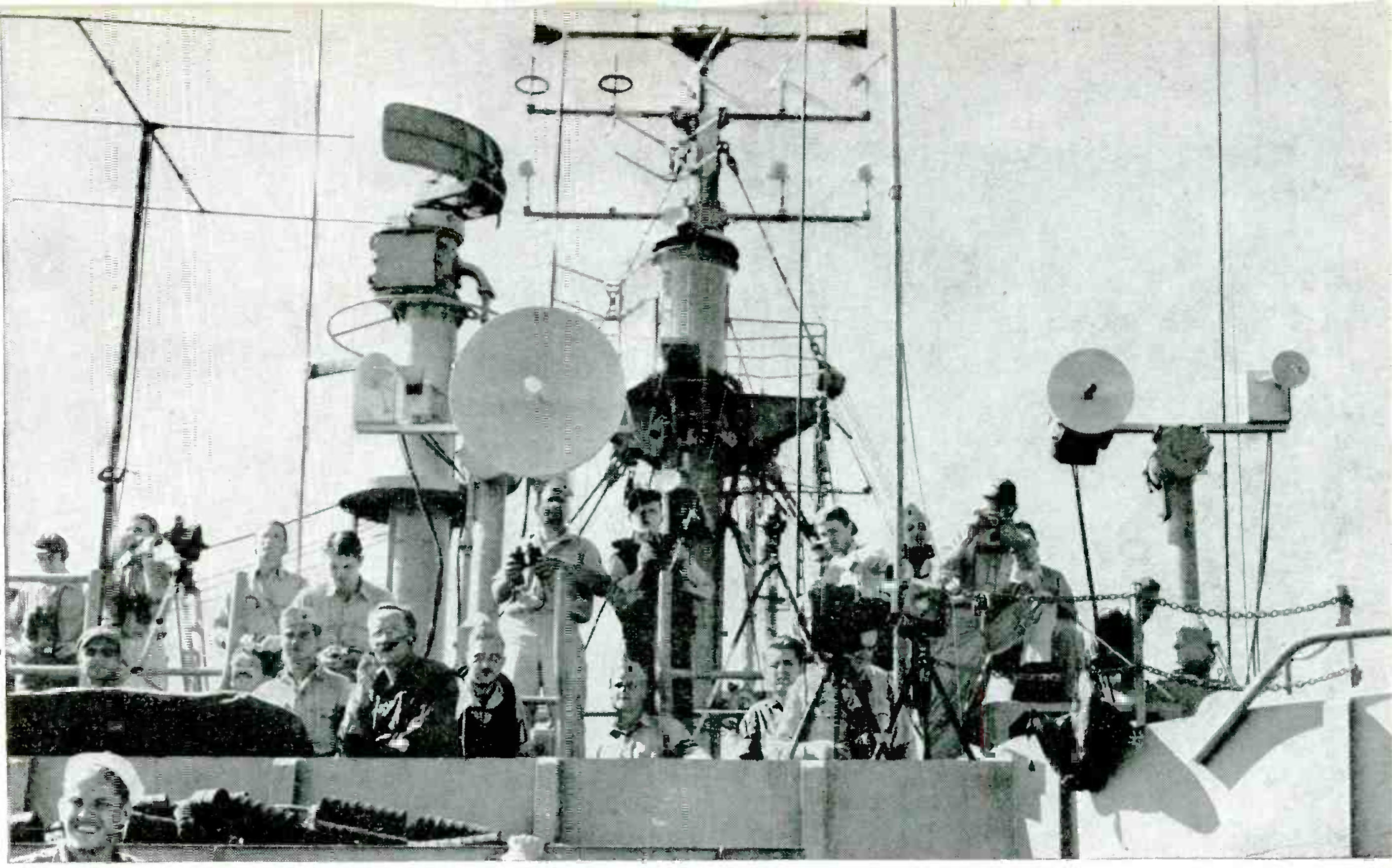
THE PURPOSE of the electronic program of Operation Crossroads was twofold: (1) to expose electronic equipment of the Navy and the Army to the effects of atomic bombs and to assess the damage, and (2) to provide electronic systems for measuring and observing the technical effects associated with bomb explosions, such as water and air pressures, radio wave propagation, wave heights and the like.

To implement this program, the Electronics Coordinating Officer was appointed to organize and direct the work. A staff of 85 officers, 75 civilians and 300 enlisted men was assembled, all electronic specialists. The civilians were recruited from the Naval Research Laboratory, the Signal Corps Engineering Laboratory, and from 13 industrial and academic laboratories. This group was charged with all the electronic activity of the task force, except the airborne drone control equipment and the Manhattan District bomb-detonating and timing-signal systems.

The base of operations of the Electronics Coordinating Officer (ECO) and his staff was the USS Avery Island, a 10,000-ton Liberty-type hull converted for use as an electronic supply and repair ship. This ship was remodeled to provide air-conditioned laboratory spaces and quarters for the staff, and a number of specialized antenna structures covering the frequency range from 7 mc to 26,000 mc were installed topside.

Telemetering receivers (center) for recording pressure-time pulse of underwater burst. High-speed camera (right) rcords at the rate of 600 inches of 35-mm film per second





All set for the Baker Blast. Technical personnel aboard radar platform of USS Avery Island, a few minutes before the second atomic explosion. Note radar monitoring dishes, and intercept antennas on mast (top center)

The basic job of the ECO was to determine what happened to standard military electronic equipment when exposed to the air burst and underwater burst of the atomic bombs. The target ships numbered 75 in Test Able (air burst) and 73 in Test Baker (underwater burst). All of the electronic equipment normally installed on these ships, including radio transmitters and receivers, radar, sonar, loran, public address and communicating equipment, was examined prior to each test and its condition recorded.

Exposure and Inspection of Equipment

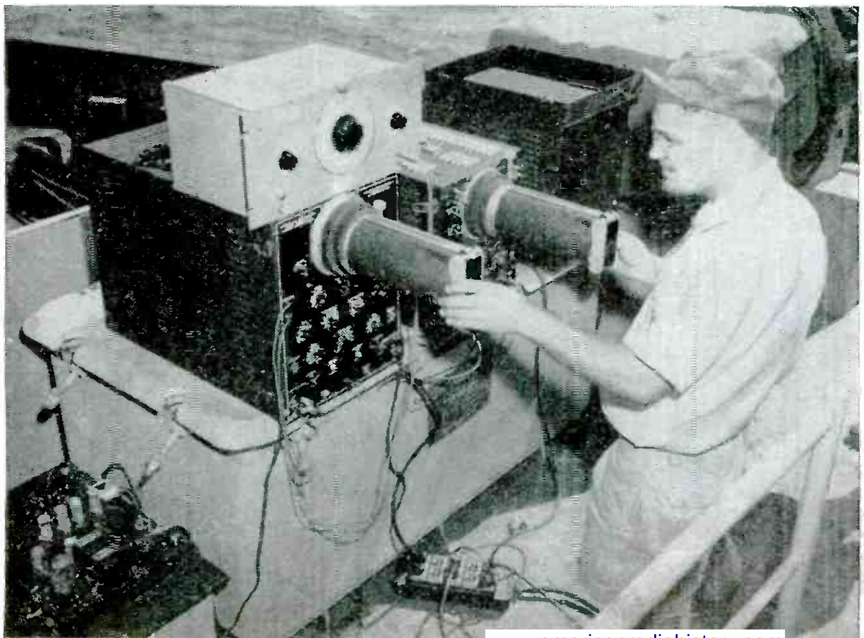
Prior to Test Able, 97 percent of all the equipment was found to be in operating condition. In addition to shipborne equipment, electronic equipments of the Naval air arm, and of the Army Ground Forces, were exposed on the decks of various vessels and on Bikini Island. In all, this array of equipment numbered 3,835 different items in Test Able, 3,529 items in Test Baker. Table I shows the breakdown of exposed equipment by types.

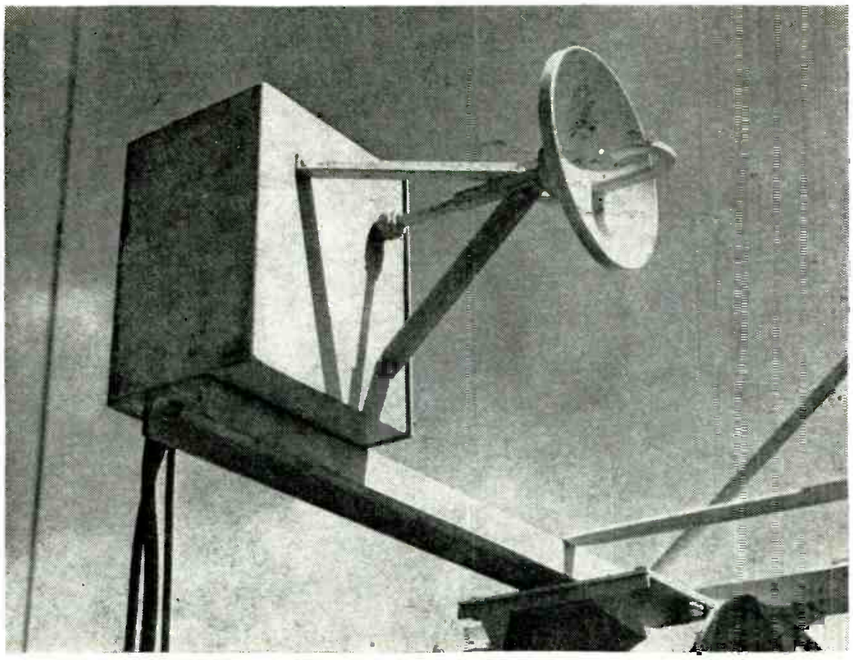
Some idea of the scope of the damage inspection job can be gathered from the fact that over 800 communications-type receivers were exposed, the radar equipment numbered nearly 300 major items, test equipment over 250 major items, and even specialized items like sonar and loran numbered approximately 50 major items of each type.

Following each blast the target equipment was inspected, at first visually and later, when power was available, by thoroughgoing application of test equipment. This job took a force of 150 specialists several weeks following each blast. The condition of each equipment following each blast was recorded in tabular form, requiring a report of 1,060 pages for the Able test alone.

Details of the damage caused to electronic equipment have been classified "secret" by the Joint Chiefs of Staff and hence cannot be revealed. The distance relative to the bomb within which equipment suffers severe damage, not repairable at sea, the additional distance within which minor damage is sus-

Permanent records of signals were made by photographing cathode-ray screens. Here is set-up for measuring infra-red radiation from blast





K-band (one centimeter) dish for monitoring APS-34 radar transmissions through blast cloud. Note curved waveguide feed

tained, and the distance beyond which the damage is negligible, are known. Thus, the damage-inspection function of Operation Crossroads was successfully accomplished. General conclusions have been drawn, the weak points of particular equipments revealed, and this information is being forwarded to equipment designers in the Naval Bureaus and the Signal Corps.

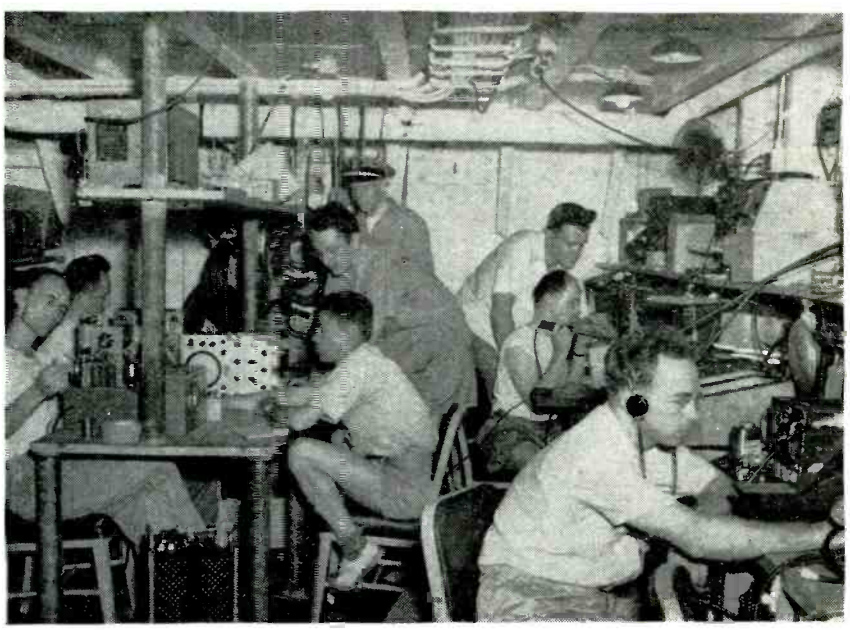
Electronic Instrumentation

While the primary purpose of the Bikini tests was to assess damage produced by the bomb at various distances, it was not sufficient merely to expose the equipment and examine it afterwards. This procedure would reveal *what* had happened, but would leave largely unanswered the question of *how* the damage was caused. This "how" factor involved the values of pressure, temperature, blast and shock to which the equipment was subjected. Without such quantitative information, designers would find it difficult to improve the designs found inadequate. To permit interpretation of observed damage, a program of scientific instrumentation was set up.

In the field of electronics, this instrumentation program had five major parts: (1) television for direct observation of the blast and its effects, and for measuring the heights of waves; (2) a study of electromagnetic wave effects, including monitoring of radio and radar equipments operating during each blast, these being on ships and on one of the Bikini islands; (3) telemetering of air and water pressures created by the explosions; (4) telemetering of radioactivity, and (5) precise measurement of the relative timing of various events connected with the explosion.

The Television System

Two light-weight television transmitting systems (type ARK/ATK or "Block III") were set up on Bikini Island, about three miles from the blast center. These equipments weigh only 100 pounds, have a power output of 10 to 15 watts in the frequency range 150 to 270 mc, and produce a 350-line 40-frame picture using a standard iconoscope camera. The equipment was mounted atop 75-foot steel towers and so positioned that one camera viewed the target fleet, taking in about 10 of the principal target ships at the center of each array, while the other was trained on the nearby beach to televise waves caused by the exposions. Approximately 20 receivers were distributed among seven observing ships, including Admiral Blandy's flagship, the press ship, two official observer ships (military, scientific and United Nations observers), and three "working" instrumentation ships. The receivers employ 7-inch, green-phosphor cathode-ray tubes, and can tune to any of ten 8-mc channels separated 12 mc. Each receiver was fitted with one or more monitor picture tubes located at various points in each ship to permit as many as 100 observers to



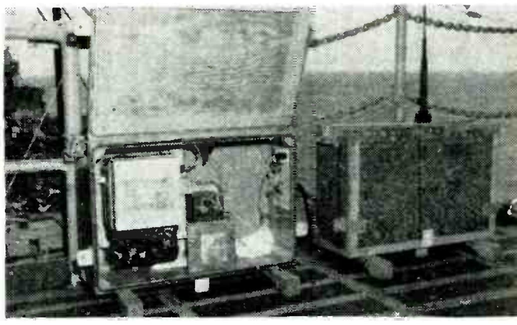
The radio and radar monitor room. These men, from Naval Research Laboratory, were busy with equipment shown and did not see Able blast view the scene simultaneously.

One of the problems of televising the air burst was the intense light generated by the atomic fission. Advance information stated that at the three-mile distance, bomb brightness would equal or exceed that of the sun for a period of several seconds. Since it was known that direct exposure to such light would burn the mosaic of the iconoscopes, tests were conducted at Bikini to determine the density of the optical filters necessary to protect the cameras. It was found that 100 percent modulation of the television carrier occurred when a camera viewed the sun through a filter of density 2.1 (transmission 0.008). It was also found that an illumination several hundred times that of the sun could be safely handled for a period of a few thousandths of a second. This was proved by exploding a four-million lumen flash bulb directly in front of the lens at a distance of one foot and noting the effect on the video waveform.

To protect the camera which viewed the air burst directly, a magnetically operated solenoid carrying a neutral-density filter of density 2.4 was positioned in front of the lens and controlled by a timing circuit having a delay of 13 seconds. The filter was positioned by a radio timing signal, scheduled for 5 seconds before the blast, and removed 8 seconds after the blast. For reasons of safety and security, several of the observing ships were stationed at about 20 miles from the air blast. This exceeded the range of the 10-watt carrier, since the transmitter and receiver antennas were no more than 75 feet above ground. Accordingly, it was decided to operate an airborne television relay on the stratovision principle. Transmitting equipment identical to that on Bikini Island was installed on two PBM Mariner flying boats. Standard Block III receivers, which had been installed in the aircraft to permit motion-picture photography of the television scenes, were connected to the transmitters. The frequency separation between received signal and relayed signal was 24 mc, sufficient to avoid feedback difficulties. Excellent reception at the 20-mile range was achieved by this method, and recognizable pictures could be seen at 45 miles. During the Baker test, the ships were located at 10 to 12 miles, and the relay proved unnecessary when three-element directive arrays were installed on the Bikini transmitters.

One of the outstanding aspects of the television project was the reliability of unattended transmitter operation. In each test the transmitters were turned on about 2:00 am, and the camera circuits adjusted without an image, since darkness prevailed. Thereafter the transmitters continued to function without interruption, and without failure of any kind, surviving the effects of the blast and continuing to operate until turned off some 15 hours later. The images, while not of broadcast quality, were entirely adequate for the purpose and gave observers the first indication of the extent of the damage. The waves were of negligible height at the Bikini shore following the air burst, but were 5 to 10 feet high following the underwater test.

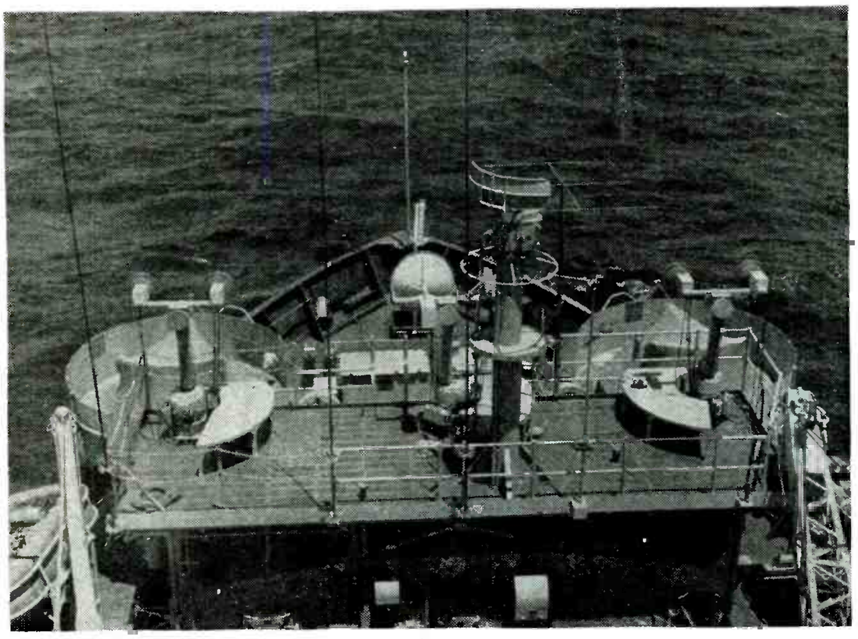
Don Fink, Executive Editor of *Electronics*, makes wire recording just prior to Able Day blast. Goggles reduced glare of blast by more than 10,000 times



"Black boxes", the battery-operated radio receivers, selective filters and relays which turned on equipment automatically just prior to each Bikini blast. Several hundred of these units were spread over target ships, observing ships, and islands

Radio and Radar Monitoring

The monitoring of radio and radar equipment had two purposes:



Bow of the USS Avery Island, showing radar platform from rear. Vertical whip antennas were used to monitor c-w transmissions on 5 to 15-mc from target ships

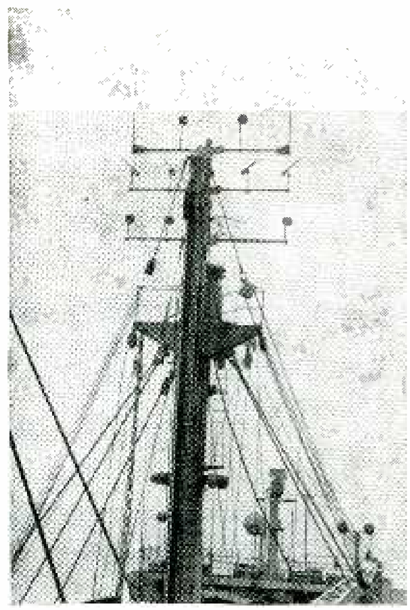
One was to observe the effects of the blast on the frequency, power output, pulse rate and pulse width of various radio and radar transmitters which were operating at the time of the blast on the target ships. The second was to observe what effects the blast cloud and its associated phenomena would have on radio wave propagation at various frequencies, particularly attenuation, generation of noise and atmospheric disturbances, and radar reflections from the target array.

For this purpose a large number of receivers and antennas were set up on the USS Avery Island and on Aomoen Island (one of the Bikini group) to record radio signals. Recording milliammeters and oscilloscopes photographed by motion-picture cameras were used to preserve the records. The frequency range covered the 5 to 15 mc short-wave communication band, the 200-mc range used by low-frequency radar and iff equipment, and the 10, 3, and 1-cm microwave radar bands. These equipments were successful in recording a number of interesting effects, details of which are still classified. In general it may be stated that an atomic explosion constitutes no serious bar to the employment of radio waves in the near vicinity.

Two 3-cm radar equipments on Aomoen Island produced records of the disposition of the target array before, during and after each explosion. These records are of value in placing the time at which various ships sank, at times when smoke and spray prevented conventional photography.

Elaborate arrangements were made to observe the blast cloud by radar at various distances. This was successfully achieved, although the distances and other pertinent details cannot be published. Records were also made of the "spherics" disturbances (natural static) present on the 0 to 5-mc range before, during, and after the blast in the Bikini area and at remote locations in Wake and Guam. The transmissions of standard Navy c-w transmitters, with keys tied down during the blasts, were monitored at Naval, FCC and other government monitoring stations.

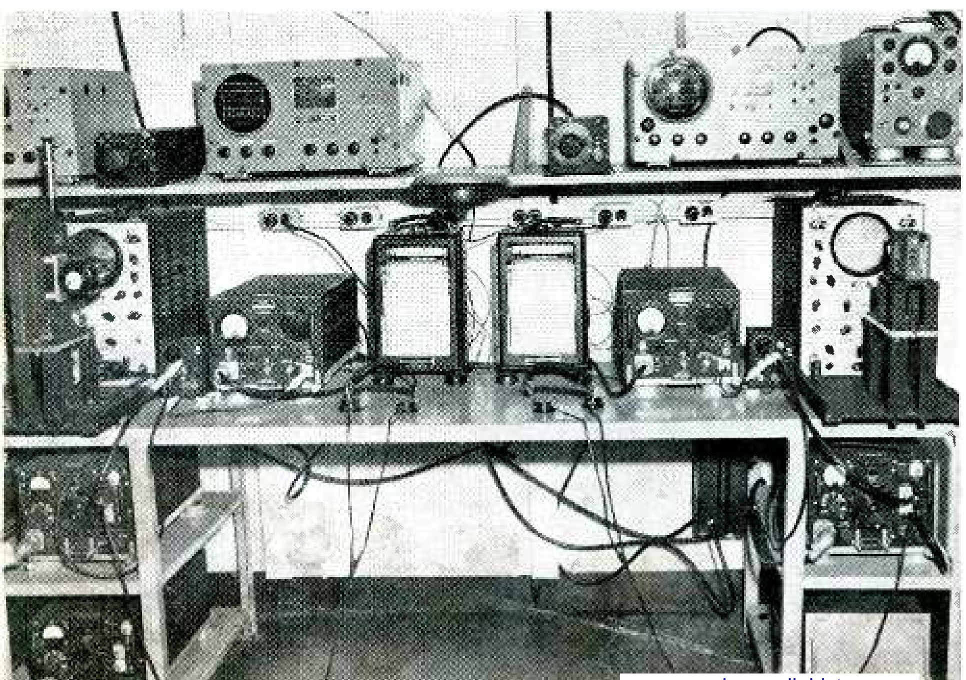
To measure air and water pressures created by the explosions as a function of time at various positions, it was necessary to set up several remote measuring systems. One of these telemetering systems used pressure gauges mounted on the superstructures and hulls of selected target vessels. The output of these gauges modulated 600-watt 70-mc frequency-modulation transmitters. In the air burst, 18 gauges were attached to a single transmitter which was connected to each gauge in turn (time sequence telemetering). In the underwater test, the rate of rise of pressure was much greater and the full bandwidth of the system was used to transmit the pressure pulse from a single gauge, five gauges and transmitters being used in all. Receivers located on the USS Avery Island reproduced the pressure-time pulse, which was recorded by a moving-coil oscillograph on paper tape in the case of the air burst, and by a high-speed cathode-ray oscilloscope on motion picture film in the underwater burst.



Weird collection of antennas on mast includes vertical 70-mc array for telemetering, seven intercept antennas with ground planes for 100-200 mc, and a corner reflector for television reception

A similar record of pressure in air and water was obtained by a string of 15 sonobuoys, (water-borne, battery-operated transmitters) arranged along a radial line from the target center at intervals of 100 feet. Microphones and hydrophones, when actuated by the blast, modulated the corresponding transmitter, which in turn actuated receivers on Aomoen Island some seven miles distant. A 15-element moving-coil oscillograph recorded the signals as functions of time on a photographic paper tape. This and similar photographic records were removed from Aomoen Island

Monitoring equipment and recorders. The photograph shows just a small portion of the gear used to cover all frequencies from 5 mc to 26,000 mc. during the Able blast. Oscillographic cameras (left and right) and recording milliammeters (center) made permanent records



after the Baker test by helicopter, since the radioactivity was too intense to permit approaching the island by boat. Film records of the radar images were fogged by radioactivity and might have been completely ruined if allowed to remain until the radioactivity had subsided.

Still another telemetering system was used to transmit radioactivity levels from the target vessels after the Baker test. Geiger-counters and ionization gauges were connected to standard Signal Corps SCR-694 battery-operated transmitters, so connected that each pulse of the detector caused a break in the carrier. The outputs of receivers on the USS Avery Island were connected to recording milliammeters which recorded the intensity for a period of several days after the explosion. The radio-activity was intense. A continuous plot was kept. From the various rates of decay observed, it was possible to predict long before the vessels were boarded that they would remain uninhabitable for many weeks if not months. Even at the present writing, more than two months later, many of the vessels can be boarded safely only for brief periods.

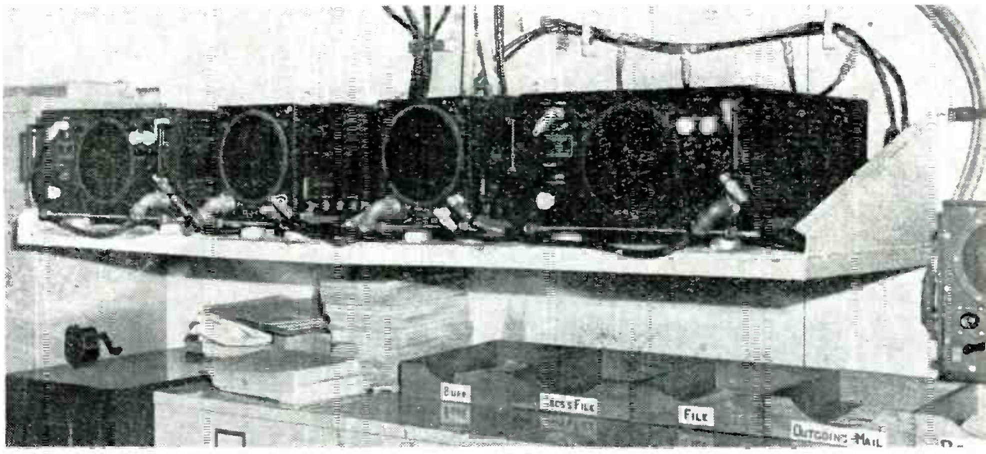
Remote control was used to guide drone boats in and out of the contaminated area, to pick up water samples as a further aid in determining radioactivity levels, and to aid in computing the efficiency of the atomic bomb. This equipment, adapted from remote control equipment developed during the war, permitted the motor to be started, the anchor slipped, the throttle advanced or retarded, and the rudder turned left, right or centered, and operated a pump for collecting water samples, all by pushbutton control from a vessel outside the lagoon. Airborne observers guided the controllers, by radioing instructions to the control ship. This equipment operated successfully and permitted observation long before human beings could approach the contaminated area.

More conventional electronic equipment in the form of a 50-watt broadcast transmitter was operated by the ECO for the entertainment of the Task Force. Wire recorders were also used to preserve running accounts of the activity aboard the ship during both tests.

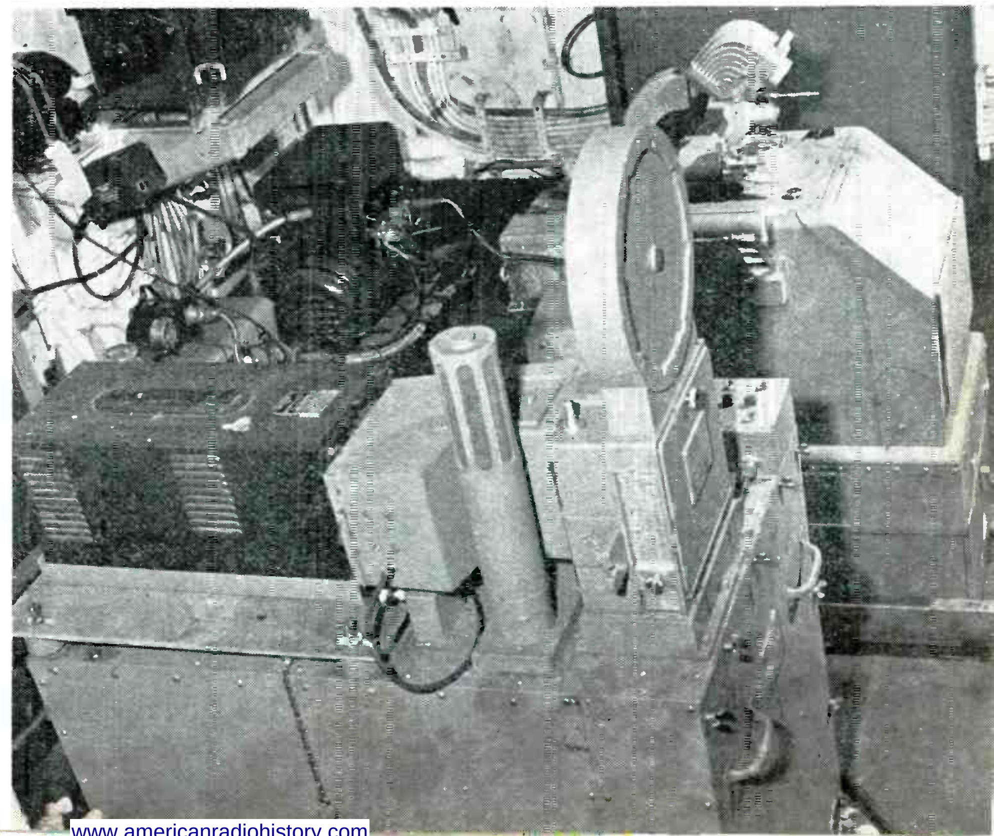
The many electronic equipments involved were set in motion just prior to the blast by audio timing signals sent by radio from the USS Cumberland Sound, the laboratory ship of the Manhattan District. These were received by battery-operated receivers, fitted with selecting filters and relays to actuate equipment at internals from two minutes to two seconds prior to each blast. As a check on the operation of these devices, in the Baker test a time-monitoring system was set up which related the time signals, and the actual detonation, with world time, by comparison with WWV signals.

All of this complicated electronic equipment operated satisfactorily, with a few exceptions traceable to human error or to the fact that the delicate equipment aboard the target ships was put out of action by failure of power supply or by the blast itself. Interpretation of the results and correlation with observed damage are now underway.

Battery of two television receivers and associated monitors, mounted in "office" of electronics laboratory ship. Additional monitors were provided in lounge and on bridge



The Hobart camera, which took still pictures from television picture tube (in black case at left), at rate of one per second, processed them automatically, and projected positive image on screen (at right) two minutes later



Wideband Microwave Amplifier Tube

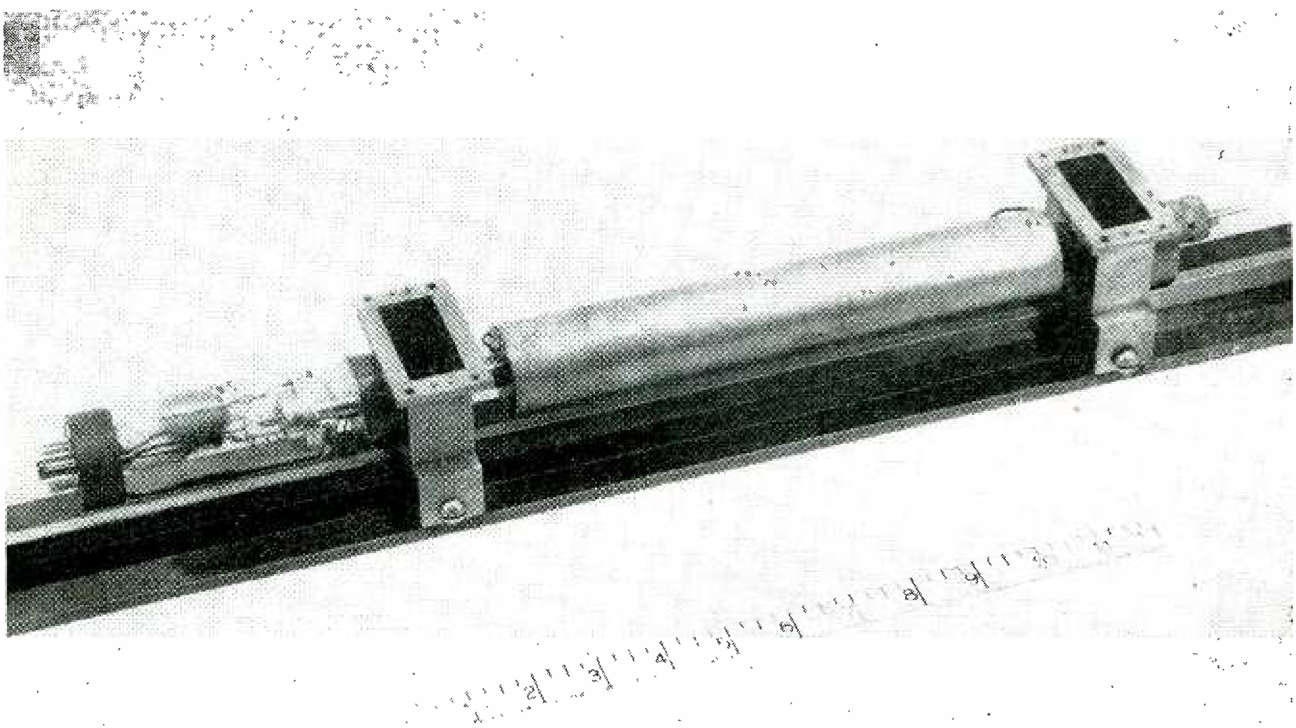


FIG. 1—The traveling-wave tube projects through the input and output couplings of a waveguide circuit. Electron gun is at the left

THE TRAVELING-WAVE TUBE, ultimately to be used as a repeater on coaxial and radio relay circuits, is a wideband amplifier for frequencies in the vicinity of 4,000 mc. It has an operating bandwidth of 800 mc, which is limited primarily by the coupling between tube and microwave waveguide circuit.

The tube consists of an electron gun that projects a beam of electrons at a velocity one-thirteenth that of light down the axis of a metallic wire helix. Both ends of the helix terminate in antennas that couple to the external waveguide circuit. The wave from the waveguide is picked up at the end of the helix at which the electron beam enters, travels down the helix absorbing energy from the electron beam as it does so, and is reradiated at increased strength from the antenna at the other end of the helix.

The tube is now undergoing extensive tests at the Bell Telephone Laboratories to determine its operating characteristics and the circuits in which it is most useful.

Coupling Circuit

Whereas other forms of microwave tubes such as the klystron and magnetron depend on resonant cavities for coupling between the electron stream and the electromagnetic circuit, the traveling-wave tube obtains the coupling by means of nonresonant line. Resonant circuits are used to obtain a high field strength and hence efficient coupling. However, in tubes using resonant circuits, the coupling is confined to a relatively small region. By extending the region over which the electrons deliver their energy to the field, which is done in the traveling-wave tube by using a nonresonant transmission line instead of a short gap in a cavity, efficient coupling is obtained despite the necessarily weaker field of the nonresonant circuit. In this manner it is possible to obtain a very wideband amplifier for the microwaves.

Wave energy is coupled into the helix by an antenna. As shown in Fig. 1, the tube is mounted so that it projects through the terminating cavities of a waveguide transmission circuit, which in turn couples to the coaxial or radio link. There are antennas similar to electrostatic probes extending from the ends of the helix into the waveguides.

Characteristics and operating principles of the traveling-wave tube are explained in nonmathematical terms. The tube, designed for multichannel microwave relay systems, provides a high gain, wideband amplifier for use in television or f-m network circuits

The antenna at the input end of the tube couples to the receiving end of the incoming circuit; the antenna at the output end of the tube couples to the transmitting end of the outgoing circuit. The electromagnetic wave traveling down the waveguide circuit is picked up by the input antenna of the tube, travels down the helix, and is reradiated into the circuit by the antenna at the other end of the helix. These antennas must have sufficiently high Q to efficiently transfer the wave energy, but must be sufficiently broad in their tuning to transmit the wide band for which the tube is to be used. These two requirements are mutually exclusive, so a compromise design must be made.

The electron beam that leaves at the output end of the tube is returned to the conductive circuit by a collecting anode as shown in Fig. 2. The velocity of the electrons is adjusted to be slightly greater than that of the axial velocity of the traveling wave. Although the electromagnetic wave travels along the wire of the helix at a velocity very near that of light, its axial velocity is less, depending on the pitch and radius of the helix ($V_A = v/2\pi rn$: where V_A is axial velocity, v is wave velocity along the wire, r is the helix radius, and n is the turns per inch of the helix).

Amplification

Gain is a function of the relative velocity between electron beam and traveling wave. Beam velocity is readily controlled by the accelerating potential in the electron gun. Tube gain rises as the initial beam velocity increases, passing through a maximum at a velocity slightly greater than that of the traveling wave, and falling off at higher velocities. The gain also increases with the number of electrons in the beam, which can readily be controlled by regulating the current

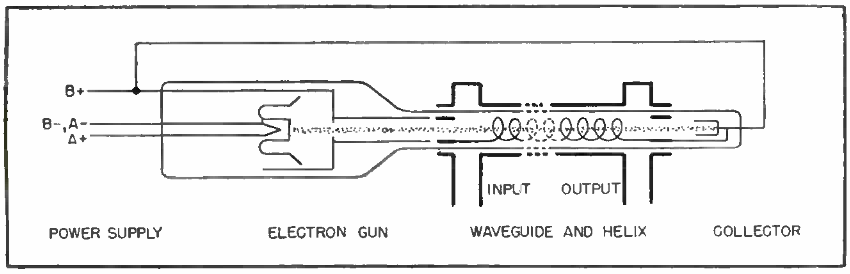
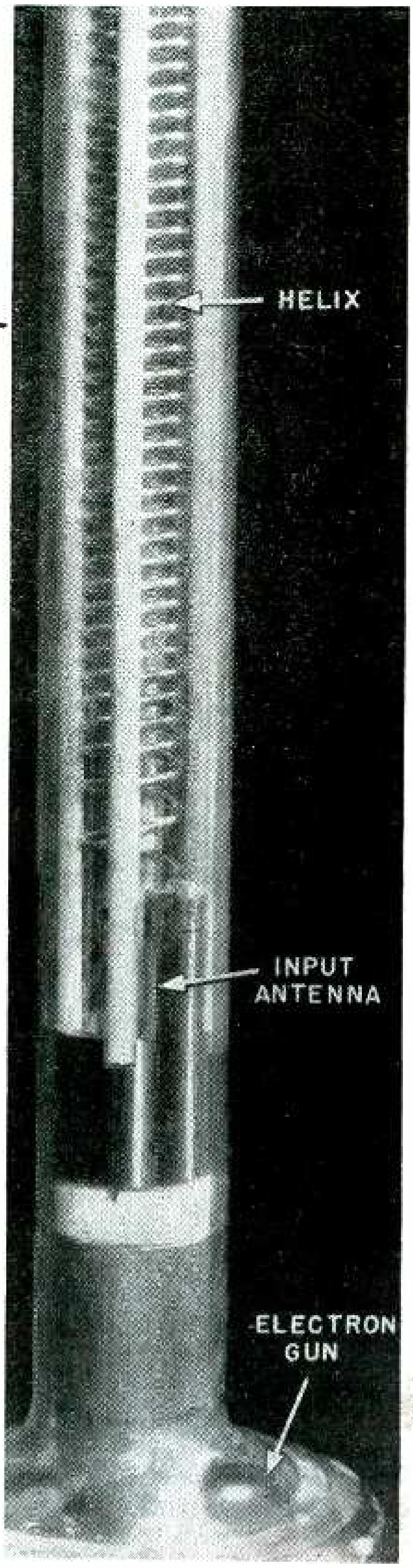


FIG. 2—Pictorial circuit shows how helix is coupled to waveguide at input and output ends. Guide extension along helix serves only as electrostatic shield



Tube provides nonresonant coupling between electron beam and traveling wave

from the cathode of the electron gun. Near the optimum velocity there is a self-regulating action of the electron beam on the wave velocity to maintain the proper relation between wave and electron velocities.

Because gain depends on velocity and density of the electron beam, operating potentials of the electron gun must be stabilized, or, if desired, variable losses over the microwave circuit can be compensated by an automatic volume control circuit operating on the electron gun potentials.

Gain also depends on the number of wavelengths along the axis of the helix, and is about a decibel per wavelength. Thus as the frequency is decreased, thereby reducing the number of wavelengths along the helix, the gain falls off. Amplification in the tube, as will shortly be explained in more detail, depends on the interaction between the beam electrons and the electric field established by the wave on the helix. As the frequency is increased, this wave field concentrates closer to the wire of the helix so that at high frequencies the field strength along the axis of the helix is weak and the gain is low. Thus there are inherent upper and lower limits of frequency for which a given tube amplifies. These limits lie far beyond those set by the antenna coupling problem mentioned before. Except for mechanical limitations, there is no reason why the tube could not be scaled to function at any desired region in the spectrum.

There are about forty wavelengths along the helix at the design center frequency. The transmission loss along the helix when the tube is cold is, in one experimental model, 30 db. When the tube is hot, it provides a gain of 20 db; however, a wave traveling the helix in opposition to the electron stream still suffers a 30 db attenuation.

That the tube transmission loss is more than its gain is desirable in that there will be no instability or tendency toward oscillation in case of impedance mismatch in the external circuit. If there should be a wave reflection caused by an impedance mismatch at the output of the tube, standing waves would appear along the helix lowering the efficiency. The high attenuation of the helix tends to reduce the standing-wave ratio should standing waves be present. However, proper terminations are essential for efficient operation.

Electron-Wave Interaction

Amplification depends on the interchange of energy between the electromagnetic field established along the axis of the helical coil and the electron beam traveling axially down the helix. Figure 3 shows representative lines of electric and magnetic flux of the traveling wave. These flux lines move with the electrons down the tube. Both electric and magnetic flux are parallel to the path of the electrons at the core of the helix. Thus there is interaction only between the electrons and the electric component of the field. (Magnetic flux acts only on the component of an electron's velocity that is perpendicular to that flux.)

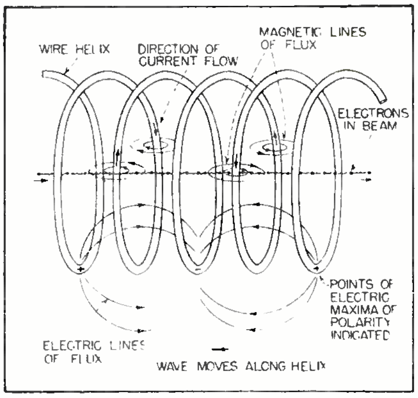


FIG. 3—Field diagram shows orientation of electric and magnetic lines of flux in relation to helix and electron beam. Coupling is only through electric field

The first function of the field is to bunch the electrons. Electrons entering the traveling-wave field at a region of positive potential gradient are accelerated; those entering at a region of negative potential gradient are decelerated. Because the entering velocity of the electrons is slightly faster than that of the traveling wave, the electrons are moving ahead, relatively, into the wave. (It is as if the wave were standing still and the electrons were moving slowly along it.) The result is that electrons entering the wave at a region of accelerating field pass quickly on into a region of decelerating field where they remain for a comparatively long time. Electrons entering the wave at a decelerating field region remain in that region for a long time. The result is that most electrons are in regions of decelerating field most of the time. Thus more electrons are being decelerated at any instant than are being accelerated. As a consequence there is an over-all absorption of energy from the electron beam by the wave field. Momentum of the electrons is transformed into field energy in the wave.

That the electrons enter the wave field at a critical velocity slightly greater than the axial velocity of the wave is essential to transfer of energy. Were the electrons to travel at the velocity of the traveling wave, they would reach their greatest bunching in a field of zero potential gradient, but because the beam enters the traveling wave at a slightly higher velocity, the electrons concentrate within the decelerating field where their kinetic energy can be transformed into electric energy. The variation of amplification with change in initial beam velocity is caused by the bunch forming more or less within the region of greatest negative potential gradient. Because of the dual action of the beam as bunching agent and energy absorbing medium, neither the condition for optimum bunching nor for optimum energy absorption can be realized. Rather, the condition that combines these functions in the proportions to give greatest amplification must be established.

During the war, R. Kompfner and others in the Clarendon Laboratory at Oxford showed that amplification was possible with a device consisting of an electron stream and a helix. J. R. Pierce and L. M. Field at the Bell Telephone Laboratories have successfully produced such an amplifier with the astonishingly high gain and broad band just described.

Practical significance of the tube can be appreciated by the fact that it provides more gain over a wider band than any other tube. It could handle 10,000 telephone conversations or several dozen television programs simultaneously.—F. R.

Duplex Operation of INDUCTION HEATERS

Multiple connection of identical units, for either two-phase or three-phase input, can be readily effected to provide twice the power of either unit operating alone

By W. C. RUDD
Chief Engineer
Induction Heating Corp.
New York, N. Y.

IN THE PRODUCTION of high-frequency power for induction heating, it has been found advantageous to use multiple unit oscillators for the production of powers beyond the capabilities of a single unit.

The problem involves the interconnection of two independent high-frequency oscillators in a manner such that the output frequency of the two units is exactly the same and so that the tank circuits are locked in step. In addition, the total load must be shared equally by the two power supplies, and the load on the power line must be balanced.

Fundamental Unit

Each basic unit consists of a modified Hartley oscillator, as shown in Fig. 1. The equipment contained within the dotted line is in the cabinet of the oscillator. The radio-frequency output transformer may be at some distance from the oscillator.

The tank circuit within the cabinet consists of the tank capacitor and an inductor. The inductor, in conjunction with a grid coil, provides adjustable feedback. The balance of the tank inductance is in

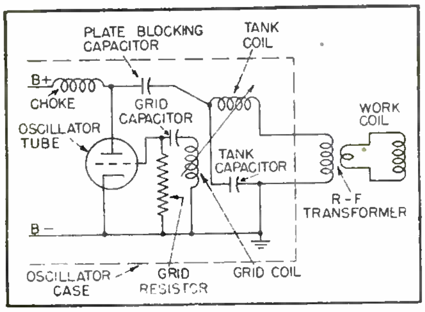
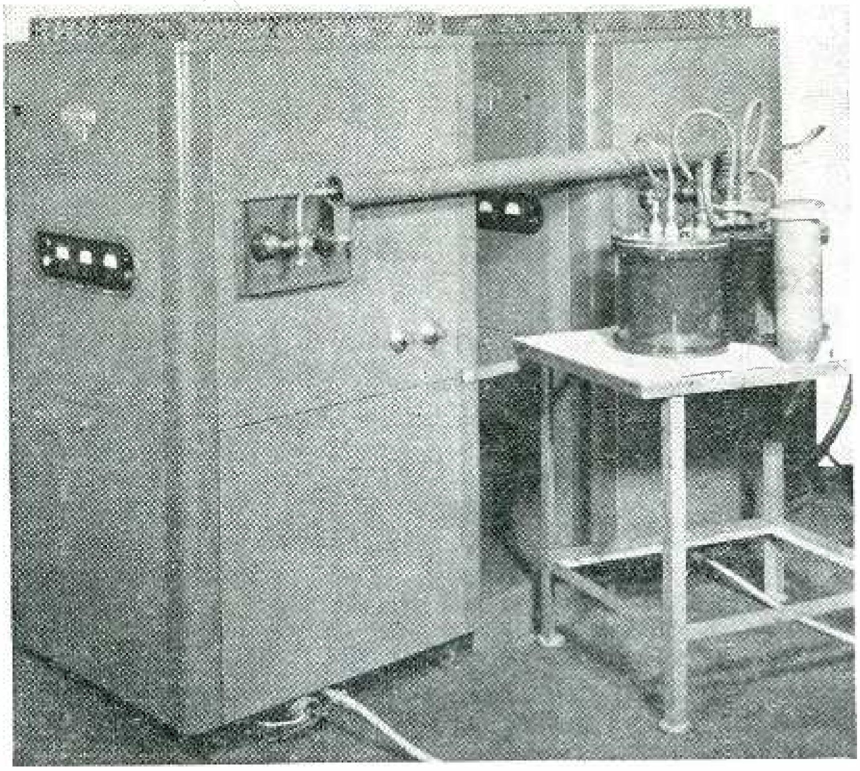


FIG. 1—Basic oscillator circuit, showing the variably coupled plate and grid coils. The r-f transformer is actually a part of the oscillator circuit but is located near the work



Side view of two heaters connected by a coaxial line to give double the power of a single unit in the common work coil. The two r-f transformers that feed the work coil rest on the table at the right

the primary of the radio-frequency output transformer. The work coil is connected to the secondary of this transformer and can be of single- or multiple-turn construction.

The basic oscillator has an output of twenty or more kilowatts, depending upon the power supply.

The power supply may be either single phase, full wave, unfiltered, or three phase, full wave, unfiltered. In the single-phase power supply, the plate transformer feeds four mercury-vapor rectifier tubes connected as a bridge rectifier. The output is pulsating direct current at an average value of 9,000 volts. In this case, the power supply is capable of delivering 40 kilowatts of unfiltered power to the oscillator section.

The three-phase power supply consists of a single three-phase transformer feeding a six-tube mercury-vapor full wave rectifier. The output of the rectifier is 12,500 volts with a 5 percent ripple. The power supply is capable of delivering 50 kilowatts of unfiltered d-c power.

Synchronizing Tank Circuits

In order to connect two oscillators together and to feed their output into a common work coil it is necessary to solve several problems. First, it is essential that the two separate tank circuits of the oscillators operate in synchronism; second, it is necessary that the two oscillators deliver equal power output; third, the total power output must equal twice the rated output of each oscillator.

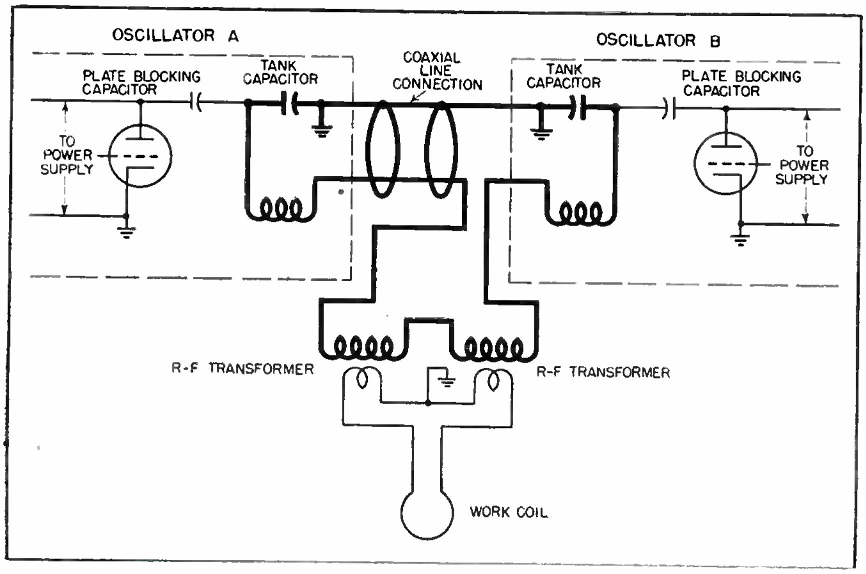


FIG. 2—Two oscillator r-f transformers and work coils can be wired in series for double power. A coaxial connection is necessary, besides other ground bonds, to maintain a low reactance between units and ground

The first requirement is accomplished rather simply. The two tank circuits are connected in series, using two r-f transformers. This connection is shown in Fig. 2 and the photograph. The circulating tank current will be the same in all parts of the circuit. The two tank capacitors are in series; therefore, the resulting total tank capacitance is one-half that of a single unit. The tank coils and r-f transformer primaries are connected in series. Therefore, the total tank inductance is twice that of a single unit. Hence, with one half the capacitance and twice the inductance, from the usual resonant circuit frequency formula $f = 1/(2\pi \sqrt{LC})$ it is seen that the frequency remains the same and, since we now have a tank circuit common to the two oscillators with the same tank current, the two must of necessity be in synchronism. The only difference between this setup and the conventional circuit is that the tank circuit is fed at two points instead of the usual single point. Each oscillator receives grid drive from its own grid coupling coil and, since both coupling coils are electromagnetically coupled to a common tank circuit, the grids are driven in the proper relationship to each other.

By connecting the tank circuits in series a new tank circuit results, with two radio-frequency output transformers the secondaries of which are connected in series and grounded at the junction. The work coil is fed by the two transformer secondaries.

Low Reactance Tie

The connection of the two tank circuits in series involves only one problem. It will be noted that two separate ground connections are required since the oscillators must remain as originally wired to operate separately. The common ground bond between the two units in series will carry full tank current, amounting in some cases to several hundred amperes. If the bond has appreciable reactance, dangerously high potentials may exist between ground and the frames of the oscillators. There may also be radio-frequency voltage between the cores of the relays and their coils that will break down insulation. Additional ground ties are made between the frames and the oscillators as shown in the photograph.

It was found necessary to reduce reactance of the interconnection by means of the coaxial line illustrated. Without the coaxial tie between the two oscillators, the voltage difference might be of the order of magnitude of one or two hundred volts, whereas with the coaxial connection and frame ground ties the difference between the two is reduced to a value of approximately fifteen volts, which is of no consequence.

Use of Multiphase Power Lines

If three-phase power supplies are used having an output ripple of only five percent no difficulty is encountered in loading the oscillators to twice the rated output. The energy drawn from the power lines is balanced on the three-phase lines inherently. In many cases, however, only single-phase power supply units are available.

If both oscillator power supplies are connected to the same phase of a three-phase system, operation will be satisfactory in that the power output will be twice the rated output of one unit. The power supply wave shapes and resulting tank current envelope are shown at the left of Fig. 3. However, there may be a serious disadvantage insofar as the power lines are concerned. If a three-phase line is used, one of the phases has a very large load and the other two are unloaded, with a resultant bad unbalance. It may therefore be desirable to put one oscillator on one phase and the other oscillator on another phase, leaving a phase of the three-phase system unloaded. Under these conditions the power line will be more nearly balanced, but it will not be possibe to obtain twice the rated output from the oscillators because the oscillator tubes are receiving grid voltage that is induced by the tank current, and are operating on a plate voltage that is independent of the tank circuit. Since the tank circulating-current envelope is the result of two power supplies feeding a common tank circuit, it will not coincide with the wave shape of the voltage from each of the individual power supplies.

When one oscillator is on each of two phases of a three-phase line, the wave shape of the d-c output from each of the power supplies will be 120 degrees out of phase, as shown at the center of Fig. 3. The resulting tank current envelope is not symmetrical with respect to the plate voltage wave shapes, causing grid voltages that do not coincide with the individual plate voltage wave shapes to be fed to the individual oscillators. Also, due to the fact that the two power-supply waves are not symmetrical with respect to each other, it is only possible to obtain a little over 1.5 times the rated output of both oscillators. In addition, the three-phase power line supplying the two oscillators is out of balance.

These two problems in operation on three-phase power lines can be corrected in two steps. First, the two high-voltage outputs of the power supplies are connected together. This connection is called a B-plus tie, and is made with a short piece of high-voltage, single-conductor armored cable. When the two power supplies are connected together both oscillators receive identical plate supply voltage wave shapes, thus causing the grid-voltage envelope to simulate the shape of the power-supply wave. As the second step, a Scott transformer bank is installed between the three-phase power line and the two single-phase power supplies. Thus, the three-phase line is converted to two-phase. As a result, instead of being 120 degrees out of phase with respect to each other, the power-supply wave shapes are now 90 degrees out of phase with respect to each other, a symmetrical condition. These steps result in equal sharing of load by the two power supplies and an improved tank-current envelope shown at the right in Fig. 3. The output of the two oscillators is now equal to twice the rated output of one. The power supplied to the duplex unit is also balanced on the three-phase line.

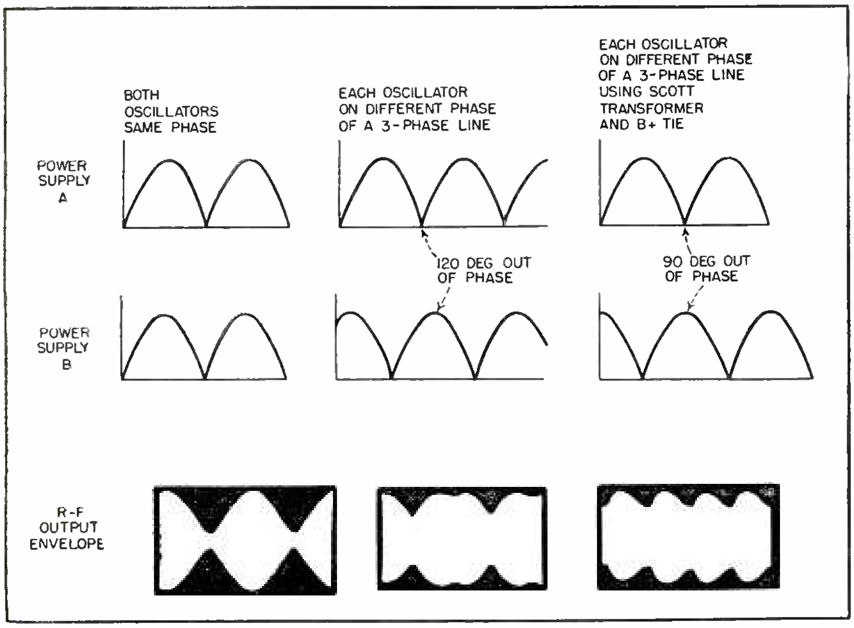


FIG. 3—Waveforms encountered in the output envelope when the heating units are connected in various ways to power lines. Double power can not be obtained from the two units unless the power input phasing is correct

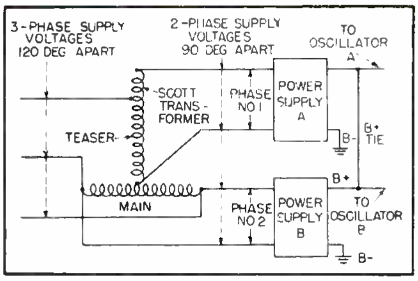


FIG. 4—Single-phase type units can be connected to a three-phase line through a Scott transformer. When the outputs of the power supplies are paralleled, the heating units give optimum power and the power line is also balanced

The connections for this setup are shown in Fig. 4. On the left is shown the transformer bank, consisting of main and teaser transformers with a three-phase power input connection and a two-phase power-output connection, one phase of which goes to power supply *A* and the other phase to power supply *B*. The high-voltage outputs of power-supply *A* and *B* are connected together, as shown, with the B-plus tie. From here they feed the two oscillators with a duplicate wave shape.

Balancing the Oscillator Loads

The sharing of load between the two oscillators can be controlled in two ways. First, an adjustment of filament voltage to the bright tungsten filament tubes used will cause one oscillator to deliver more or less power, so that the load between oscillators can be balanced. As an alternative, small adjustable resistors installed in series with the grid-bias resistors can be used to increase grid bias slightly on the tube assuming the greater load. Once made, neither of the above adjustments need be changed until there is a replacement of oscillator tubes. Generally speaking, it has been found unnecessary to make any adjustment in the individual oscillators in order to realize reasonably equal load sharing.

In actual practice, installations have been made in which the change from single units to duplex is made by switching, and in which the time for change is less than a minute.

DESIGN OF F-M SIGNAL GENERATOR

Requirements of a reactance modulator for producing constant deviation of a variable oscillator are developed. Design data is given for an f-m signal generator covering 54 to 216 megacycles. Operation from 100 kilocycles to 25 megacycles is provided

By DONALD M. HILL and MURRAY G. CROSBY

Development Engineer
Boonton Radio Corporation
Boonton, New Jersey

Consulting Engineer
Paul Godley Company
Upper Montclair, New Jersey

In the design of a frequency-modulation signal generator, the choice of the general type of circuit is considerably affected by the problem of modulation calibration. The usual reactance-modulator circuits produce deviations of the oscillator frequency which vary with the oscillator frequency. Since it is necessary to permanently calibrate the deviation obtained from the instrument, some means must be employed to maintain a constant modulator sensitivity over the frequency range. Two systems are available for accomplishing this purpose: the heterodyne system and the constant-deviation variable-oscillator system.

Heterodyne System

The basic operating principle of the heterodyne system is indicated in the block diagram of Fig. 1, which is reproduced from a paper[1] by A. W. Barber, C. J. Franks, and O. W. Richardson. In this system, frequency modulation of the fixed oscillator is controlled by variation of the modulating voltage applied to the reactance tube by means of a deviation control potentiometer. When the desired deviation has been chosen, this is necessarily held constant regardless of the output frequency, since it is the fixed oscillator that is modulated, and its frequency deviations are transferred unaltered to both the sum and difference frequencies which are generated in the mixer stage. The desired sum or difference frequency is amplified to obtain the required output voltage.

It is possible to gang the deviation control potentiometer to the variable tuning element of the variable oscillator to produce a constant deviation of the variable oscillator and to heterodyne this with an unmodulated fixed oscillator; however, modulation of the fixed oscillator is obviously preferable.

Although the many desirable features of the heterodyne system made it convenient for the original f-m broadcast band (42-50 mc), it is not well suited for a generator covering a large part of the vhf region. In addition to the desired sum or difference frequencies, the mixer output contains the harmonics of the two oscillators and the sum and difference frequencies of the various harmonics. These spurious frequencies are not harmonically related to the desired output frequency and, in fact, sometimes coincide with it[2]. To keep the output signal reasonably free from spurious signals over a wide frequency range, it is necessary to use the difference frequency and operate the oscillators at frequencies so high that frequency stability would be a major problem.

If sufficient oscillator stability could be attained, there would remain the problem of amplifying the desired signal in the mixer output. In the vhf region, this would require a tuned r-f amplifier. The problem of ganging the variable oscillator with an amplifier operating at the difference frequency is

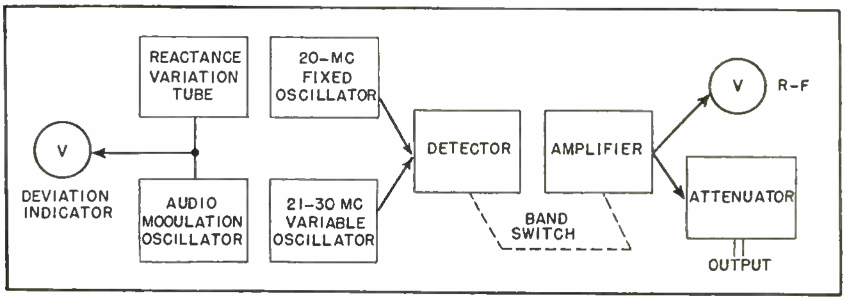
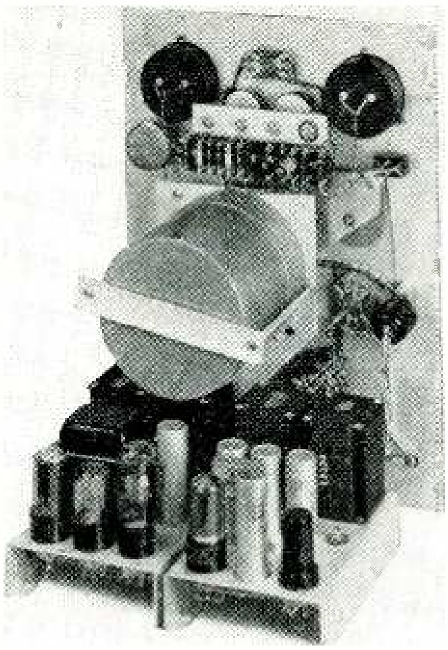


FIG. 1. Essential stages of f-m signal generator employing the heterodyne system



Front and rear views of the signal generator. Frequency deviation and percent of amplitude modulation are controlled by two potentiometers below the modulation meter switch. On the tuning dial, the vernier scale changes the frequency by about 26 kc on the low-frequency range and 52 kc on the high range. Choice of modulating frequency is provided by the dial at lower left and output from 0.0000001 to 0.2 volt is controlled by the attenuator dial at lower right

not very inviting since the rate of change of the output frequency is considerably different from the rate of change of the variable-oscillator frequency.

Constant-Deviation Variable-Oscillator System

If a constant-deviation modulation system is utilized, the signal generator does not require the step of heterodyning with its attendant spurious responses. Either an oscillator operating directly at the output frequency or a master-oscillator-multiplier arrangement may be used. Such arrangements confine the spurious responses to harmonics or subharmonics which are inherently low in output and are simply related to the output frequency so that they may be readily identified.

The constant-deviation system gives a greater output per tube used in the signal generator. With the elimination of the heterodyne step, only a single oscillator is required. Also, the efficiency of amplifiers or multipliers is considerably greater than that of a frequency converter.

In reactance-tube frequency modulation, there are two general types of reactance tubes employed. One type appears as a controllable inductance and the other as a controllable capacitance. The equivalent inductance or capacitance produced by the usual reactance tube with a two-element phase shifter results in an equivalent inductance or capacitance which is independent of frequency[3]. The reactance tube is placed in parallel with the tuned circuit to be modulated so that the inductive type may be considered as adding a controllable inductance in parallel with that of the tuned circuit while the capacitive type adds a controllable capacitance in parallel with the tuned-circuit capacitance.

For the inductive type of reactance tube, the resulting total tuned-circuit inductance is that of the tuned circuit and the reactance tube in parallel or

$$L_t = L_e L/(L_e + L) = L/(1 + L/L_e) \quad (1)$$

where L is the fixed inductance of the tuned circuit and L_e is the effective inductance of the reactance tube.

When Eq. 1 is inserted in the expression for the resonant frequency of the tuned circuit, the frequency is given by

$$f = 1/[2\pi\sqrt{LC/(1 + L/L_e)}] = f_r(1 + L/L_e)^{1/2} \quad (2)$$

in which C is the fixed capacitance of the tuned circuit and $f_r = 1/(2\pi\sqrt{LC})$. The quantity L/L_e is normally small in comparison to unity, so that Eq. 2 simplifies to

$$f = f_r(1 + L/2L_e) = f_r + f_r L/2L_e \quad (3)$$

The second term in Eq. 3 is the frequency deviation which results from the reactance-tube modulation. It is seen to be proportional to the resonant frequency f_r and the ratio L/L_e between the tuned-circuit inductance and the effective inductance of the reactance tube.

For the capacitive type of reactance tube, the resulting total tuned-circuit capacitance is that of the tuned circuit and the reactance

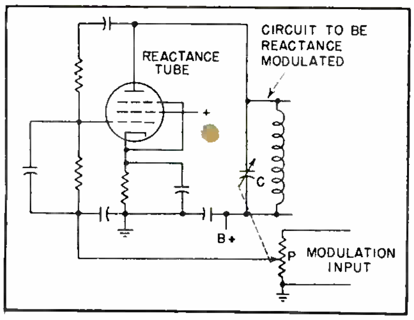


FIG. 2. Constant deviation is obtained by ganging a modulation input potentiometer with the tuning capacitor

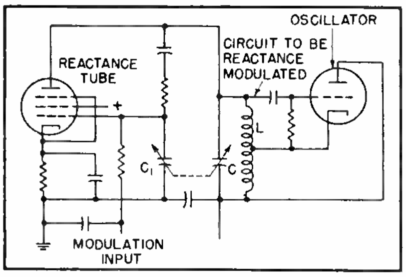


FIG. 3. Method of obtaining constant deviation by ganging an element of the phase shifter with the tuning capacitor

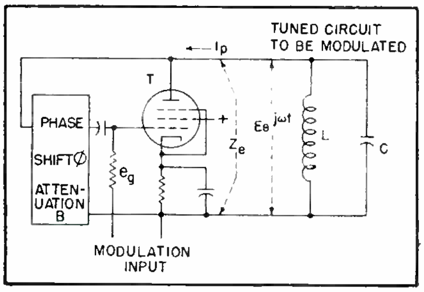


FIG. 4. Fundamental reactance-tube circuit

tube in parallel. The frequency is then given by

$$f = 1/[2\pi\sqrt{L(C + C_e)}] = f_r(1 + C_e/C)^{-1/2} \quad (4)$$

For the practical case, C_e/C is small compared to unity, so that

$$f = f_r(1 - C_e/2C) = f_r - f_rC_e/2C \quad (5)$$

It is thus seen that the frequency deviation produced by the capacitive type of reactance tube is proportional to the resonant frequency f_r and to the ratio C_e/C of equivalent reactance-tube capacitance to tuned-circuit capacitance.

The manner in which the frequency deviation varies with resonant frequency is also dependent upon which element of the tuned circuit is varied. If the tuned circuit is of the variable-capacitance, fixed-inductance type, and the reactance tube is of the inductive type, the frequency deviation may be taken from Eq. 3 which is $f_rL/2L_e$. In this type of circuit, L is fixed and L_e is independent of frequency. The result is a fixed percentage variation of inductance which produces a fixed percentage frequency variation. The frequency deviation in cycles is therefore proportional to the resonant frequency.

If the tuned circuit is of the variable-capacitance fixed-inductance type, and a capacitive reactance tube is used, the percentage capacitance variation varies with frequency as the tuning capacitor is varied. That is, the ratio C_e/C varies with frequency since C is varied. The value of C is varied in accordance with the formula $f_r = 1/(2\pi\sqrt{LC})$, which may be rewritten

$$C = 1/[L(2\pi f_r)^2] \quad (6)$$

Substituting Eq. 6 in Eq. 5 gives

$$f = f_r - 2\pi^2C_eLf_r^3 \quad (7)$$

In the frequency deviation given by the second term in Eq. 7, the quantities C_e and L are independent of frequency for the fixed-inductance type of tuned circuit. The percentage frequency deviation is thus proportional to the square of the resonant frequency. The deviation in cycles is proportional to the third power of the resonant frequency.

If the tuned circuit is of the variable-inductance fixed-capacitance type and the reactance tube is inductive, the ratio L/L_e varies with frequency. The tuned circuit inductance L is tuned in accordance with $f_r = 1/(2\pi\sqrt{LC})$, which may be rearranged to

$$L = 1/[C(2\pi f_r)^2] \quad (8)$$

Substituting Eq. 8 in Eq. 3 gives

$$f = f_r + 1/[(2\pi)^2L_eCf_r] \quad (9)$$

The values of L_e and C are independent of frequency for this combination so that the frequency deviation is inversely proportional to the resonant frequency. The percentage frequency deviation is therefore inversely proportional to the square of the frequency.

When the fixed element of the tuned circuit and the reactance tube type are the same (both capacitive or both inductive), the deviation sensitivity is proportional to the operational frequency. With fixed C in the tuned circuit and an inductive type reactance tube, deviation is inversely proportional to frequency. With fixed L in the tuned circuit and a capacitive type reactance tube, the deviation is directly proportional to the third power of the frequency.

The nearest approach to constant-deviation operation that may be obtained with the conventional reactance-tube circuits is a deviation which is either directly or inversely proportional to the operational frequency. Two combinations of reactance tube and tuning element produce deviations proportional to frequency. One of these is obtained by the familiar variable-capacitance tuned circuit in combination with an inductive reactance tube, and the other is obtained by a variable-inductance (such as a permeability-tuned) circuit in combination with a capacitive reactance tube. When either one of these combinations is employed, the deviation increases with frequency so that some means must be provided to reduce the deviation sensitivity as the frequency is increased.

Correction Methods

Various means may be applied for correcting the inherent deviation variation with frequency. One method is to gang a modulation input potentiometer with the tuning dial as shown in Fig. 2. Potentiometer P is designed to have a resistance taper such that, when ganged to the shaft of tuning capacitor C, the modulation sensitivity is maintained constant as the frequency is varied. For the circuit shown, the potentiometer reduces the modulation input as the frequency is increased.

Figure 3 shows how the modulation sensitivity may be maintained constant by ganging an element of the reactance-tube phase shifter to the shaft of the tuning dial. For the inductive-reactance tube and variable-capacitance tuned circuit shown, phase-shifter capacitor C_1 is ganged to tuning-capacitor C in such a manner that C_1 is increased as C is decreased. This increases the phase-shifter attenuation as the frequency is increased so that the degree of modulation produced by the reactance tube falls off with frequency sufficiently to produce constant deviation. A particular shaping of the plates of C_1 with relation to those of capacitor C is required.

In the circuit of Fig. 3, the attenuation of the phase-shifter is mechanically varied to produce constant-deviation operation. It is also possible to arrange constant-deviation sensitivity over a given frequency range by means of a particular phase-shifting network which inherently produces the required phase shift and has the proper attenuation characteristic. The requirements of such a network may be seen from the following analysis.

Equivalent Circuits

In the reactance-tube circuit of Fig. 4, the plate circuit of tube T appears as a reactance by virtue of, the reactive current it draws due to the phase-shifted voltage fed from the plate to the grid. The impedance looking into the plate circuit is given by

$$Z_e = E\,e^{j\omega t}/i_p \qquad (10)$$

If the input impedance of the phase-shifter is assumed to be negligibly high, the current i_p is

$$i_p = e_g G_m \qquad (11)$$

in which G_m is the transconductance of tube T. The grid voltage e_g is

$$e_g = BE\,e^{j(\omega t + \phi)} \qquad (12)$$

in which B is the attenuation of the phase-shifter, expressed as a fraction less than unity, and ϕ is the phase shift produced by the phase-shifter. Substituting Eq. 12 in Eq. 11, then substituting the resulting plate current in Eq. 10 gives

$$Z_e = E\,e^{j\omega t}/G_m BE\,e^{j(\omega t + \phi)} = e^{-j\phi}/BG_m \qquad (13)$$

$$Z_e = (\cos\phi - j\sin\phi)/BG_m = R_e + jX_e \qquad (14)$$

in which

$$R_e = \cos\phi/BG_m \qquad (15)$$

and

$$X_e = -\sin\phi/BG_m \qquad (16)$$

Thus the impedance looking into the plate circuit of the reactance tube is composed of a series combination of a resistance R_e and a reactance X_e. If ϕ is between zero and +180 degrees (leading) the equivalent reactance is negative and therefore represents a capacitance. Likewise, if ϕ is between zero and −180 degrees (lagging). the equivalent reactance is positive and represents an inductance. For the practical case in which ϕ is close to ±90 degrees, the resistive component may be neglected and the reactance becomes

$$|X_e| = 1/BG_m \qquad (17)$$

In the case of the inductive type of reactance tube, the equivalent inductance is

$$L_e = X_e/\omega = 1/\omega BG_m \qquad (18)$$

When the equivalent inductance of Eq. 18 is inserted in 3, the frequency is

$$f = f_r + f_r\omega LBG_m/2 = f_r + \pi LBG_m f_r^2 \qquad (19)$$

Thus, with a fixed phase-shifter attenuation B and tuning inductance L, frequency deviation is proportional to the square of the resonant frequency f_r. Hence, by using an inductive reactance tube with a phase-shifter attenuation inversely proportional to the square of the frequency, constant-deviation operation may be obtained with a fixed-inductance, variable-capacitance tuned circuit.

In the case of the capacitive reactance tube. the equivalent capacitance is

$$C_e = 1/\omega X_e = BG_m/\omega \qquad (20)$$

Inserting C_e from Eq. 20 in Eq. 5 gives

$$f = f_r - f_r BG_m/2\omega C = f_r - BG_m/4\pi C \qquad (21)$$

The deviation term $-BG_m/4\pi C$ in Eq. 21 shows that the deviation is independent of frequency if the phase-shifter attenuation B and the tuned circuit capacitance C are also independent of frequency. Hence, constant-deviation operation may be obtained by the use of a fixed-capacitance, variable-inductance tuned circuit and a capacitive-type reactance tube employing a phase-shifter having an attenuation independent of frequency.

Figures 5 and 6 show capacitance-tuned circuits and inductive-reactance tube arrangements which produce constant frequency deviation over a range of frequencies. The resulting phase-shifter attenuations have the general shape shown in Fig. 7. The attenuation is such that the phase-shifter output amplitude is inversely proportional to the square of the frequency over the tuning range ($B \propto 1/f_r^2$, assuming constant phase-shifter input). The normal attenuation produced by conventional two-element phase-shifters is an output amplitude inversely proportional to the first power of the frequency, $B \propto 1/f_r$. In Fig. 5, this inverse square-law characteristic is obtained by tuning L_1C_1 to frequency F_t in Fig. 7. Tuned circuit L_1C_1 operates on the capacitive side of resonance and therefore appears as a capacitance to produce an inductive-reactance tube.

In Fig. 6, the bridged-T network R_1R_2 and $C_1C_2C_3$ is tuned to locate its rejection frequency at the frequency F_t. This network is capable of constant-deviation operation over a frequency range of about two-to-

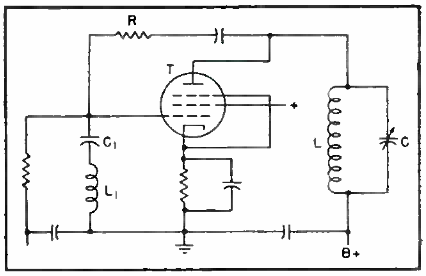


FIG. 5. Constant-deviation reactance-tube circuit. Phase shifter R, C_1, and L_1 produces an attenuation inversely proportional to the square of the frequency over the tuning range

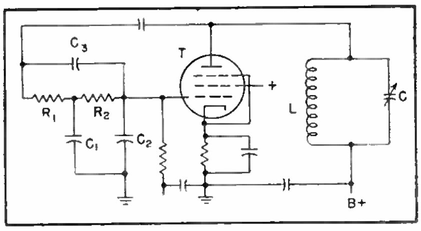


FIG. 6. In this constant-deviation network, the required inverse-square attenuation is obtained by the bridged-T phase-shifting network R_1, R_2, C_1, C_2, and C_3

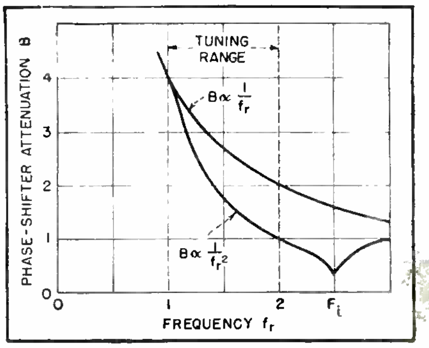


FIG. 7. Attenuation $B \propto 1/f_r$ produced by conventional two-element inductive reactance-tube phase shifter and attenuation $B \propto 1/f_r^2$ required by an inductive reactance tube for constant deviation of a capacitance-tuned circuit

one, while the network of Fig. 5 covers a range of about 1.5 to one. The exact magnitude depends upon the constancy of deviation required.

Over-All Design

A frequency coverage of two-to-one can be obtained by coupling an attenuator to the modulated oscillator. This system is not suitable for a wider frequency coverage since the phase-shifting network and the oscillator tank coil have to be switched. The network is rather critical and switching of this circuit at very high frequencies would probably lead to trouble.

A design which permits a four-to-one frequency coverage without switching oscillator and modulator circuits is obtained by following the oscillator with a class-C stage whose tank coil is switched to operate either as an amplifier or as a doubler. This design permits the oscillator and modulator to operate at half the frequency of the high output-frequency range. At lower frequencies, the effects of stray and residual reactances are not as troublesome as they would be at the higher frequencies. It also permits amplitude modulation of the output stage.

This design is not entirely satisfactory because some undesired amplitude modulation is produced during frequency modulation of the oscillator and the oscillator voltage is not sufficient to permit the class-C stage to remove this spurious amplitude modulation by limiting. A second objection is that amplitude modulation of the class C stage produces a considerable amount of spurious frequency modulation of the oscillator. Both of these objections can be removed by adding a second class-C stage.

The design which proved to be most satisfactory is shown in Fig. 8. The reactance-modulated oscillator operates from 27 to 54 megacycles. This is followed by a doubler stage and an output stage. The output stage operates either as an amplifier or as a second doubler (quadrupler), thus providing frequency coverage from 54 to 216 megacycles. This design provides the maximum of stability and simplicity since the oscillator and modulator operate at a relatively low frequency and the only r-f switching required is to switch a ground contact on the output coil.

The reactance tube uses a bridged-*T* type network similar to that of Fig. 6, in which C_2 and C_3 are replaced by the input capacitance and the grid-to-plate capacitance of the reactance tube. Capacitor C_1 is made variable and ganged with the tuning capacitor to provide the precision of deviation calibration required in a signal generator.

The slotted stator of C_1 is visible in the foreground of Fig. 9. By bending the sections of the stator, the deviation can be made as constant as desired over the entire frequency range. Resistor R_4 is bypassed for r-f only so that it causes degeneration at modulation frequencies and is used as a modulation sensitivity control. Resistor R_3 controls the cathode bias by bleeding current through the cathode resistor and is used to adjust the modulator tube to its most linear operating point. Total rms distortion of less than one percent at 75-kc deviation can be obtained with a modulating signal containing less than one-half percent distortion.

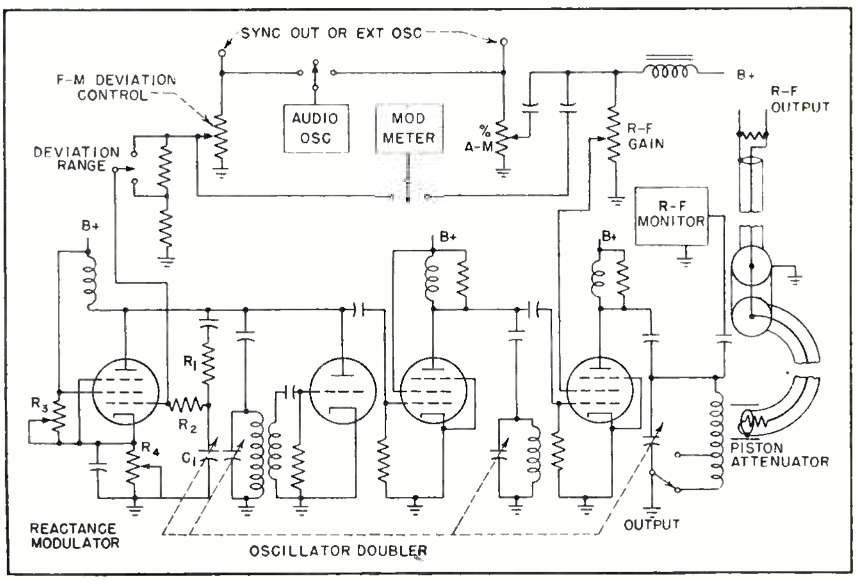


FIG. 8. Simplified diagram of the f-m signal generator

Doubler Tracks

A conventional self-biased class-C doubler is used. This stage tracks with the oscillator if the inductance of the tank coil is made one-fourth that of the oscillator tank and an identical capacitor section is employed. However, a higher tank circuit impedance can be obtained by decreasing the capacitance and correspondingly increasing the inductance. The requirements for tracking are that the shape of the capacitor plates be identical and that the ratio of maximum capacitor-and-circuit capacitance to total minimum-capacitance in the doubler circuit be the same as for the oscillator circuit.

Amplitude modulation is produced by modulating the screen circuit of the output stage. Since the power required is small and comparable with that required for frequency modulation, a simple resistance-tuned modulating oscillator serves for either amplitude or frequency modulation. Distortion is less than 3.5 percent for amplitude-modulation depths up to 50 percent. Due to the effective buffer action of the doubler stage, the spurious frequency modulation produced during amplitude modulation is small.

Frequency range switching is accomplished by providing the output tank coil with two contact points, one or the other of which is grounded by spring-contact fingers actuated by the frequency range switch. This method avoids most of the mechanical and electrical difficulties of coil switching.

In the output tank circuit, a high Q was desired to reduce the harmonically-related spurious output signals, while a low Q was desired to reduce the amplitude modulation

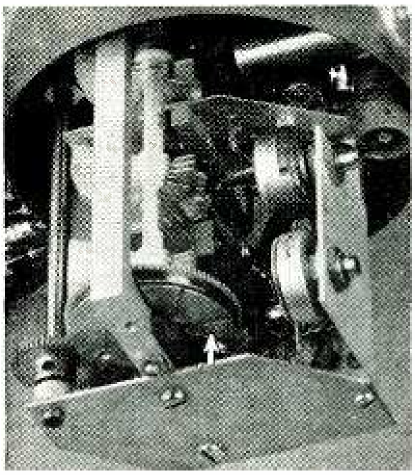


FIG. 9. Mechanical details of the r-f assembly. The arrow indicates the slotted stator of C_1

introduced on frequency-modulated signals by the selectivity of the circuit. In the final design, the damping was adjusted to reduce spurious signals to more than 35 decibels below the desired signal. The resulting amplitude modulation at 75-kc deviation is about two percent.

A mutual-inductance (piston) attenuator's is coupled to the tank-circuit inductor of the output stage. This is a simple and accurate attenuator for the vhf range since the rate of attenuation is dependent only on the inner diameter of the attenuator tube after sufficient attenuation has been introduced to suppress undesired modes of propogation of the electromagnetic field in the tube. The attenuator dial is calibrated from 0.1 microvolt to 0.2 volt; correction being made for a slight nonlinearity at the high-voltage end of the range.

Figure 10 shows the design of the output system. The voltage induced in the attenuator coupling loop L_2 in Fig. 10A is

$$e' = I\omega M = \frac{E}{\omega L_1}\,\omega k\sqrt{L_1L_2} = E\,k\sqrt{\frac{L_2}{L_1}} \quad (22)$$

where $\omega = 2\pi$ times the frequency and k is the coefficient of coupling between L_1 and L_2.

This equation shows that e' is a function of the tank voltage E and the coefficient of coupling k only. The attenuation law of the piston attenuator controls k. Voltage E is monitored by a voltmeter of the set-to-line type, the level being adjusted by a control in the screen circuit of the output tube. The output tank coil is physically flattened on the side facing the attenuator to present a more uniform field to the attenuator and permit larger values of k than are obtainable with a coil of circular cross-section. Although tank voltage E is smaller when doubling, the transformer ratio ($\sqrt{L_2/L_1}$ of Eq. 22) is larger and the allowable Q is greater. By placing the attenuator in proper relation to the tank coil, equal output is obtained on the two frequency ranges with very little change in the gain control setting.

A switch, ganged with the frequency range switch, actuates a precision voltage divider to halve the frequency-modulating voltage when the high-frequency range is being used since otherwise the deviation would be double that on the low-frequency range. A section of this unit switches calibrating resistors in the r-f monitoring voltmeter circuit.

Output

Standard 53-ohm RG58/U cable is used for the output cable. To keep the output impedance of the generator constant, a 53-ohm resistor is placed in series with the coupling loop and another is used to terminate the output cable. From Fig. 10B, the voltage e across the terminating resistor is then:

$$|e| = \left|\frac{53\,e'}{106 + j\,(\omega L_2)}\right| = \frac{53\,e'}{\sqrt{(106)^2 + (\omega L_2)^2}} \quad (23)$$

Since L_2 is less than 0.01 microhenry, $(\omega L_2)^2$ can be neglected in comparison with $(106)^2$ and $e = e'/2$.

Neglecting L_2 in Fig. 10B, an application of Thevenin's theorem yields the equivalent circuit of the signal generator, shown in Fig. 10C. Thus the generator can be represented as a source e in series with a resistance of 26.5 ohms. The attenuator is calibrated in terms of the open-circuit output voltage e.

If the load impedance is not large compared with 26.5 ohms, the voltage applied to a load attached to the output terminals can be calculated by using the equivalent circuit of Fig. 10C.

To provide frequencies below the range of the signal generator, a converter consisting of a fixed oscillator operating at 70 mc, a linear mixer, and an amplifier which has flat response from 100 kc to 25 mc has been constructed. When the signal generator is tuned from 70.1 to 95 mc, the difference frequency of 100 kc to 25 mc is obtained from the converter. With frequency modulation the useful low-frequency limit is obviously dependent on the deviation employed.

By adjusting the over-all conversion-amplification of the converter for unity gain, the output voltage can be read directly from the attenuator dial of the signal generator without requiring an additional monitoring system or attenuator. Provision is also made for an uncalibrated voltage with about ten times the amplitude of

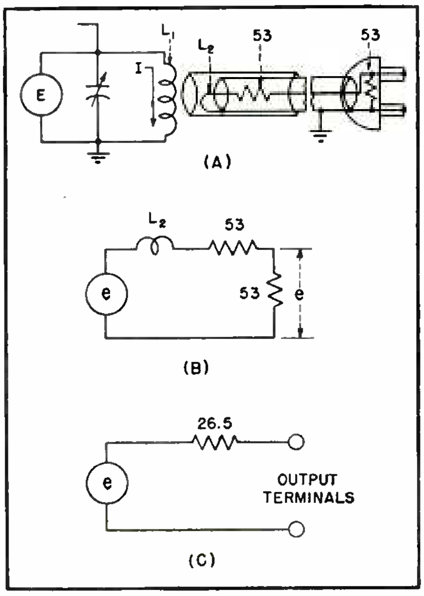


FIG. 10. Circuit (A) is the output system in which the D-shaped coil L_1 is used. The equivalent circuit of the attenuator is shown at (B) and the equivalent circuit of the signal generator at (C)

the input signal. The fixed oscillator is provided with a calibrated incremental trimmer capacitor for selectivity measurements.

The authors wish to acknowledge the considerable contribution of W. D. Loughlin to the success of the work reported in this paper.

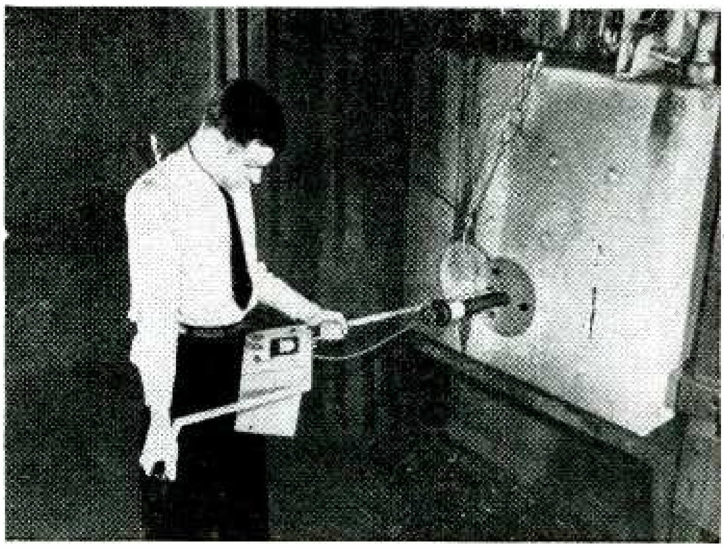
REFERENCES

(1) Barber, A. W., Franks, C. J. and Richardson, A. G., A Frequency-Modulation Signal Generator, ELECTRONICS, April 1941, p 36.
(2) Badessa, R. S., Mixer Frequency Charts, ELECTRONICS, August 1946, p 138.
(3) Hund, August, "Frequency Modulation", p 166, McGraw-Hill Book Co.
(4) Harnett, D. E. and Case, N. P., The Design and Testing of Multirange Receivers, *Proc. IRE*, 23, June 1935, p 578.

Flame Radiation

By EDWARD M. YARD

Staff Engineer
John A. Roebling's Sons Co.
Trenton, N. J.



Flame radiation measuring instrument in use. This same furnace is shown in natural color on cover of this issue

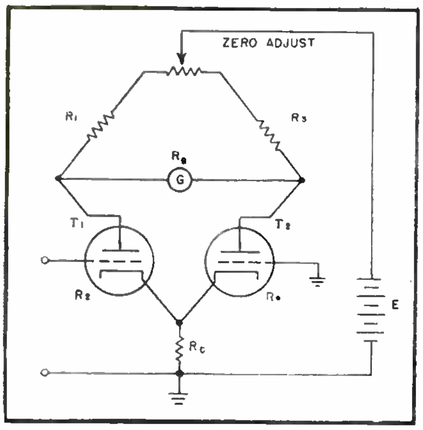


FIG. 1—Basic bridge-type vacuum-tube voltmeter circuit used with radiation pyrometer for flame radiation measurements

IN AN OPEN HEARTH steel furnace, transfer of heat from the flame to the charge depends largely upon radiation. This is especially true after the charge has melted, when it lies flat on the hearth and the flames sweep above it.

It is for this reason that measurements of flame radiation have for some time been made in steel mills. The basis of most practical measurements has been the radiation pyrometer, which develops an emf proportional to the total energy received. It consists of a group of tiny thermocouples upon which the radiant energy is focussed by a quartz lens or a mirror. The measuring equipment used ranges from sensitive voltmeters to electronic recording potentiometers. Good results can be obtained, but there are disadvantages in manipulation, portability, cost, or convenience.

Designing a voltmeter for this purpose is a problem when the small voltages to be measured and the factors of light weight and portability are given appropriate consideration in setting specifications.

It has been shown by investigators[1, 2] that furnace efficiency can be related to the total flame radiation, and that this is not necessarily dependent on flame temperature. One practical embodiment involved

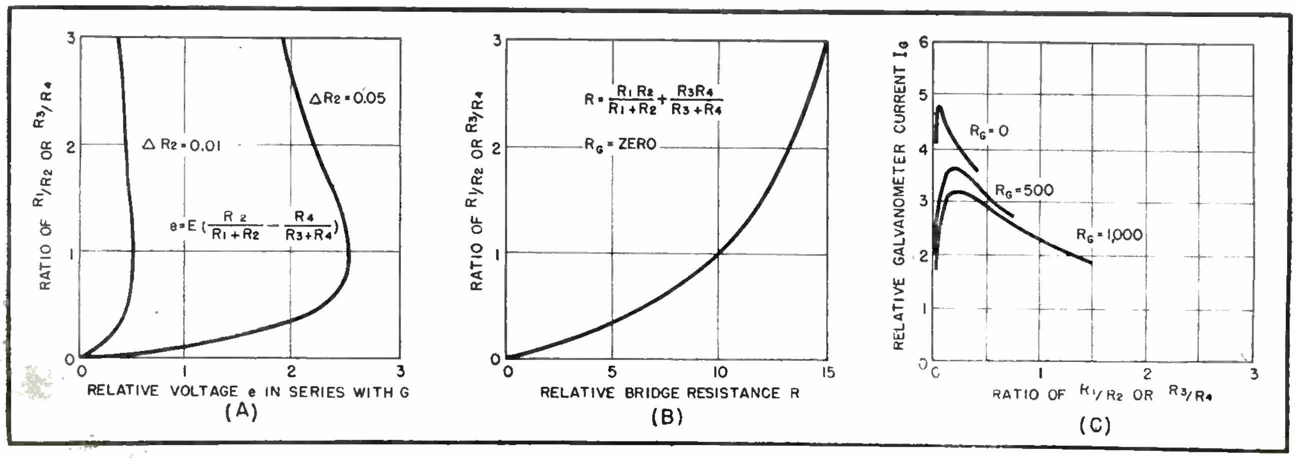


FIG. 2—Curves used in determining optimum values of circuit parameters for stable high-sensitivity vacuum-tube voltmeter

Measuring Instrument

Operating efficiency of open-hearth steel furnace can be checked quickly with highly stable bridge-type battery-operated vacuum-tube voltmeter connected to a radiation pyrometer that can be aimed at any desired portion of the 4,000-degree flame

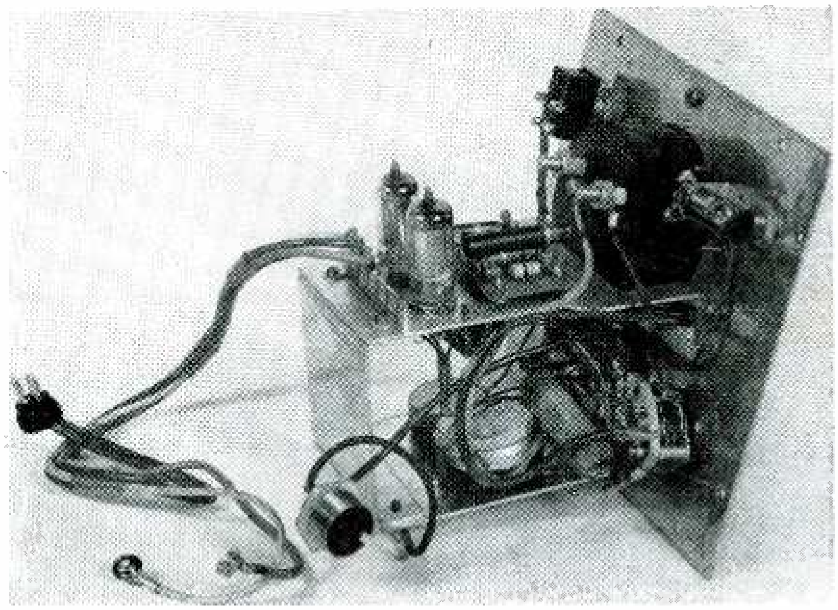
a recording potentiometer made portable by mounting it upon a wheelbarrow. By means of a hand-held scanning head containing a radiation pyrometer as a detector, flame radiation at each furnace door could be measured during the course of a heat. This equipment was effective but expensive, cumbersome, and inconvenient.

The portable battery-operated radiation-measuring instrument to be described was developed to overcome the drawbacks of earlier instruments in providing quick checks on firing conditions throughout a large shop.

Choice of Circuit

Because of the small permissible current drain in a radiation pyrometer it is not practical to use a microammeter directly as the indicating instrument. This suggested the use of a bridge-type vacuum-tube voltmeter.[3] The basic circuit chosen (Fig. 1) achieves the required stability by using vacuum tube T_2 as a fixed resistance in one leg of the bridge and by employing resistor R_G to provide degeneration.[4]

The design problem involved securing a sensitivity of the order of a galvanometer current of 50 microamperes for a grid input of 100 millivolts. This would give a deflection of at least half scale using a radiation pyrometer as a detector, when directed at flames of normal intensity in open hearth furnaces. To keep weight down, it was decided to limit supply voltages to 67½ volts and limit current drain to about 10 milliamperes.



Chassis of vacuum-tube voltmeter used to measure output voltage of radiation pyrometer. Battery and pyrometer connections are at left

A type 1S4 button-base tube having a 1.4-volt filament was found to be most suitable. When operated as a triode, it has a sufficiently low d-c plate resistance to compare favorably with the smaller power triodes for bridge use.

Design Procedure

To find an operating point that would be within the allowable battery drain, provide a low d-c tube resistance, be in a negative grid region, and utilize the available plate voltage to maximum advantage, design curves based on Thevenin's theorem were constructed. If the circuit of Fig. 1 is broken at point X, the voltage e at this point will be

$$e = E\left(\frac{R_2}{R_1 + R_2} - \frac{R_4}{R_3 + R_4}\right) \quad (1)$$

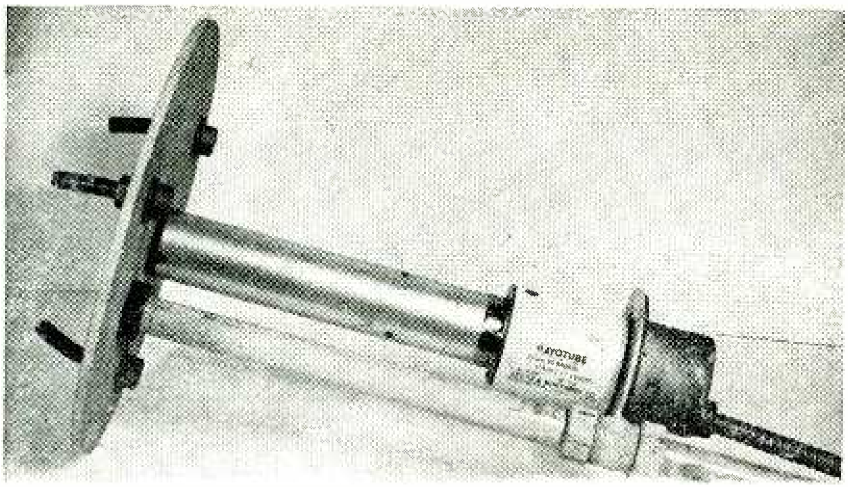
Plotting the bracketed term for two assumed increments of R_2 and various ratios of R_1/R_2 and R_3/R_4 gives the curves of Fig. 2A, which show that the greatest bridge voltage unbalance will be obtained when R_1 equals R_2 and R_3 equals R_4. The combined bridge resistance R in series with this potential then is

$$R = R_G + \frac{R_1 R_2}{R_1 + R_2} + \frac{R_3 R_4}{R_3 + R_4} \quad (2)$$

Relative bridge resistance R for zero galvanometer resistance R_G is plotted in Fig. 2B for various ratios of R_1/R_2 and R_3/R_4. The current through the galvanometer will be

$$I_G = e/R \quad (3)$$

For assumed increments of R_2 and



Radiation pyrometer (Leeds & Northrup Rayotube) used with bridge-type vacuum-tube voltmeter. Projecting lugs on heat shield at left engage wicket hole of furnace

R_4, relative values of I_G are plotted in Fig. 2C against ratios of R_1/R_2 and R_3/R_4 for several values of galvanometer resistance. These curves show that for usual galvanometer resistances the resistance ratios should be in the neighborhood of 0.2 to give maximum galvanometer current. This will allow the load resistors to be chosen.

Since a tube d-c plate resistance of a little over 10,000 ohms was expected at the operating point, a load of 2,250 ohms was assumed ($R_1 = R_3 = 2{,}250$) in order to make the resistance ratio equal to about 0.2. By trial, 1,000 ohms was found to be the largest value of R_C that could be used to approximate the desired operating point. Using these values in the circuit of Fig. 3 gave a sensitivity of 23.8 microamperes for an input signal of 50 millivolts, which is appreciably better than the minimum requirements.

The bias cell and voltage divider were provided so that at any time a known potential could be switched into the input to check calibration of the instrument.[5] A wire-wound zero-adjust potentiometer was used at first, but later replaced with a carbon control in order to get a stable adjustment for mobile use in the mill.

Operation of Instrument

To take a reading the instrument is placed at a furnace door so that lugs on the heat screen engage the wicket hole. This centers the radiation pyrometer in the aperture and assures an unobstructed view of the flame. Because of the rapid response of radiation pyrometers, a reading is obtained in a few seconds. The pyrometer can be aimed by means of the frame and sighted over quite an angle in the furnace.

The readings are left in arbitrary scale values since it is not intended to find furnace temperature, but to obtain comparative data on the radiating power of the flames. The readings can be converted, if desired, into millivolts pyrometer output. The results are affected by radiation from the furnace walls and the bath as well as by the flame, and this must be borne in mind when evaluating the readings. They are of comparative significance only in revealing efficiency of combustion.

It thus becomes possible with this type of instrument to obtain quickly a relative measure of furnace efficiency, free from errors of human judgment. By successively making changes in furnace control settings and taking readings of flame radiation, it is possible to find the best control settings and thus achieve higher average furnace efficiencies. One man can check five or six furnaces with the instrument in less than an hour.

The instrument is intended for use by combustion technicians to diagnose furnace troubles, and as a measuring tool to help them set up standard furnace adjustments.

This instrument was built in the electrical department of John A. Roebling's Sons Co. by regular personnel. The writer wishes to acknowledge the great assistance of Albert Buchanan, Special Electrician, in the construction of the unit. His clear understanding of the project contributed in large measure to the attainment of design expectations in a first model.

References

(1) Fisher, A. J., Relation of Flame Character to Open Hearth Operation, *Iron and Steel Engineer Year Book*, 1941.

(2) Fisher, A. J., Relation of Flame Character to Open Hearth Operation, *Iron and Steel Engineer Year Book*, 1943.

(3) Hoare, S. C., A New Thermionic Instrument, *Trans. American Institute of Electrical Engineers*, 46, p. 541, 1927.

(4) Williamson, C. W. and Nagy, J., Push-Pull Stabilized Triode Voltmeter, *Rev. Scientific Instruments*, p 270, September 1938.

(5) Thurston, J. N., An A-C Operated Vacuum Tube Voltmeter, ELECTRONICS, p 102, October 1943.

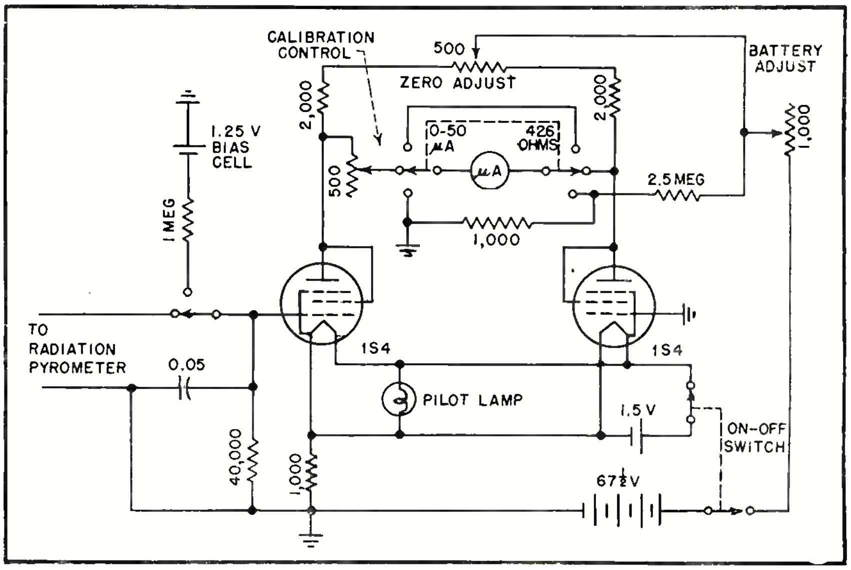


FIG. 3—Circuit of final instrument developed for flame radiation measurements

Logarithmic Photometer

> **USEFUL CIRCUITS**
>
> In describing a photometer of varied application the author presents several interesting electronic circuits, including a method for obtaining logarithmic response to light intensity from a phototube, a system for correcting nonlinearity by automatically introducing meter shunts, and an improved connection of gaseous regulator tube between power supply and load. These circuits can be used in a variety of ways on other instruments

Multiplier phototube and circuit used to obtain logarithmic response to light intensity are described. Instrument gives linear meter indication of film density for use as direct-reading densitometer, or of concentration for metering chemical concentration by monochromatic optical methods

By MONROE H. SWEET
Physics Laboratory
Ansco
Binghamton, N. Y.

It is desirable, in a large number of photometric problems, to use a logarithmically responsive instrument.

In photography, brightness levels of ordinary scenes vary over an enormous range and it is therefore convenient to provide an exposure meter whose response is approximately logarithmic.

In measuring absorption characteristics of photographic films, results are customarily expressed in terms of optical density. Density is the logarithm of the reciprocal of transmissivity. By using a logarithmic phototube amplifier system, a uniform density scale can be obtained. One commercial densitometer which utilizes the logarithmic grid current versus plate current relationship existing in thermionic triodes is the Ansco Model 11 Densitometer[1]. A photomultiplier tube instrument based on this circuit has been described in the literature[2].

In chemical analysis, where chemical concentration of a solution is to be studied as a function of optical transmission of that solution (best done at a single wavelength), a logarithmically responsive photometer is desirable. Such a photometer gives a uniform scale of concentration values.

A number of papers have recently been presented which deal with the application of multiplier phototubes to spectrochemical analysis and to other photometric problems.[3, 4, 5] In general the effort has been to obtain a stable system of linear response and this aim has been achieved to a considerable extent, although logarithmic circuits have a number of advantages in such applications.

An ideal electronic photometer may be defined as one having the following characteristics: (1) high sensitivity, (2) good stability, (3) direct reading operation, as distinct from manual or automatically actuated null balance type, (4) logarithmic electrical response over an intensity range of at least 1,000 to 1, electrical, as distinct from mechanical, because devices which rely on magnetic or mechanical compensating features to obtain uniformity of response cannot readily be used in recording or computing circuits, (5) simplicity, (6) compactness, (7) low cost, and (8) flexibility of design.

Principle of Operation

The simplified circuit shown in Fig. 1[6] provides the basis for an instrument which meets these requirements unusually well.

Theoretically, sensitivity of electron multiplier tubes depends on applied dynode voltage according to the relation

$$S \cong kV^{n/2} \qquad (1)$$

where S is sensitivity expressed in terms of anode current versus incident light (S is proportional to the electron current gain of the tube as a whole), V is dynode voltage per stage, n is number of stages, and k is a constant characteristic of the individual multiplier tube. From this relation it will be seen that if

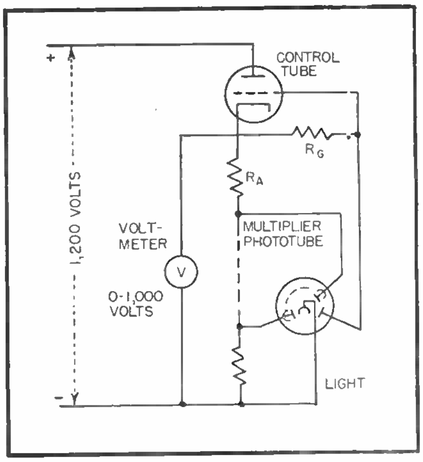


FIG. 1—Basic feedback circuit for producing logarithmic relation between light intensity and dynode voltage of multiplier phototube

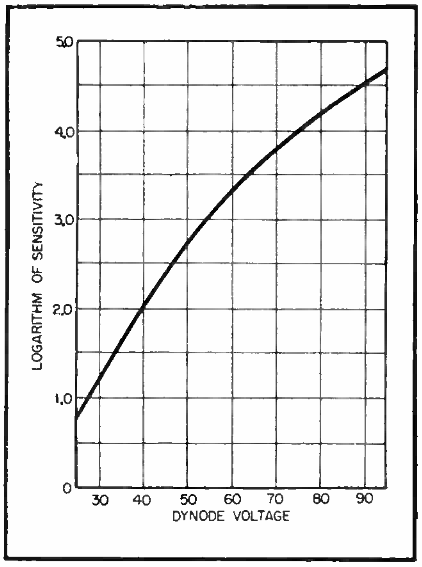
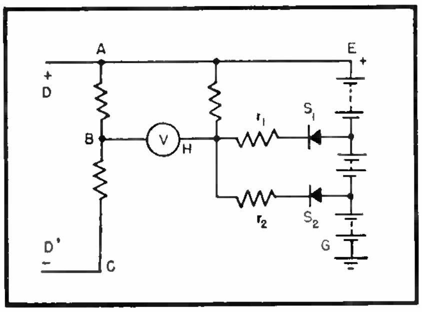


FIG. 2—(left) Were the transfer characteristic of the circuit of Fig. 1 ideally logarithmic, this response function would be a straight line

FIG. 3—(below) Automatic electrical introduction of meter shunts compensates for nonlinearity of phototube circuit response



the dynode voltage is adjusted so as to maintain constant anode current in the presence of variations in incident light intensity, the relationship between the logarithm of light intensity and voltage will be

$$\log F = -(n/2) \log V + k' \quad (2)$$

where F represents radiant flux incident on the photocathode, $k' = -\log k$ and F is proportional to 1/S.

The circuit shown automatically and instantaneously performs this constant current operation. As the light intensity falling on the photosurface is increased, the anode current tends to increase too. However, as the anode current increases, the grid of the control tube is driven to a more negative potential. Consequently the bleeder current is reduced, the dynode voltage is reduced in proportion, and the sensitivity of the tube as a whole decreases. In the limiting case, wherein the control tube has a high amplification factor (virtually infinite) the control grid voltage (and therefore the anode current through the grid resistor R_g) is sensibly constant. Under ideal conditions anode impedance of multiplier tubes is relatively high so that ordinary variations in the anode-dynode No. 9 voltage have small effect on the light intensity versus bleeder current relationship.

Voltmeter Response

When a voltmeter is connected across the total bleeder circuit it will respond nearly uniformly to changes in the logarithm of light intensity. Theoretically the slope of the log F versus voltage curve is

$$\frac{d(\log F)}{dV} = -\frac{[(n/2)\log e]}{V} \quad (3)$$

and $$\frac{d(\log S)}{dV} = \frac{[(n/2)\log e]}{V}$$

For practical multiplier tubes such as the 931-A or 1P21 the relationship for d (log S)/dV versus V indicated in Fig. 2 is representative and it will be observed that a range of 25 to 70 volts per stage corresponds to a sensitivity ratio of 1,000 to 1. It will be noted that the actual slope d (log F)/dV is reasonably uniform over this voltage range, more so than Eq. 3 indicates, and the slight nonlinearity of this function can be compensated by the corrective output circuit whose basic features are shown in Fig. 3.

If total dynode voltage is connected at DD′, selenium rectifiers S_1 and S_2 will be inoperative at voltage values of DD' which correspond to the condition wherein voltage AB is less than EF and EG. Under these circumstances resistors r_1 and r_2 are ineffective. At dynode voltages high enough to elevate AB above EF but lower than EG, S_1 will conduct current and resistor r_1 will act as a shunt resistance across the AB portion of resistor ABC. If the resistor network is designed properly, the rate of increase of voltage AB versus dynode voltage DD' can be modified to give the desired correction over a portion of the input range. By using two corrective shunts of this type it has been found possible to obtain a circuit which gives linearity accurate within ±0.02 log F over a log F range of 0 to 3.

High-Voltage Supply

From a consideration of feedback principles involved in the operation of this circuit it is obvious that even large changes in supply voltage will not affect the dynode voltage (provided that the supply voltage does not fall below the minimum value required for the equilibrium bleeder voltage). In fact, changes in characteristics of the control tube, such as those due to aging and replacement have negligible effect on calibration of the instrument. If the circuit is properly designed only sensitivity versus dynode voltage characteristic of the multiplier phototube influences calibration of the instrument.

Figure 4 is a detailed schematic diagram of the complete circuit. The power supply consists of a conventional power transformer whose high voltage secondary winding energizes two type 816 hot cathode, high voltage, gaseous rectifiers in a full-wave voltage doubler circuit. Necessary voltage isolation of the heaters is obtained by using the 5-volt winding plus a voltage dropping resistor as a source for one of the filaments and the 2.5-volt winding directly for the other. The 100,000-ohm bleeder resistor and double section 3-μf filter capacitors used as indicated, provide a d-c source of 1,200 volts with a ripple component of less than five percent. A relay in the rectifier circuit for the screen voltage supply closes the high voltage a-c circuit to the 816's only after all of the filaments are heated.

Control Tube

In order to utilize the full sensitivity of which the photo-multiplier tube is capable, it is necessary to operate it at low anode currents. Our experience has shown (and subsequent private communications with the tube manufacturers have confirmed) that:

(1) Optimum signal-to-noise

ratio for multiplier phototubes of present day construction occurs when they are operated at about 70 to 95 volts per stage. Higher voltages give rise to spurious gas discharge pulses and overall instability.

(2) Fatigue (gradual change in anode current for steady state voltage and constant incident flux) increases rapidly with anode current. We have observed that in some tubes anode currents in excess of two to ten microamperes are accompanied by pronounced fatigue. For this reason it is desirable to operate the tube at anode currents of about one-half to one microampere. Appreciably lower operating currents are undesirable because dark current and other extraneous currents then become a significant fraction of the signal current.

By using an 807 power pentode as shown, it is possible to operate the multiplier tube under conditions which give excellent stability and sensitivity. Because the total dynode voltage varies from approximately 300 to 900 volts, the 807 plate to cathode voltage will range from about 850 to 250 volts.

The 807 control tube meets the requirement for extremely low grid current, even in the presence of very high plate voltages. Tests conducted with several 807's at 1,000 volts plate to cathode voltage show that if the screen voltage is maintained at 40 volts the grid current is less than 0.01 μa over a plate current range of 0-8 ma. Under these conditions and with a 135,000-ohm load the voltage gain of the tube is quite high, about 150,

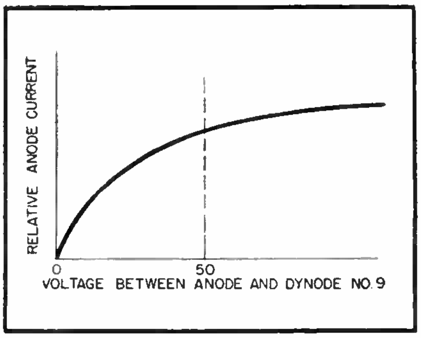


FIG. 5—Voltage versus current relationship of anode of multiplier phototube for constant dynode voltage and constant incident illumination

so that the control-grid to cathode voltage varies by only 4 volts over a light intensity range of 1,000 to 1.

In order to minimize effects on calibration of variations in gain characteristics of the 807 control tube and to take full advantage of the high impedance of the multiplier anode, the control grid bias voltage is fixed at a high positive potential with respect to cathode, 60 volts, and a grid resistor of correspondingly high value is used, 100 megohms. The anode-dynode No. 9 voltage is held at a virtually constant potential of 50 volts for all values of bleeder current by the NE32 neon discharge tube. This anode voltage value is recommended by the tube manufacturers for most satisfactory results. If the NE32 tube were replaced by an extension of the bleeder resistor, anode voltage would be nearly proportional to bleeder current and calibration of the instrument would be seriously affected by changes (due to warmup and aging) in mutual conductance of the 807. This change is because the multiplier anode impedance varies to

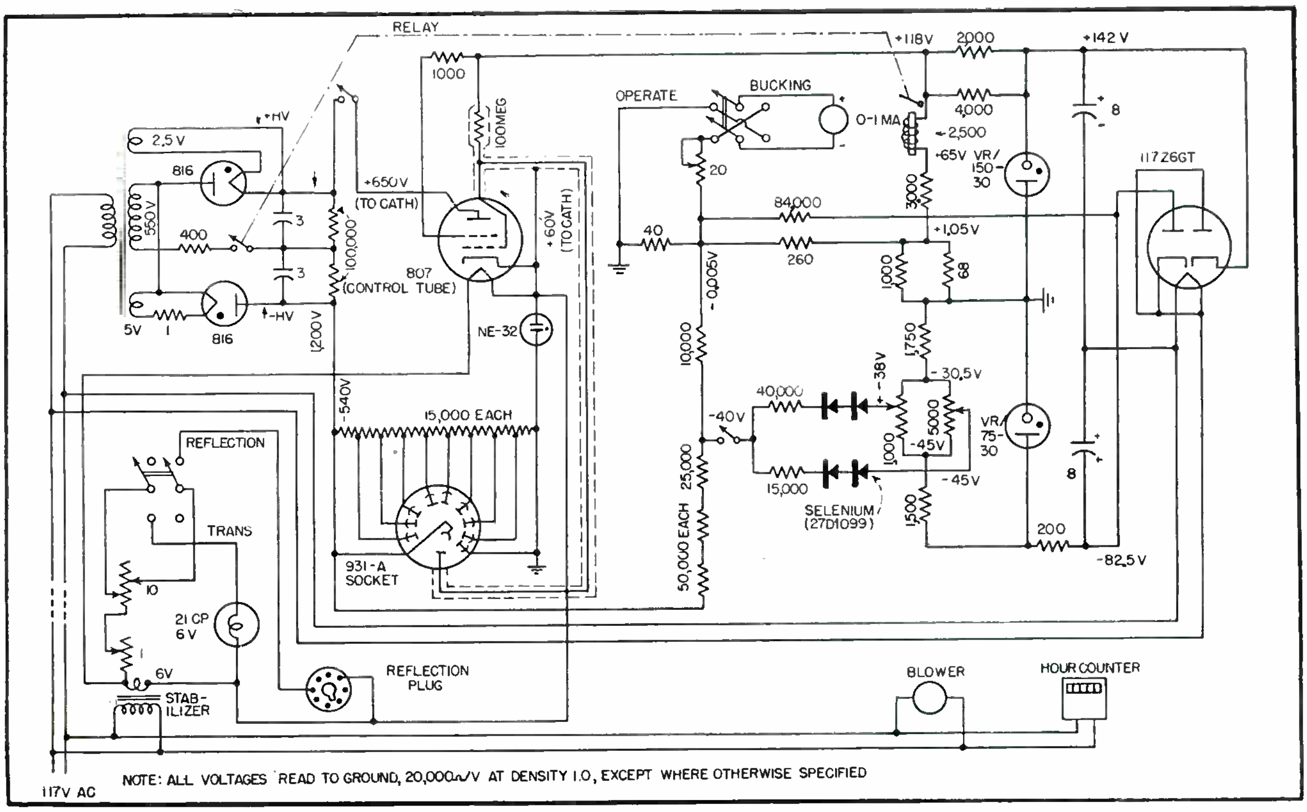


FIG. 4—Complete logarithmic multiplier phototube photometer circuit

some extent with voltage, particularly at low voltages, as is evident from the curve shown in Figure 5.

Regulated Low-Voltage Supply

A stabilized d-c supply isolated from the plate cathode circuit of the 807 is obviously necessary to provide the screen and control grid bias voltages and voltage for the compensating circuit. This additional supply was conveniently obtained by rectifying the 110-volt a-c power supply. By using a vacuum type rectifier and a relay in the bleeder circuit, automatic time delay was obtained for closing the 816 high voltage plate supply circuit. A VR150 gas stabilizer tube maintains (in combination with the NE32 tube) the constant screen and control grid supply voltages.

The output meter is a Weston model 273 0-1.0 milliammeter and is connected from ground (dynode No. 9) to the negative terminal of the power supply (cathode).

A bucking current for the output meter is derived from the positive portion of the screen voltage supply. The purpose of the bucking circuit, which gives a result equivalent to that of a suppressed zero meter, is to permit the entire scale of the meter to be used for only those dynode voltage values of interest. In the present circuit, zero meter current corresponds to about 30 volts per stage on the multiplier tube.

All commercial gaseous discharge VR tubes (type VR75, VR105, VR150 etc) exhibit a slightly positive voltage current coefficient (i.e. their terminal voltage rises with increasing tube current) and consequently they do not provide perfect stabilization as used in conventional bleeder circuits. In general, they improve the stabilization by a factor of about 10.

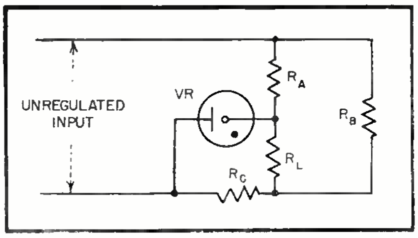


FIG. 6—Improved gaseous tube stabilizer circuit makes voltage across load resistance independent of input over a wide voltage range

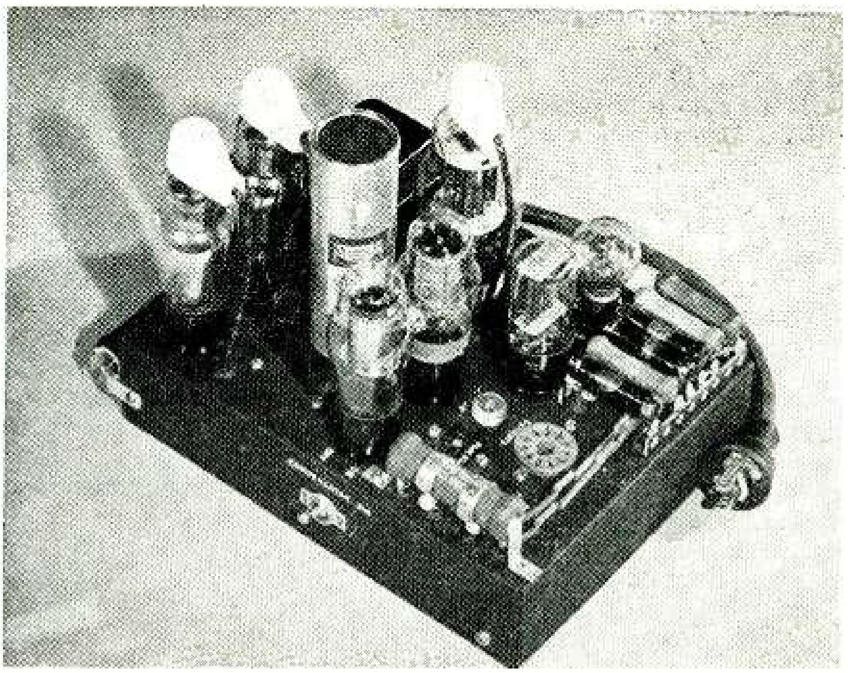


FIG. 7—Assembled power supply and control circuit of photometer

However, by using a circuit of the type illustrated in Fig. 6 the stability of load voltage may be further improved, in fact, even negative voltage-current characteristics can be obtained. In this circuit the voltage drop across the load resistor R_L will increase slightly with increasing supply voltage if R_B is infinite, due to the normal increase in voltage across the VR tube. By inserting R_B as indicated, the rate of increase in voltage drop across R_C with increasing supply voltage may be made sufficient to maintain the voltage drop across R_L at a constant value. It can be shown that if $R_E R_B = R_A R_C$ then the voltage across R_L will be independent of the supply voltage (R_E is the a-c resistance of the VR tube and is equal to the ratio of an incremental change in voltage across the VR tube to the resulting incremental change in current through the tube).

By suitable selection of the corresponding resistor values in the photometer, bucking current was compensated in such a way as to yield a minimum variation in output meter reading with changes in supply voltage.

For a range of illumination of 0.02 to 20 microlumens the corresponding 807 plate-cathode current varies from 6.6 to 2.2 ma respectively or approximately 100 to 35 volts per stage.

Figure 7 is a photograph of the power supply unit and Figure 8 shows the whole instrument, used in this case for color densitometry.

Calibration and Accuracy

The present circuit was first used to measure transmission and reflection color densities[7], and to obtain values in agreement with those derived from the use of a Schmidt and Haensch (S & H) visual polarization spectrophotometer. Therefore a number of practical specimens calibrated as to spectral density on the S & H instrument served as reference standards.

The output meter had been precalibrated to indicate density uniformly with respect to input current. As mentioned earlier, the uncompensated log F (or density) versus dynode voltage characteristic is not strictly uniform. However, it is sufficiently close so that, with the meter shunt properly adjusted, density readings from 0 to 0.8 are in satisfactory agreement with the reference densities without resort to compensation. By adjusting the S_1 rectifier voltage tap of Fig. 3 so that the rectifier passes current only at densities of 0.8 and higher, correction is effected at densities above 0.8. In this way the instrument response is satisfactorily corrected for densities up to approximately 1.5. Similarly, by adjustment of the voltage tap for rectifier S_2 additional correction can be obtained for densities above 1.5. By proper choice of both the two rectifier voltage taps and the supplementary shunt resistors r_1 and r_2 satisfactory accuracy was obtained over the whole range (0 to 3). The corrective action is smooth and instantaneous and thereby facilitates use of the circuit in conjunction with automatic recording instruments.

FIG. 8—Color densitometer employing the circuit described with text. Other applications are possible

Uniformity of response was checked by alternately inserting and shorting out a resistance in the lamp voltage supply circuit. This technique provided an accurately reproducible variation in light source intensity. When densities of different values (0 to 3) were interposed in the light beam, the difference in density readings produced by intermittently shorting the lamp series resistor was virtually identical over the entire scale of values. The light source modulation provided a constant percentage variation in flux and the interposition of density specimens altered the total flux level. Cumulative nonuniformity was determined by using sufficient intermittent lamp resistance to cause a log F difference of about 1.0 and incremental nonuniformity by using a low resistance which gave log F differences of only 0.05 or 0.10. If the ratio of lamp intensities for a given lamp resistor is accurately determined by any convenient method (such as the inverse square law, or by holding the dynode voltages temporarily constant and measuring the anode current values for the two conditions) the instrument can be calibrated independently, without reference to the S&H or other comparison values. The latter method of calibration may be regarded as a calibration of the slope of the log F versus current function and the former method a check on the linearity of this function.

The relationship between S&H densities and meter readings with and without compensation is shown in Figure 9.

A unique advantage of an instrument whose response is electrically uniform with respect to the log F versus current function is that it can be directly compensated for variations in light source intensity. Although the instrument described in the present paper utilizes a magnetic stabilizer in the lamp voltage circuit, this can be eliminated and the bucking current portion of the output meter circuit altered so that the proper decrease in bucking current accompanies each increase in lamp voltage. Because a given change in lamp intensity requires the same magnitude of change in bucking current to correct it regardless of the portion of the scale being used, by proper choice of circuit constants the effects of lamp intensity variations can be eliminated without resort to control of the lamp voltage.

The prototype instrument has been used for some time in the routine analysis of color products (transmission and reflection materials) and for high density measurements. The usual difficulties, well known to workers in high voltage were experienced during the early development of the instrument but it is believed that they have been eliminated in the present design. Multiplier phototubes show some individual variation with respect to stability, spectral sensitivity, and fatigue, some even exhibiting positive fatigue at one dynode voltage and negative fatigue at another, but tubes can be found which exhibit virtually zero fatigue (at the low anode current involved in this circuit) over the entire dynode voltage range of interest.

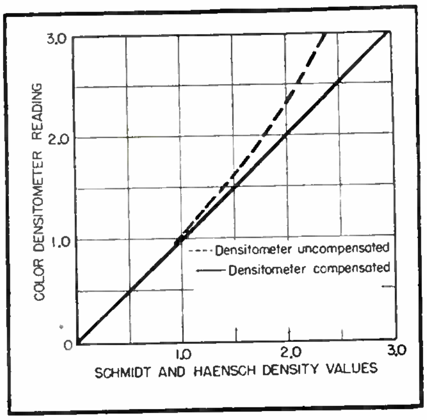


FIG. 9—Measured accuracy of color densitometer indicates improvement made by meter compensating circuit

The response of the circuit to changes in illumination is instantaneous. There is no tendency to oscillate, because of the high percentage of negative feedback, and no shunt capacitor is needed in the 807 grid circuit. The instrument is eminently suited for use in conjunction with spark recording instruments because of its insensitivity to intense high frequency radiation fields. The stability to changes in supply voltage is such that over a voltage range of 100 to 130 volts there is negligible variation in meter reading except at the highest bleeder currents (highest densities).

References

(1) *J.S.M.P.E.*, Feb. 1942, p 148.
(2) Sweet, M. H., Direct-Reading Color Densitometer, ELECTRONICS, March 1945, p 102.
(3) Boettner and Brewington, The Applications of Multiplier Phototubes to Quantitative Spectrochemical Analysis, *J.O.S.A.*, Jan. 1944, p 6.
(4) Dieke and Crosswhite, Direct Measurements of Spectrum Lines with Photomultiplier Tubes, *J.O.S.A.*, July 1945, p 471.
(5) Saenderson, Cadecourt, and Peterson, A Photoelectric Instrument for Direct Spectrochemical Analysis, *J.O.S.A.*, Nov. 1945, p 681.
(6) Patents on novel features of this circuit have been applied for.
(7) For a discussion of various types of optical density, see American Standard for Diffuse Transmission Density Z38.2.5—Appendix.

Continuously Variable
Radio Remote Control

Phase-shifting properties of a resonant circuit provide automatic self-adjustment of a radio control system. Guided missiles, aircraft, satellite transmitters, and telemetering systems can be radio controlled by the stepless positioning provided

By DAVID W. MOORE, JR.

Engineer in Charge
Fairchild Camera and Instrument Corp.
Jamaica, New York

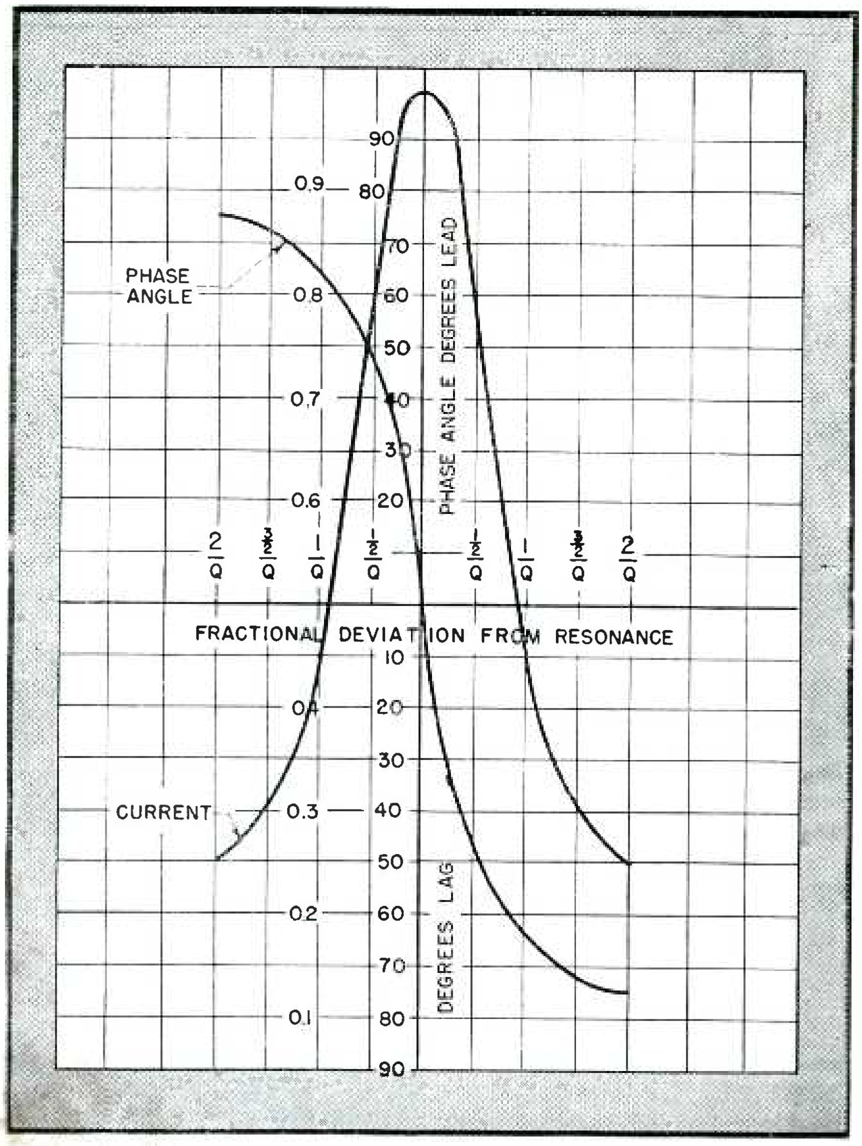


FIG. 1—Near resonance, the phase angle changes rapidly. Advantage of this characteristic is taken in design of the control system

THE HEART of any type of remotely operated device is the control method used. Its speed of response, accuracy, and ease of operation must all be satisfactory or the efficiency of the controlled object will be impaired. In some applications, such as guided missiles, the equipment for locating the missile with respect to the target may be more complicated than that for effecting control, but the control must be satisfactory to insure the success of the missile.

The basic problem of radio control may be stated as that of definitely positioning a rotating shaft by means of signals transmitted on a radio channel. Many methods have recently been developed for doing this on a step by step basis in which the controlled shaft positions itself in definite increments in response to the control signal. Some systems merely control the direction of rotation of the controlled shaft, the duration of the running determining the ultimate shaft position. In comparison to these control means, a smooth, stepless, and definite positioning device is usually preferable.

Resonant Circuit

The radio control system to be described is this latter type, and its operation is obtained from the phase-shifting properties of an electrical series resonant circuit that consists of an inductance and capacitance in series. The phase of the current flowing through a series resonant circuit is a function of the relation of the

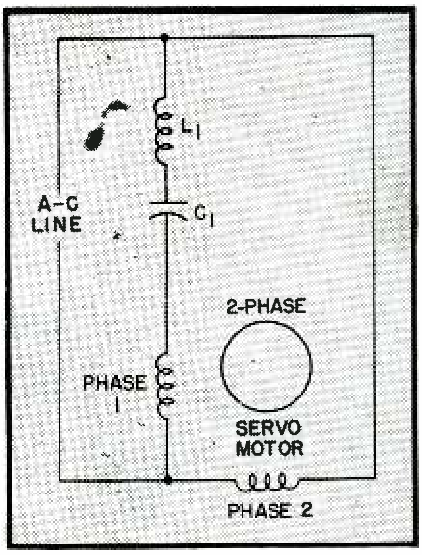


FIG. 2—The reasonant circuit formed by L_1 and C_1 controls the current flowing through the motor winding of phase 1

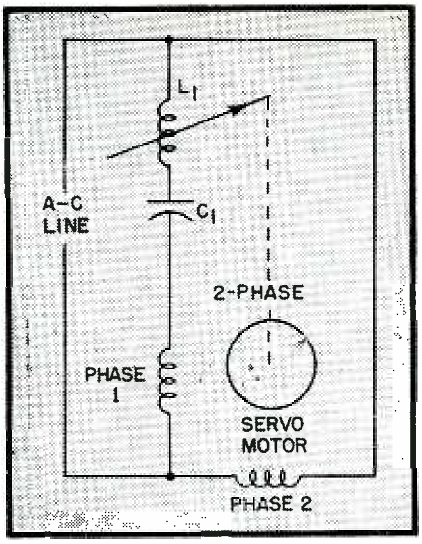


FIG. 3—Coupling the servo motor to L_1 provides automatic tuning of the motor circuit to the line frequency

resonant frequency of the circuit to the applied voltage frequency. If the resonant frequency of the circuit is the same as the line frequency, the current flowing will be in phase with the line voltage and the series resonant circuit is said to be tuned to resonance with the line.

If the line frequency is varied above or below the resonant frequency of the circuit, the phase of the current with respect to the line voltage will vary as a function of this frequency difference. Figure 1 illustrates graphically this phase-shifting property of the series resonant circuit.

The rate of change of the phase angle close to the point of resonance is particularly interesting and is the characteristic that makes possible a sensitive control system. The effective Q, or figure of merit, of the circuit elements used controls the slope near resonance, the higher the Q the greater the rate of change of phase angle. Values of Q of five to ten, which can easily be obtained with commercial inductors, will enable a very sensitive control.

Use of Servo Motor

Figure 2 shows how a circuit of this type may be used in conjunction with a phase-sensitive servo to control the speed and direction of rotation of a shaft. The phase-sensitive servo used is a conventional two-phase motor which is sensitive to small, phase angle shifts. The resonant circuit consisting of C_1 and L_1 is in series with phase 1 of the motor and so controls the phase of the current flowing through that motor winding. Phase 2 is connected directly across the line and, because it is wound to be essentially resistive, the current flowing through it is approximately in phase regardless of the line frequency.

The torque output of a two-phase motor is proportional to the product of the current in phase 1 and phase 2 and the sine of the phase angle between the two currents. Figure 1 shows that the phase of the current through phase 1 can be varied by changing the line frequency. By adjusting this frequency above and below the resonant point of L_1 and C_1, the current through phase 1 can be made to either lead or lag the current through phase 2, thus causing the servo motor to develop torque in either direction.

If the line frequency is equal to the resonant frequency of the tuned circuit, the current in phase 1 will be in phase with the line voltage and also in phase with the current through motor winding 2. This condition will result in zero torque, or a condition of equilibrium.

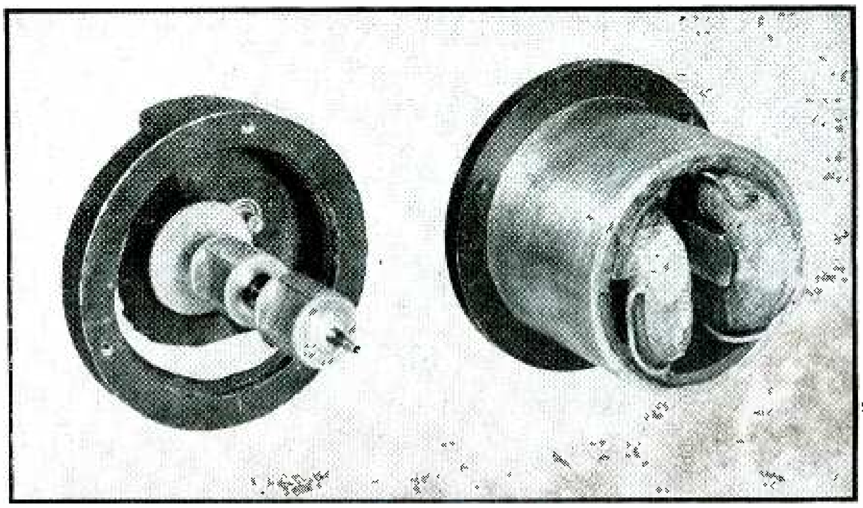
Because the line frequency can be transmitted by radio, we have a means for remotely controlling the operation of a servo motor. Thyratron tubes can be employed as phase-sensitive servos instead of a two-phase motor, to control large motors by a small amplifier.

Motor Controls Inductance

For most control applications, a control which definitely positions the controlled shaft is desired rather than one which only governs the rotation of a servo motor. Figure 3 shows how the servo motor of Fig. 2 can be coupled mechanically to a variable L_1. If the motor is phased correctly, it will automatically tune the circuit L_1 and C_1 to resonance with the applied voltage by varying the value of L_1. The position of the shaft which controls the value of L_1 is a function of the value of L_1 and therefore of the line frequency, because L_1 is automatically adjusted to keep circuits tuned to line frequency.

In appearance, the variable inductance resembles a motor. Figure 4 shows the construction of a double variable inductance unit. There are no windings on the rotor, and conse-

FIG. 4—Construction of a double variable inductance. A single unit, such as L_1 of Fig. 3, would have one rotor



quently no brushes or slip rings to wear and deteriorate. The inductance variation is linear for a little more than sixty degrees rotation of the shaft.

Figure 5 shows an inductance transmitter on the right, and a position receiver consisting of an inductance and two-phase servo motor and the necessary gearing between the two. The gear sector couples the inductance shaft which is positioned by the line frequency to the load to be controlled.

Values of Circuit

A range of line frequency is necessary to position the shaft of L_1 throughout its range of some sixty degrees. The magnitude of this frequency band is determined by the inductance value and that of the tuning capacitor. Typical calibrations are shown in Fig. 6 and 7.

Referring to Fig. 6, control throughout sixty degrees of inductance shaft rotation requires a frequency band of from 50 to 80 cycles. In this example the inductance value is 20.5 henrys and the tuning capacitor 0.283 μf. The inductance of the motor winding in series with the resonant circuit is 5.65 henrys.

The control whose calibration is shown in Fig. 7 was adjusted for a different frequency band, seventy degrees of motion being controlled by a frequency variation from 135 to 198 cycles. The value of inductance is 28.2 henrys and the tuning capacitor is 0.033 μf.

Both of these controls could be transmitted on one carrier requiring an audio band of from 50 to 198 cycles. More controls at higher frequency bands could be added. For a large number of controls on one carrier, though, a subcarrier frequency system should be employed which would enable a practically unlimited number of controls especially if microwave transmission is employed. The carrier with the numerous subcarriers could be beamed to the controlled unit along with any other necessary intelligence.

Torque-error Data

The relationship between the torque generated by this system of radio control and the error between the control resonant frequency and the frequency of the voltage applied to the control is shown by the graph of Fig. 8. The solid lines illustrate the motor torque for different applied frequencies for three settings of the control. The graph covers a band of 50 to 75 cycles with the control set at 52, 60, and 73 cycles. These control setting frequencies are the frequencies to which L_1 and C_1 are set. Zero torque is not usually obtained when these frequencies are impressed upon the control due to slight phase shifts in phase 2 with changes in frequency.

The dotted lines show the motor torque for various constant displacements between the control setting and applied frequency throughout the bands. For example, it may be seen that for a one-percent deviation, substantially 0.025 inch ounce can be obtained at any place in the band. Five-percent deviation increases this torque to 0.13 inch ounce.

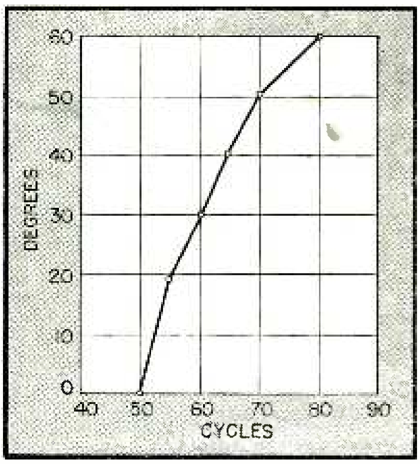
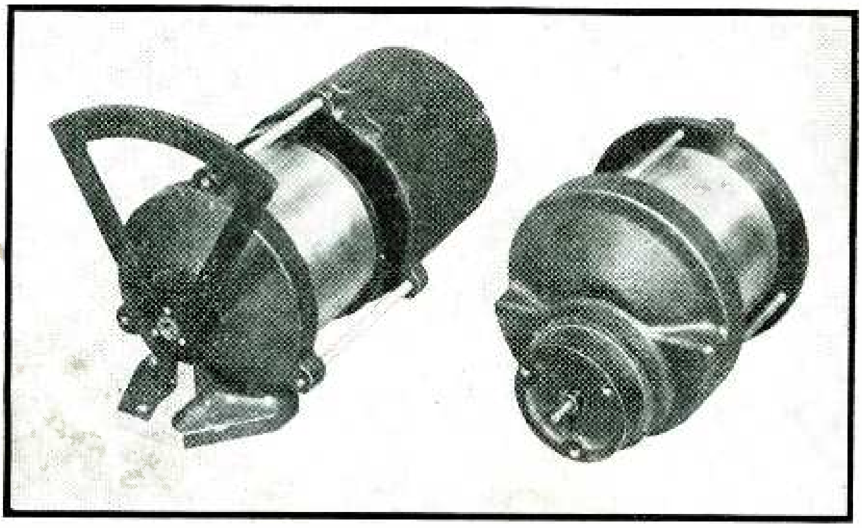


FIG. 6—Operation in the frequency range from 50 to 80 cycles provides 60 degrees of rotation of the inductance shaft

From these charts the operation of a system of this type can be easily predicted. These figures are typical only of the control constructed and more or less torque could be obtained by suitable design. The torque output shown is that obtained at the motor shaft and gearing to bring this up to the required amount must be employed.

The tuned circuits of this radio control method are natural filters and help to minimize any effects due to harmonic content of the applied frequency. However it is best to keep the harmonic content low. If trouble were experienced from this source, additional harmonic filters could easily be included. Phase shifts in the filters would not affect the operation.

FIG. 5—At left, a two-phase motor and a variable inductance are combined in one unit. A separate variable inductance unit is shown at right



Complete System

Figure 9 is a schematic of a complete single-channel control system which has been designed to permit very close tracking between the position of the transmitting inductance shaft and the position of the controlled inductance shaft. The transmitting inductance is electrically identical to the controlled inductance and, the tuning capacitors are also equal; thus $L_1 = L_2$ and $C_1 = C_2$.

The radio position transmitter is designed to operate in conjunction with a standard type of audio-frequency oscillator and adjusts the tuning control of the oscillator until its output frequency is equal to the resonant frequency of the circuit L_1C_1. The resonant frequency of this circuit is adjusted to the desired value

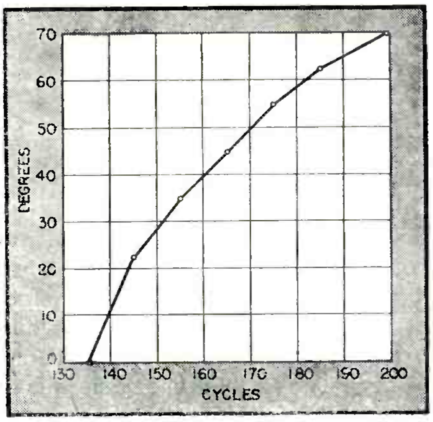


FIG. 7—Seventy degrees of rotary motion were obtained by using frequencies between 135 and 198 cycles

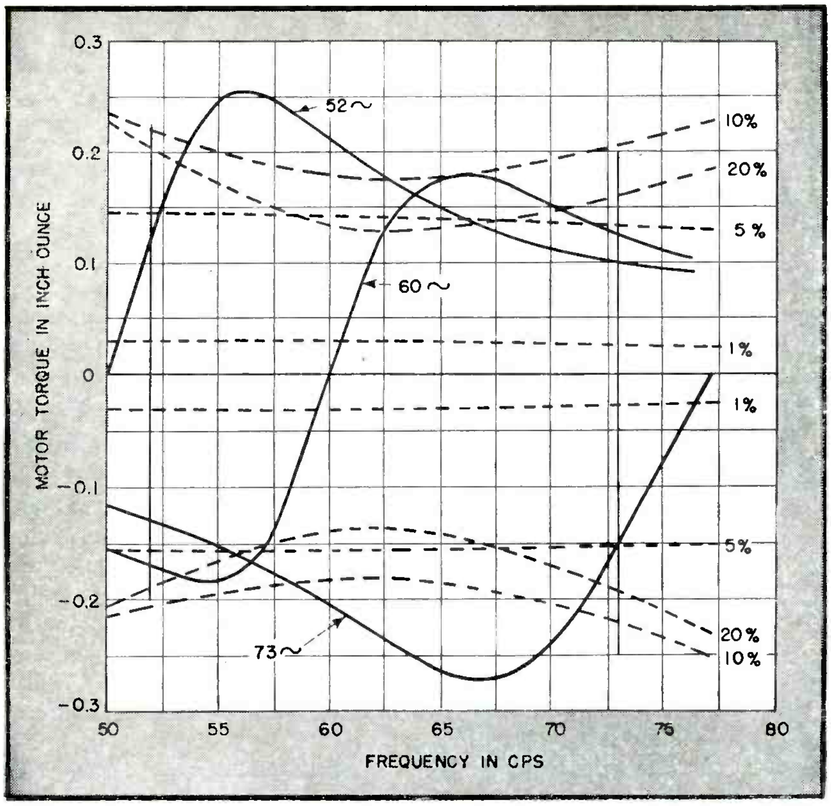


FIG. 8—Torque response curves of the control when set for resonance at frequencies of 52, 60, and 73 cycles. The solid lines indicate the resonant frequency constant; the dashed lines show the constant deviation in percent

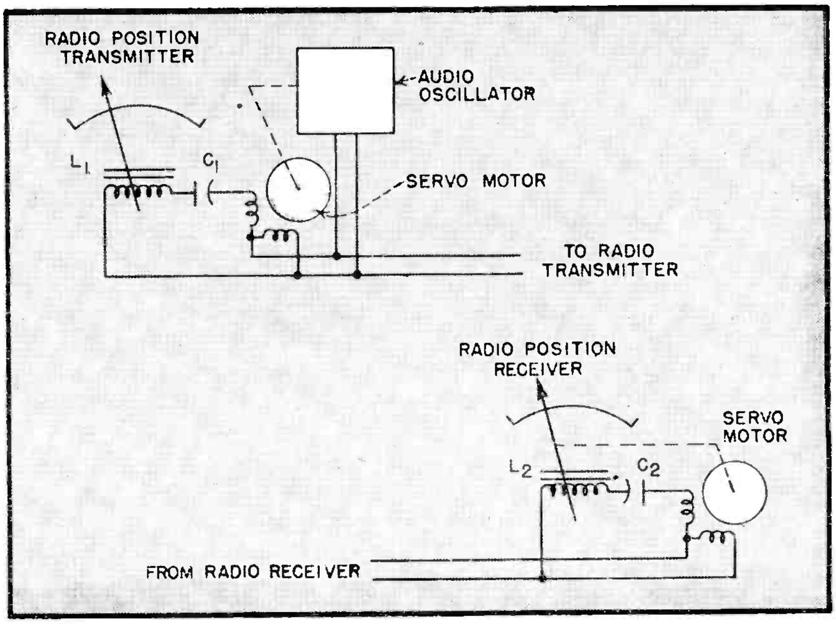


FIG. 9—Essential units of the receiver and transmitter of the radio control system

by setting L_1, manually or otherwise. The oscillator frequency is then transmitted by radio to the radio position receiver.

The radio position receiver tunes itself to the oscillator frequency, and, because the tuned circuit constants are identical elements, L_2 is driven by the servo motor to a position corresponding to the position of L_1, effecting the desired control.

The detailed operation is as follows: First, L_1 is adjusted, setting the resonant circuit L_1C_1 to a definite resonant frequency. The audio oscillator output is impressed across the radio position transmitter circuit which is like that shown in Fig. 3, except that the servo motor adjusts the audio oscillator frequency instead of the inductance L_1. Thus the servo motor tunes the oscillator to the resonant frequency of L_1C_1 instead of adjusting L_1 to tune L_1C_1 to the oscillator frequency.

The radio position receiver is identical to Fig. 3, the servo motor adjusting L_2 to tune L_2C_2 to the oscillator frequency which has been transmitted by radio. The control shafts of inductances L_1 and L_2 are thereby synchronized.

The purpose of this circuit is twofold. It permits a linear response between the transmitting and controlled shafts which makes for ease of control in many applications. It also automatically compensates for frequency drift in the audio oscillator due to temperature or supply voltage changes because the servo motor will retune the oscillator should frequency variation occur.

If a subcarrier system were employed, the desired number of controls would be set up and each oscillator output would modulate a subcarrier. The subcarriers would be transmitted by a high-frequency carrier to the controlled device. The frequency of the carrier would be determined by the number of subcarriers desired.

Small, two-phase, servo motors operating in the type of circuits shown will develop adequate power to set the controls of an automatic pilot in any aircraft to be remotely guided. More power, to adjust the aircraft control surfaces directly, could be easily obtained by having the two-phase, servo motor operate a hydraulic pilot valve or through the use of thyratron tubes. Other interesting variations can be worked out.

NOISE and

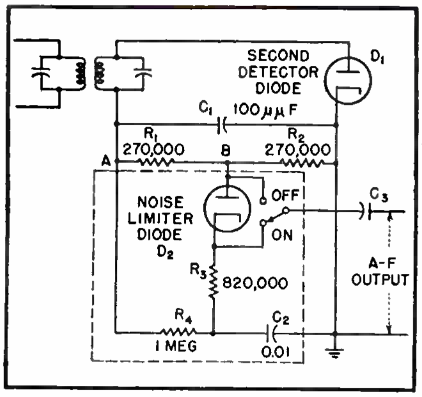


FIG. 1—Simple series limiter, requiring only the four additional components inside the dash-dash rectangle

By EMERICK TOTH

Associate Head, Receiver Section
Ship-Shore Radio Division
U. S. Naval Research Laboratory
Washington, D. C.

LIMITERS, as the name implies, are restrictive devices. The limiter circuits discussed in this report are curative means designed to mitigate the effects of undesired electrical disturbances of an impulse nature, such as static, ignition noise, and radar signals, on the output of radio receivers designed particularly for amplitude-modulated communications use.

Preventive means operating directly in the antenna circuit have not as yet been developed with any considerable degree of success. The circuits described below center at or near the final detector in a receiver, and the best of them, when properly designed and operated, can provide very considerable assistance in reception through many forms of noise.

Limiters are divided into three groups: (1) instantaneous noise-peak limiters, whose primary usefulness is in modulated-wave (mcw) reception such as speech and music; (2) output limiters, useful mainly for continuous-wave (c-w) reception, such as telegraph signals; (3) circuits not falling directly into the first two groups.

Instantaneous Noise-Peak Limiters

Limiters of this general group are actually operative only when the instantaneous value of the carrier exceeds some reference level, which may be a d-c bias voltage controlled from the front panel of the receiver or, better, the average value of the rectified carrier itself as it appears across the final detector load.

Essentially, an instantaneous noise-peak limiter usually involves two circuits, one having a time-constant corresponding to the usual detector load circuit, and the other having a much longer time-constant. The time-constant differential of these two circuits is responsible in large part for the successful operation of the limiter.

Most of the instantaneous limiters to be described are half-wave devices and operate on the modulation envelope resulting from rectification of the positive half-cycles of r-f input to the detector. The usual form of half-wave diode detector does not respond substantially to the negative half-cycles of signal, and therefore suppresses also the negative half-cycle of r-f noise peak where it exceeds the equivalent of 100 percent modulation of the desired carrier. Full-wave limiters generally do not provide a substantial improvement when applied to such detector circuits on mcw operation, unless considerable clipping of the desired modulation is tolerable.

Series Noise-Peak Limiters

The most useful and successful of the instantaneous group are series noise-peak limiters. In contrast to others of this group, which have not been very effective on the longer wave-trains resulting from impulse excitation in receivers operating below about 10 mc, series-type limiters have been highly effective in receivers covering the signal range from 15 kc to over 400 mc. They also satisfy one general requirement for limiters intended for mcw use by not causing a degree of distortion which would affect the intelligibility of voice signals or seriously impair the quality of music, when the usual average values of carrier modulation are employed at the transmitters.

In addition, series limiters require very few components over those normally found in the usual half-wave diode detector, and are easily adaptable to automatic threshold biasing by the rectified voltage of such a detector. These limiters have also been found useful for c-w reception if care is taken to provide the proper value of beating or heterodyne voltage at the final detector.

> The second and final part of this paper will take up six basic versions of r-f and a-f output limiters, an f-m discriminator for a-m limiting and a number of special types of limiters, then give characteristics of crystal and thermionic diodes for limiting and make recommendations of the best limiter choices for mcw operation and for c-w operation.

Simple Series Limiter

Figure 1 shows the simplest form of series limiter, widely used in Navy shipboard receivers. It requires only one fixed capacitor, two fixed resistors, and an independent diode in addition to the normal components of a diode second detector. No front-panel control of threshold for varying carrier levels is required, threshold bias being automatic in the sense that it is directly derived from the rectified carrier. Its operation can be briefly described as follows:

Assume a rectified d-c potential of 10 volts developed across R_1 and R_2 in Fig. 1 by a constant carrier. The cathode of the limiter diode is then initially at about −10 volts with respect to ground because of its connection to point *A* through R_3 and R_4, while the limiter plate is at about −5 volts to ground. The plate is thus momentarily 5 volts positive with respect to the cathode and the limiter diode becomes conductive, its resistance being fairly

OUTPUT LIMITERS
Part I

Comprehensive two-part survey of instantaneous noise-peak and output limiters for a-m communications receivers. Eleven noise limiter circuits are presented in this part with representative values of components, analysis of operation, and conclusions as to usefulness

low compared to the other resistance values in the circuit. Output capacitor C_3 is thereby connected through the conductive diode to junction B, so that a constant modulated r-f carrier input provides a-f output. This output is about 45 percent of what it could be without the limiter, but generally this reduction is of little significance since it usually affects only the reserve gain and not the sensitivity of the receiver.

Under the above conditions, capacitor C_2 is charged through

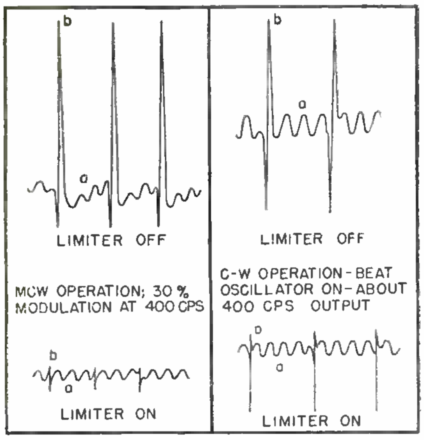


FIG. 2—Oscilloscope tracings of audio output of receiver, illustrating noise suppression of simple series limiter. Signal input to receiver is 80 microvolts, and avc is off

1-megohm resistor R_4 to a potential of about −7 volts. Any appreciable change in this potential would require about 0.01 second, due to the time-constant of R_4C_2. The time-constant of $(R_1 + R_2)C_1$ is, however, only about 50 microseconds, so that the potential at the limiter diode plate can change in about 1/200th of the time required for its cathode to assume a new potential. Therefore, if a noise potential of perhaps 100 volts suddenly appears across $R_1 + R_2$ and brings the plate of the limiter diode to −50 volts from ground potential, the diode plate becomes about 43 volts more negative than its cathode and the diode stops conducting. This in effect disconnects output capacitor C_3 from point B, and the a-f amplifier has no appreciable input for the duration of the noise modulation. By the time that the cathode of the limiter diode has assumed an effectively more negative potential, the noise pulse will usually have decayed and the limiter diode will have become conductive again, restoring the a-f input to the audio amplifier.

With this limiter, appreciable distortion can be seen on an oscilloscope only above approximately 40 percent modulation. In listening tests involving both speech and music, most personnel have found it extremely difficult to detect distortion by ear on transmission maintaining an average modulation level of between 30 and 40 percent, a condition commonly encountered. With the circuit constants shown in Fig. 1, the time-constant of recovery from surge input is very satisfactory, an item of importance, especially in shipboard receivers.

It should be noted that the modulation threshold value given above applies to distortion of only that half of the audio envelope appearing across the detector load which corresponds to increasing rectified current, the other half-cycle being unaffected with a half-wave limiter. This is likewise true of most of the limiters described below.

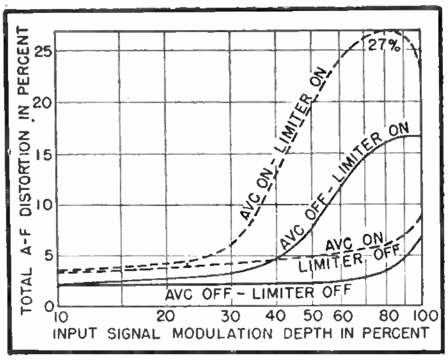


FIG. 3—Modulation distortion curves as measured at output of typical communications receiver using simple series limiter. The avc-off curves are substantially the same as for weak-signal avc-on operation. Signal input frequency is 4,000 kc, a-f output frequency is 1,000 cycles, and signal input level is 1,000 microvolts

Oscilloscope tracings illustrating the operation of the simple series limiter on both mcw and c-w signals in a typical receiver appear in Fig. 2. On c-w, the beat oscillator acts to produce operation of the limiter similar to that with a very low percentage of desired signal modulation at the detector.

Modulation distortion under various conditions of mcw operation is indicated by the curves in Fig. 3. The change in threshold of limiter action between weak and strong signals is particularly evident.

Operation of the series limiter on c-w reception may be improved by the incorporation of some additional degree of r-f limiting in the i-f (or r-f) amplifier immediately preceding the final detector. This can take the form of an added grid leak and capacitor between the control grid and the i-f transformer of this amplifier stage. The resultant better i-f limiting will allow the use of a lower beat oscillator injection voltage to the detector without abrogating resonant overload performance, a condition favoring good operation of the limiter following the detector.

Series-Type Noise Limiter With Threshold Adjustment

With a potentiometer substituted for fixed resistor R_1 in the circuit of Fig. 1, the limiter threshold can be varied from about 65 percent modulation down to substantially zero percent (on half the modulation cycle). This control varies the d-c bias due to the rectified carrier at the cathode of the limiter diode, which bias determines the limiting threshold.

The modified circuit, shown in Fig. 4, may also include an additional diode. This is shunted across resistor R_3 to buck the internal (thermionic) potential of the limiter diode, as this residual voltage reduces the effectiveness of the limiter at low carrier levels by raising the limiting threshold in terms of modulation percentage. The voltage built up across R_3 due

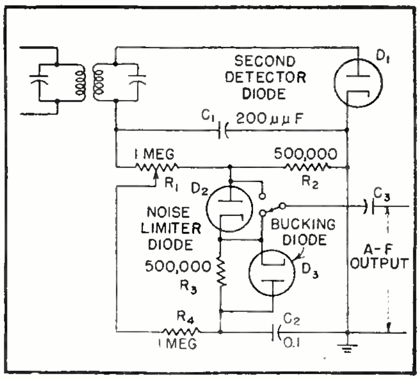


FIG. 4—Series-type noise limiter with threshold adjustment so that limiter operation can be set to start anywhere in range from 0 to 65 percent modulation

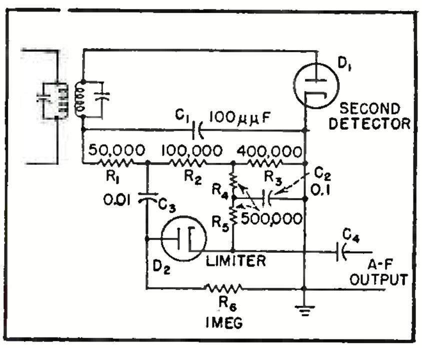


FIG. 5—Low-loss series limiter, requiring three more components than the simplest version in Fig. 1

to rectified direct current from the detector will, together with the time-constant of C_3 and the grid resistor in the first a-f stage, tend to maintain this additional diode biased to cutoff, except on weak signals. The price paid for this improvement in weak-signal limiting, however, is generally a considerable increase in audio distortion at all useful levels. Making the time-constant of C_3 and the audio amplifier grid leak equal to that of R_4C_2 will assist in keeping this increase in distortion to a minimum.

Low-Loss Series-Type Noise Limiter

The reversal of cathode and plate connections of the limiter diode in the variation of the series-type limiter shown in Fig. 5 necessitates the use of two more resistors and a capacitor (over those required by the simplest form) to provide the required biasing and *RC* delay circuits for the diode elements. It has, however, the advantage of providing the a-f amplifier with a higher percentage of the a-f voltage appearing across the detector diode load, as contrasted with the circuit of Fig. 1. For a comparable degree of modulation distortion, this improved transfer of a-f voltage will amount to about 2 or 3 db, which is usually not of great importance unless the receiver is deficient in reserve gain.

The cathode of limiter diode D_2 is biased negative relative to its plate by connection to the junction of detector-load resistors R_2 and R_3 through resistors R_4 and R_5. R_4C_2 provides a long time-constant circuit similar to R_4C_2 in Fig. 1 while R_6 serves as the cathode load resistor across which the limiter output voltage is developed in a manner similar to R_3 in Fig. 1. Capacitor C_3 provides a-f coupling to the plate of D_2 for the detector audio output voltage appearing between the junction of R_1 and R_2 and ground. Resistor R_1 serves only as an r-f filter element. The action of this circuit in limiting peaks of noise or other modulation is identical to the circuit shown in Fig. 1, the plate of D_2 being free to follow variations in detector a-f output voltage, while the cathode circuit is held by the longer time constant of R_4C_2.

Hum is one of the serious difficulties in any system wherein audio signals are taken from a relatively high value of resistance load located in the cathode circuit of an a-c heated vacuum tube. The heater-cathode capacitance of the most widely used receiver tubes will be on the order of 5 to 10 $\mu\mu$f, which at 60 cps presents a capacitive reactance of 250 to 500 megohms. With a resistive load between cathode and ground of perhaps 0.5 megohm, about 0.1 percent of the heater-to-ground potential will appear across the cathode resistor. This would be about 6 millivolts with a 6.3-volt heater.

Hum Reduction in Simple Series Limiter

When using the simple series limiter circuit of Fig. 1 with a 6H6 duodiode, the hum voltage appearing across R_3 may be approximately halved by grounding that end of the heater which is closer to the cathode element used for the limiter diode, since in the 6H6 the individual diode heater windings are in series. With even fairly high-gain a-f amplifiers, however, the hum will usually be troublesome even though this precaution is taken.

The circuit arrangement in Fig. 6 has been found highly satisfactory for further reducing hum from the series limiter. The reduction obtained will generally be on the order of 20 db with normal commercial variations in tubes and other components. The cathode resistor of the a-f amplifier following the limiter will not be bypassed to ground, resulting in some decrease in the gain otherwise obtained from this audio stage, due to degeneration. Two additional capacitors and a resistor are required over those needed for a normal a-f amplifier input system with unbypassed cathode.

The equivalent circuit is that of a bridge, with e_h as the limiter diode heater voltage (normally grounded on one side in most receivers) and C_{hk} as the heater-cathode capacitance. R_3 and C_2 form another arm of the bridge and are shunted by the equivalent resistance R_e, which is a composite of R_1, R_2, R_4, the effective resistance of D_1, etc. R_7 is the cathode bias resistor for a-f amplifier tube V_4. The

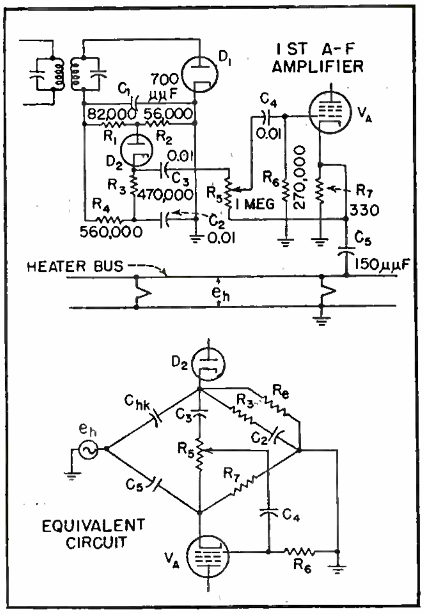


FIG. 6—Hum-reduction version of simple series limiter, with equivalent circuit arranged to show bridge configuration

bridge configuration is completed by capacitor C_5, which is connected between the ungrounded side of the heater supply and the cathode of V_A. Fortunately, the value of C_5 with the usual limiter circuit values is quite low; in the circuit shown it is only 150 $\mu\mu$f. It should be noted that this hum-bridge scheme allows normal location and operation of the a-f gain control R_5, even to the extent that despite unbypassed cathode resistor R_7, the gain control can reduce the input to V_A substantially to zero, since its low end returns to the cathode of V_A. It should also be noted that, if a LIMITER ON-OFF switch is used, two different values of C_5 will be required, due to slight changes in bridge configuration when switching from the cathode to the plate of the limiter diode.

Balanced-Detector Noise Limiter

The circuit of Fig. 7 functions as a balanced bridge arrangement for detector voltages above the limiting threshold, with unbalance being maintained at all other times. It must be adjusted manually for each carrier level, but automatic operation can be achieved by adding another diode, as in Fig. 8.

When the contact arm of R_6 in Fig. 7 is at the grounded end of R_6 and R_4 is set equal to R_2 (47,000 ohms), R_1, R_2, R_3, and R_4 form a balanced resistance-bridge circuit which is fed from the i-f output through the second detector and noise limiter diodes. If both diodes rectify in phase and their loads are equal, the a-f output across R_5 is essentially zero. When the limiter diode is made inoperative by adjusting R_6 to bias its cathode with a positive d-c voltage, the bridge becomes unbalanced and a-f output is obtained when a constant modulated carrier input is present. If, now, a noise peak arrives that exceeds the limiter diode bias, the bridge will be rebalanced and substantially no a-f output will be obtained for that part of the noise peak during which it exceeds the diode bias voltage.

The limiter normally is initially balanced by adjusting R_4, and is thereafter adjusted for each carrier level and desired modulation threshold only by means of front-panel control R_6. Adjustment of R_6, however, disturbs the balance of the bridge by varying the resistance of one arm, hence it may be desirable to gang a variable resistor with R_6 so as to hold its equivalent resistance constant. For most effective operation, the time-constant of $(R_1 + R_2)C_1$ should equal that of $(R_3 + R_4)C_2$ for all settings of R_6, and the capacitances of the two diodes should be equal.

During tests at U. S. broadcast frequencies, no improvement in receiver performance was discernible with this limiter, improvement becoming noticeable only above about 10 mc and only on ignition-pulse types of interference. The need for adjusting to changing carrier values makes this circuit practically useless on fading signals, unless limiter control settings such as would cause serious distortion are tolerable. No appreciable limiting was obtained on c-w reception employing a beat oscillator.

Automatic Balanced-Detector Noise Limiter

By adding another diode circuit to the arrangement of Fig. 7, automatic operation is obtained, eliminating adjustment of a balancing potentiometer with each change in carrier level. The additional diode is operated from a tertiary winding on the final i-f transformer, as shown in Fig. 8. This diode rectifies the i-f carrier to provide a d-c bias of about twice the mean rectified voltage furnished by the detector diode, so that limiting does not take place on modulation depths below about 100 percent. The bias voltage is applied to R_3 at the point where R_6 (Fig. 7) introduces the bias in the manually controlled circuit. The cathode delay bias on the noise limiter diode is thus maintained automatically at a substantially constant ratio with respect to the carrier input. The depth of modulation at which audio distortion begins is mainly determined by the ratio of the rectified voltage supplied by the automatic biasing diode to that supplied by the detector diode. The limitations in performance of this circuit, however, are otherwise similar to those applying to Fig. 7.

Balancing-Type Noise Limiter

The balancing (or bucking) effect of a diode shunted across the second detector with reversed polarity is used in the circuit of Fig. 9. When the limiting threshold is passed, as on noise peaks, the variations in limiter diode current oppose the normal demodulation current in the second detector.

Assume that an unmodulated car-

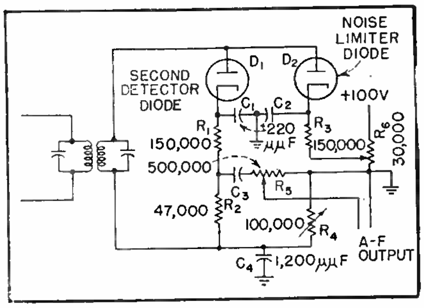


FIG. 7—Balanced-detector noise limiter

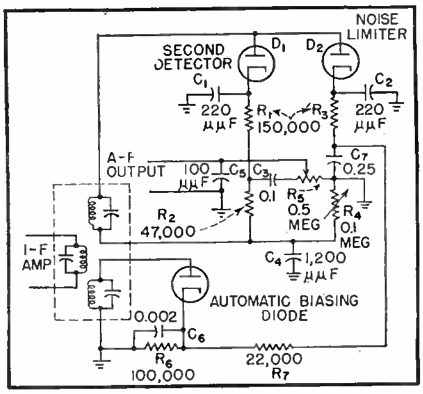


FIG. 8—Automatic balanced-detector noise limiter

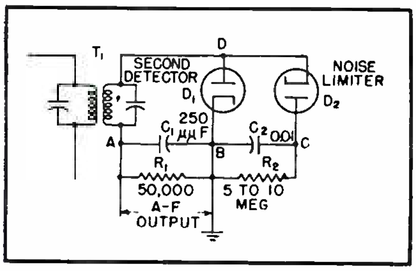


FIG. 9—Balancing-type noise limiter

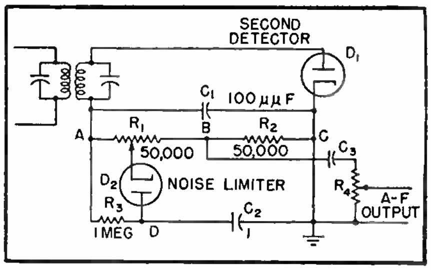


FIG. 11—Diode shunt-type noise limiter

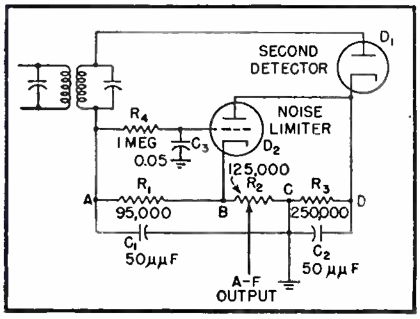


FIG. 10—Triode shunt-type noise limiter

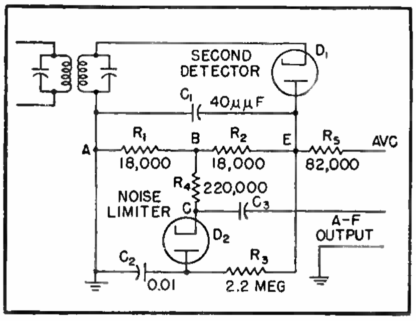


FIG. 12—Modified shunt noise limiter

rier produces a rectified potential of 10 volts across second detector diode load R_1, making point A 10 volts negative with respect to ground. Then, on positive peaks of carrier input, point D will be close to ground potential, because point A remains relatively constant over an r-f cycle and the 10-volt positive r-f peak across the i-f transformer secondary acts to cancel the negative 10 volts at A. On negative peaks, point D will therefore be about -20 volts with respect to ground.

The voltage impressed across the noise limiter diode in series with R_2 will then vary between substantially zero and -20 volts at an r-f rate. This builds up a potential of about -20 volts across capacitor C_2, thereby biasing the limiter diode plate 20 volts negative with respect to ground. The net effect is that the second detector diode is shunted by a high impedance, between about 2.5 to 5 megohms for the value of R_2 shown, until such a time as the i-f input voltage increases substantially above the 10-volt value, as on a noise peak or with modulation of the carrier. When this occurs, the limiter diode becomes conductive for all portions of the modulated wave having an instantaneous value in excess of 10 volts negative. It should be noted that the audio voltage appearing across R_1C_1 is added to the instantaneous negative voltage peaks appearing across the secondary of T_1, in addition to the mean value of rectified carrier voltage across R_1. Since the time-constant of R_2C_2 is long, about 0.05 to 0.1 second, C_2 will serve mainly as a coupling capacitance to R_1 as regards a-f variations. These variations, being of opposite polarity to those across R_1, will tend to cancel the latter on half the audio cycle. The magnitude of the cancellation effect will depend on the impedance of the limiter diode when conducting, which in turn will depend on the values of the impressed voltages and R_2, so that better cancellation will in general be obtained as R_2 approaches R_1 in value. This would necessitate increase of C_2 to a large value to maintain the time-constant of R_2C_2 at the desired magnitude, and would increase the a-c loading across R_1 as regards audio output, seriously affecting modulation distortion except with the limiter disabled.

The modulation distortion of this type of limiter is quite high, even on relatively low modulation depths, with effective limiting of noise peaks. Although the distortion can be reduced by various expedients, perhaps the most attractive feature of the circuit is its ability to provide about twice the normally obtainable avc voltage when the d-c potential across R_2 is utilized.

Triode Shunt-Type Noise Limiter

The circuit of Fig. 10 employs the plate resistance of a triode shunted across a portion of the second detector diode load, the magnitude of the shunt resistance being controlled by the grid and plate voltages, which act in conjunction with differential time-constants.

Assuming a carrier input that produces a total rectified voltage of 10 volts across the diode load (between A and D), potentials relative to the second detector cathode will be -10 volts for A, about -8 volts for B, and about -5.3 volts for C. The triode plate is thus 8 volts positive with respect to its cathode, while its control grid (connected to A through R_4) is 2 volts negative. For a triode with a μ of 20, this produces plate current cutoff, so that the triode plate resistance is high and has little shunting effect on second detector load resistor R_2 and R_3. Now if a 100-volt noise pulse suddenly appears between points A and D, the triode plate-cathode voltage rises to 80 volts relatively long before the grid potential can change, since the plate circuit time-constant is about 12 microseconds while that of the grid circuit is about 50 milliseconds. The triode then becomes conductive and shunts section B-D of the detector load for the duration of the noise pulse, thereby reducing the audio output from the detector. The noise disturbance should subside before the control grid swings sufficiently negative to stop this limiting action.

The percentage of modulation at which audio distortion due to the limiter appears depends upon the type of triode used, the relative values of R_1, R_2, and R_3, the time-constants involved, and the absolute carrier level. The higher carrier levels produce no distortion (and no limiting). Serious distortion, however, has been observed for modulation as low as 10 percent with low signal levels. Effective limiting action is restricted to a narrow range of carrier input levels, generally being evident above 10 mc in carrier frequency.

Simple Diode Shunt-Type Noise Limiter

In Fig. 11 is shown the simplest limiter of them all, requiring only an additional resistor and a capacitor, along with an independent diode.

Here R_1 and R_2, bypassed by C_1, provide a detector diode load with a time-constant of about 10 microseconds, to which is connected the cathode of the noise limiter diode. The limiter plate circuit time-constant is 1 second, so that the limiter diode conducts and shunts the detector diode load on noise (and modulation) peaks. During such peaks, the a-f output of the detector is reduced by an amount which depends on the value of R_3 plus the portion of R_1 between point A and the limiter cathode, the position of the variable contact on R_1, and the noise peak voltage. The depth of modulation above which distortion begins is determined by the relative values of R_1 and R_2 and by the setting of R_1. The performance of this limiter was not very good, some improvement being evident on pulse-type interference on signals above 10 mc. The shunting effect of the limiter diode is appreciable only when the variable contact on R_1 approaches point *B*.

Modified Shunt-Type Noise Limiter

The limiter circuit in Fig. 12 resembles the series-type limiter of Fig. 1 except that the plate of the limiter diode and the low end of its cathode resistor are interchanged. As a result, the limiter diode acts to shunt *C*, thereby reducing the a-f output voltage whenever a noise-peak makes the diode conductive. The arrangement shown permits grounding the low end of the i-f transformer secondary when desirable for stability reasons.

Assume a constant carrier making point *E* on the detector diode load 10 volts negative with respect to *A* (ground). Points *B* and *C* are then both −5 volts to ground because the limiter diode is nonconducting, its plate being effectively at the −10 volt potential of *E*. The plate circuit time-constant is much longer than that of the cathode circuit of the limiter, so that any noise surge in excess of 20 volts across the entire detector load drives the cathode of the limiter diode more than 10 volts negative with respect to ground and the diode conducts, shunting the input to the following a-f stage. This shunting action is made more effective by series cathode resistor R_4, which with the limiter diode closed acts as part of a voltage divider to attenuate detector-load voltage peaks. Limiting action ceases when *C* becomes positive with respect to *D* due either to decay of the noise pulse or to charging up of C_2. The limiter will begin to cause audio distortion at about 100-percent modulation for the values shown. If R_2 equals 0.4 R_1, distortion will begin at about 40 percent modulation and a greater percentage of the a-f output developed across the detector load will be available to the following a-f amplifier. This limiter has been found to be much more effective than the simple shunt limiter, although not as good as the simple series-type limiter at the lower carrier frequencies.

Degenerative Noise Limiter

Degenerative feed to the i-f amplifier prior to final detection is used in the circuit of Fig. 13. A portion of the output from the first i-f amplifier is amplified in the first and second noise limiter amplifiers, and the resulting i-f output is coupled into a full-wave rectifier having R_1 as a load. The d-c voltage developed across R_1 provides the bias for the injector grid of a 6L7 pentode serving as the final i-f amplifier tube. Front-panel control R_3 provides a positive delay voltage for the diode cathodes, to prevent rectification until signal or noise peaks exceed this bias. Since the time-constant of the diode load is only 5 microseconds, the d-c potential across R_1 can fluctuate at a rate of up to about 200 kc.

If the normal carrier peak impressed across the diodes is 10 volts and the delay bias is 5 volts, the diodes do not rectify (since each gets only half the applied voltage) and the 6L7 injector grid then has substantially no bias relative to ground. Now if a 100-volt noise peak appears across the secondary of the diode transformer, the delay bias on each diode is exceeded by 45 volts and a negative potential of about 45 volts is therefore applied to the 6L7 injector grid. If this change in injector grid potential occurs simultaneously and in opposition to the change in the control grid potential of the 6L7 due to the same noise pulse and at the same rate, the effects of the noise pulse on the second detector can be reduced considerably by the resulting bucking action. Ideal phase and amplitude balance usually are, however, difficult to achieve, due in large part to the many circuits involved in the noise limiter amplifier and rectifier channel.

This limiter requires manual adjustment of the threshold of operation and is useless on fading signals. Circuits may be added to provide automatic biasing from an additional avc system, resulting, however, in almost prohibitive complexity. One version of this latter form has been found to be almost as effective as the simple series limiter at the higher signal frequencies. Modulation distortion is determined by the delay bias obtained from R_3 or by the accessory avc bias in the automatic form.

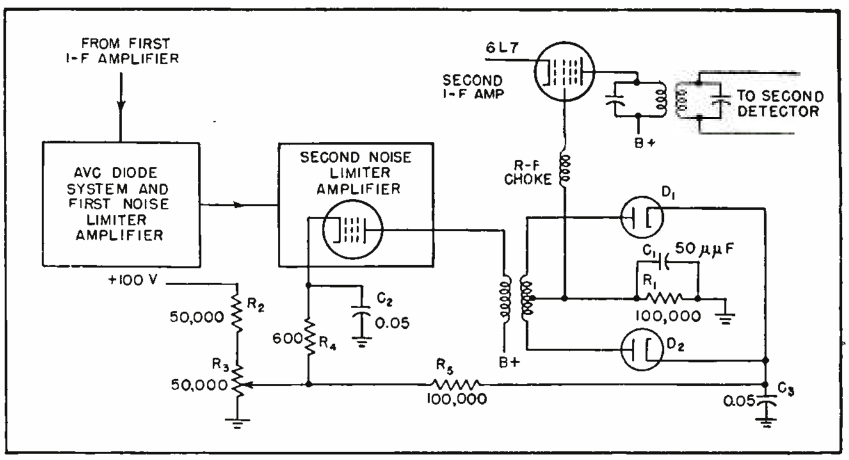


FIG. 13—Degenerative noise limiter, acting between first and second i-f stages

TEST OSCILLOSCOPE for Television

A modified standard oscilloscope is used to measure television transmitter modulation. Either the radio frequency or a video signal can be used for synchronization. Design and installation of additional circuit elements is discussed

THERE has been a definite need for some simple means of checking the modulation of television transmitters quickly and with reasonable accuracy. No commercial equipment suitable for operation at the high carrier frequencies involved has thus far become available.

It is possible to modify a commercial oscilloscope so that the technique of employing a trapezoidal pattern to measure modulation, used in sound broadcasting, may be adapted to television. The equipment provides a convenient means of determining the percent of carrier amplitude devoted to synchronizing pulses and hence compliance with the standard.

The modification necessary consists of providing a linear horizontal sweep at half the line or frame scanning frequency and of adapting the input circuits to the television carrier frequencies. The modified circuit of such an instrument is shown in Fig. 1.

Choice of Standard Oscilloscope

Use of the type 5JP1 cathode-ray tube is advantageous since the deflection plate leads terminate on the

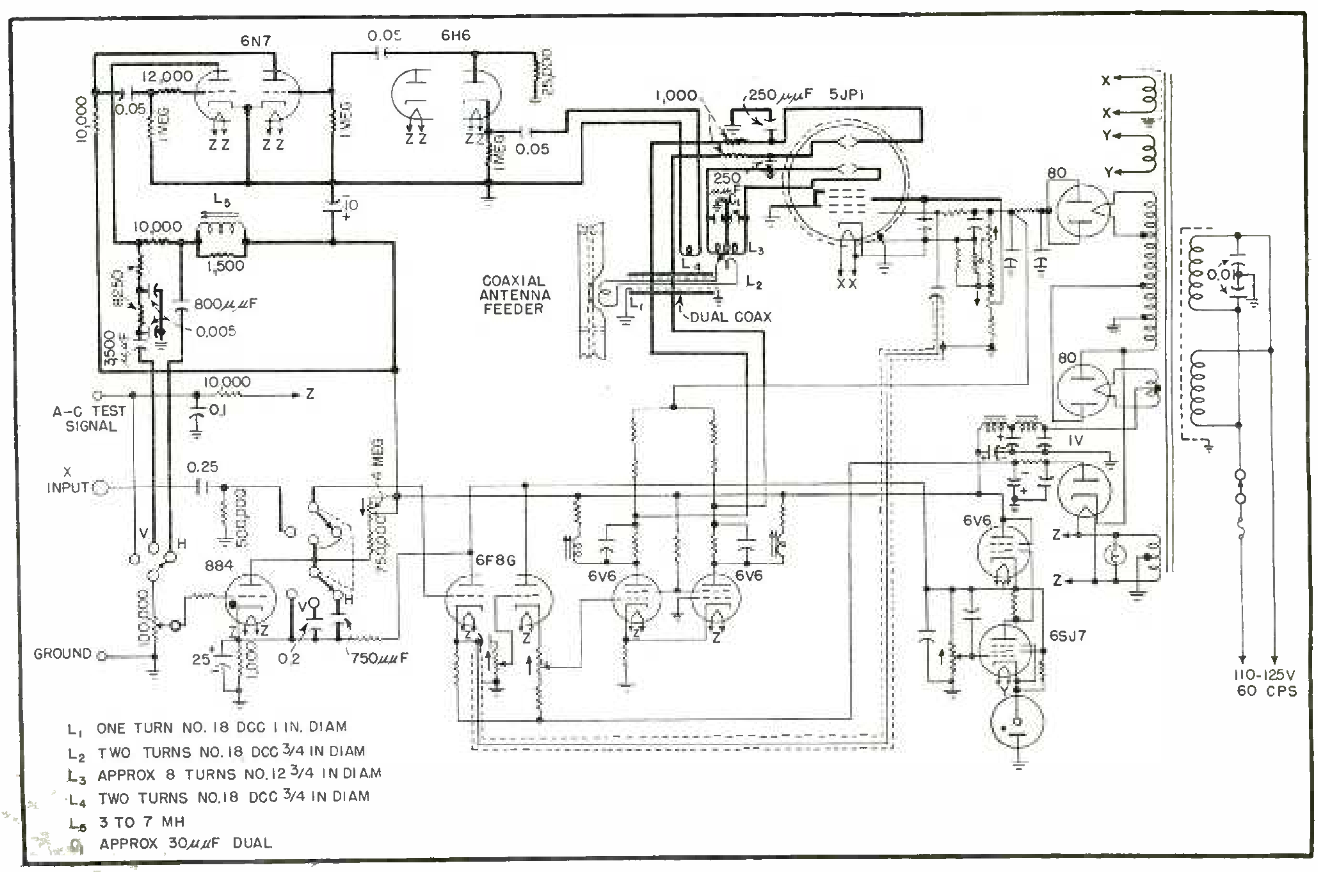


FIG. 1—Circuit modifications, shown in heavy lines, adapt standard oscilloscope for operation at television carrier frequencies

Stations

By A. H. BROLLY
and
W. R. BROCK

Engineers, Station WBKB
Chicago, Ill.

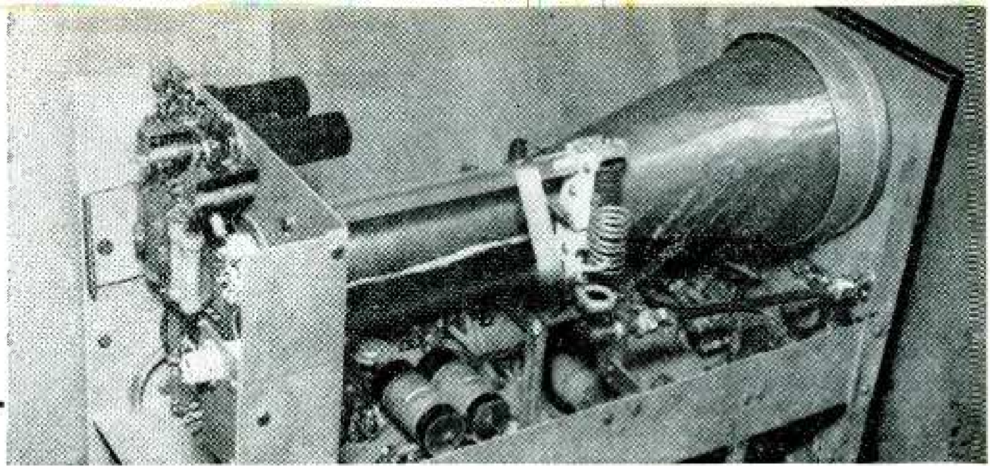


FIG. 2—High-frequency line terminating loop can be seen coupled to tuning coil of vertical deflection circuit in the converted oscilloscope

bulb. This feature minimizes capacitance coupling between horizontal and vertical plates, and simplifies the r-f circuit. It is desirable to shield the tube electrostatically by wrapping it in a sheet of copper foil as shown in Fig. 2, and to provide an aluminum or brass case for the whole instrument. In addition to shielding it is wise to isolate the leads from the horizontal sweep amplifier by some resistance to prevent any possibility of resonance in these lines. For this purpose 1,000 ohms was found satisfactory.

Filament, anode and bias supply circuits are those commonly employed in most oscilloscopes, with the exception that the high voltage supply should have a positive ground. This feature is important since it permits grounding the center tap of the tuned circuit and the use of low voltage r-f bypass capacitors on the horizontal deflection plates. The plate supply of the critical stages of the sweep amplifier is regulated and the horizontal sweep oscillator and amplifier are similar to those of conventional oscilloscopes with the exception of the synchronizing circuit and sweep-speed control.

The most critical consideration when using very high frequencies for vertical deflection is the tendency of these voltages to stray over to the horizontal deflection plates, causing a curvature of the parts of the pattern that should be vertical. The resulting image distortion can be prevented by symmetrical voltage distribution in the r-f circuit and effective r-f bypassing of the horizontal deflection plate leads. Capacitors must be selected that will have a low reactance at carrier frequency but a high reactance through the tenth harmonic of the horizontal sweep frequency. A 250 micromicrofarad capacitor has a reactance of 10.7 ohms at 60 megacycles and 8,100 ohms at 7,875 × 10 cycles and gives good results. The frequency 7,875 is one half the 15,750 cycles required for horizontal scan in 525-line television. This sweep frequency permits patterns of two scan lines to be shown on the screen.

The vertical deflection plates are driven by a tuned circuit that provides enough voltage at resonance to produce adequate deflection with small power input. In the lower group of television channels, 44 to 88 megacycles, a split-stator capacitor of 20 to 30 micromicrofarads per section is used for tuning. It is not necessary to load the circuits to pass the wide sideband since the highest frequency components in the extremes of the sideband are not necessary for ordinary measurements.

The center of the coil feeding the vertical deflection plates must be grounded to provide the required d-c potential on these plates. The rotor of the tuning capacitor may also be grounded. This common ground must be connected to the shield on the cathode-ray tube by a strap, ribbon, or wire of large area and as short as is feasible. Such an arrangement assures symmetry of voltage on the vertical deflection plates and reduces coupling to the horizontal plates.

A coil suitable for the lower group of television frequencies can be wound with no. 12 wire on a ¾-inch form. An 8-turn coil of this diameter has been found suitable for the 60- to 66-megacycle channel. One or two turns more or less will be required for other channels of the group.

R-F Pickup

To secure a balanced feed, a dual coaxial line is desirable. The line should be flexible so that it can be run through conduits or wire ducts with ease and its losses are low enough so that almost any reasonable length can be used.

Coupling coils at the input and output of the feed line are connected to the inner conductors and not to the outer sheath. The feed line input coil is a ¾-inch, one-turn loop inserted part way into an opening in the outer conductor of the transmitting antenna coaxial line just outside the transmitter cabinet. Where the coaxial line enters the oscilloscope cabinet the outer sheath must be grounded to the metal cabinet. The cable terminates in a two-turn coil of ¾-inch diameter and is loosely coupled to the tuned circuit of the oscilloscope.

Since such a loop cannot be expected to provide an entirely nonreflecting termination there will be some standing waves in the line, and some degree of unbalance in spite of precautions. Coupling between loop and tuning coil is adjusted by trial, inserting the loop a small distance between the turns of the coil; the most effective point may be found one or two turns above or below center as shown in Fig. 2. Because of standing waves in the line it is possible for the loop initially to be at a low-current point in the standing-wave pattern, in which case the line can be shortened somewhat.

Synchronizing voltage for the horizontal sweep may be taken from a video line if available or, if more convenient, it may be taken from the r-f signal (Fig. 1). The detector circuit shown is suitable for either method.

A small pickup coil of two turns is loosely coupled to the lower end of the tuned circuit and applies about a volt to the cathode of the 6H6 tube. This tube is located directly below the pickup coil so that the leads are kept short. Peaks of the r-f signal corresponding to the sychronizing pulses are rectified, biasing the cathode of the diode positively so that only synchronizing pulses appear in the plate circuit.

The diode performs the two functions of rectifying r-f and clipping off picture components. Negative impulses appear across the plate load resistor. If video signals are used for synchronizing, they may be applied to the diode that will serve in the same way to separate synchronizing pulses from the picture. If the pulses are negative with respect to ground, the signal is applied to the cathode of the 6H6 tube in the same manner as the r-f signal. If the pulses are positive, they are applied to the plate of the diode through a network consisting of a 0.05 microfarad capacitor and a one megohm resistor. The output is then taken from the cathode across a 25,000-ohm load resistor. In this case the output pulse is positive. This difference of polarity does not adversely affect synchronism of the sweep for reasons that will be pointed out later.

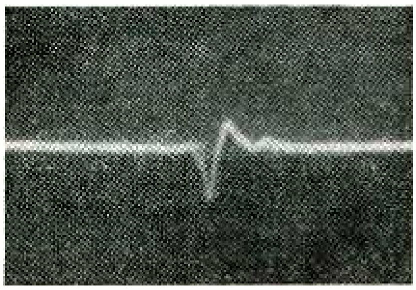


FIG. 3—Integrated vertical synchronizing pulse fed to the type 884 tube

Signal Amplifier

The output pulses from the detector are amplified by the two-stage amplifier utilizing a type 6N7 tube that operates without external bias since the plate current is sufficiently limited by the 10,000-ohm plate resistors. As long as there is a substantial signal applied to this amplifier, grid rectification provides bias for the tube. The time constants of the grid resistor and coupling-capacitor networks are large enough to permit amplification of the 60-cycle field scanning impulses.

Impulses passing through the amplifier will usually be of both line and field frequencies. It is the function of the two networks in the plate circuit of the left section of the 6N7 tube to separate the two frequencies so that either can be applied to the horizontal sweep oscillator of the scope. The network consisting of two 8,250 ohm resistors and 0.005 microfarad capacitors, separates by integration the vertical pulse from the composite of both pulses. After separation the pulse is partially differentiated by the 3,500 micromicrofarad coupling capacitor and the 884 tube grid resistor producing both a positive and negative pip as shown in Fig. 3. Therefore, the polarity of the pulse from the 6N7 amplifier is unimportant since the 884 tube will always receive a positive impulse on which it synchronizes best.

The horizontal pulses are separated from the vertical by differentiation in L_5. Again a positive and negative swing is produced, as shown in Fig. 4, to synchronize the 884 tube.

Switching circuits are provided to select synchronizing voltage from either the vertical or horizontal separator output or from the 60-cycle line.

Appropriate *RC* networks can be switched into the plate circuit of the 884 tube to generate suitable sawtooth waves at 30 and 7,875 cycles for sweep speeds to show either frame or line patterns. Provision is made for external deflection for special cases. A potentiometer in the plate circuit of the 884 tube permits continuous adjustment of sweep frequency over a range from 3 or 4 lines or frames to one line or frame. The sawtooth output of the sweep oscillator is amplified by a 6F8G and two 6V6 tubes in a conventional circuit before being applied to the horizontal deflecting plates. A back-trace blanking impulse is fed to the cathode ray tube from the cathode circuit of the 6F8 tube.

Use of the Instrument

A typical pattern of two frame periods of a television signal as it appears on the oscilloscope screen is shown in Fig. 5. The synchronizing pulse envelope may be seen at the vertical extremities of the pattern. Between these the horizontal line indicates the peaks of the line impulses.

At the base of the synchronizing impulses, the bright line indicates the blanking pulse shoulders or black level. The whole central portion of the pattern is taken up with picture components.

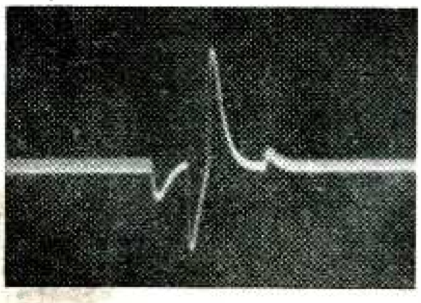


FIG. 4—Horizontal synchronizing pulse taken from L_6 through the *H* position of selector switch

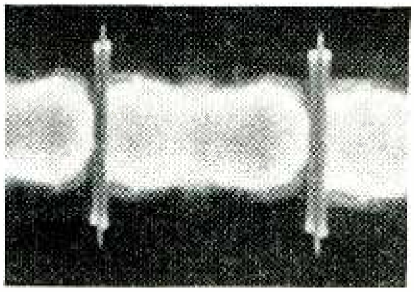
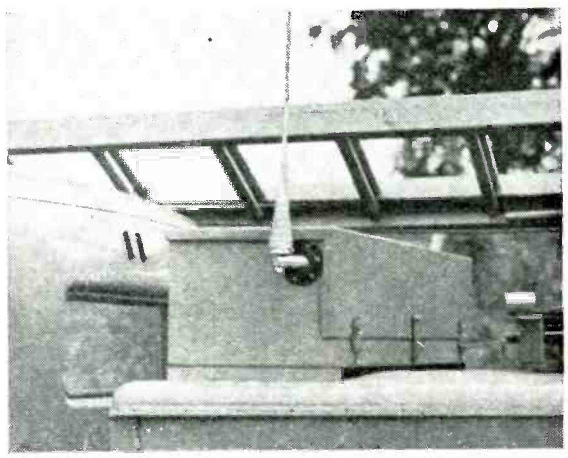


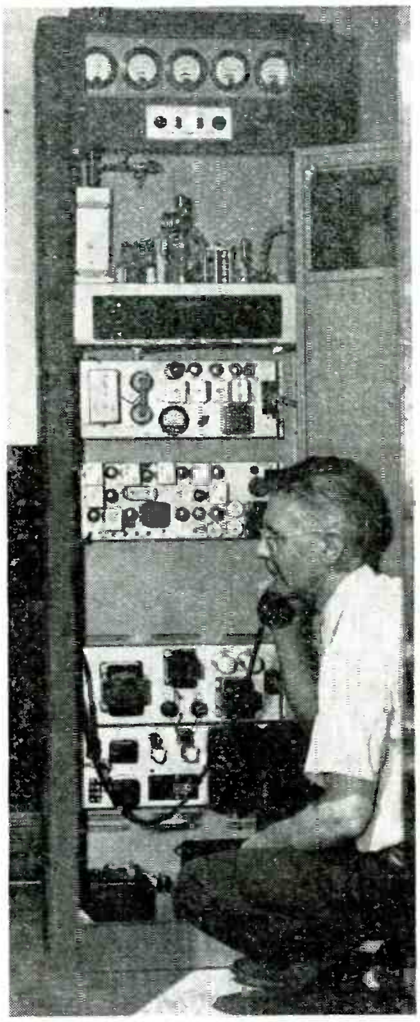
FIG. 5—One frame of a typical television signal as seen on the screen of the modified test oscilloscope

TWO-WAY RADIO for Power Line Crews

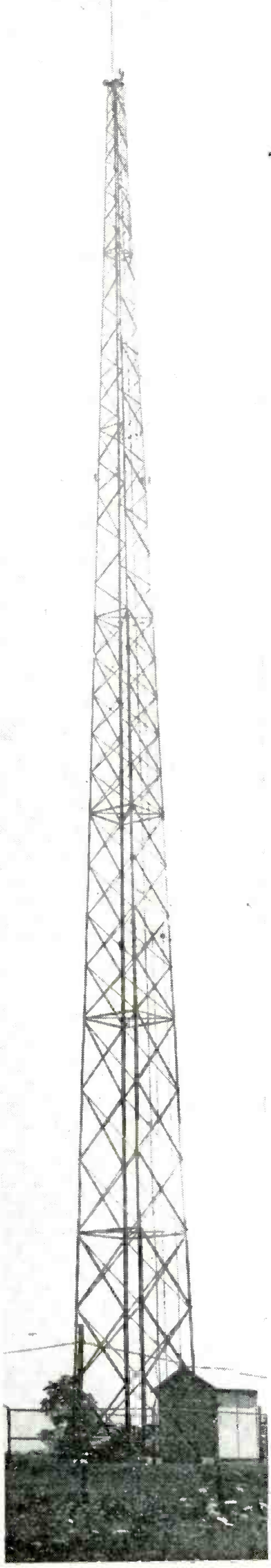
A TWO-WAY radio system employing frequency modulation on 37.18 megacycles has proved the answer to West Penn Power Company's problem of providing quick and reliable communication between central stations and service trucks when line trouble develops. Fourteen trucks have been equipped, each having a 35-watt transmitter, and the 250-watt fixed station with call letters WNAA is now in regular operation at the company's principal substation. Reliable reception is obtained in trucks within a 30-mile radius of Charleroi in all kinds of weather, and the station has been heard up to 150 miles away. Mobile radio is now being planned for the rest of the system.



BELOW—The Link radio equipment for each truck is in a weatherproof cabinet just behind the cab, with whip antenna mounting at side



ABOVE—Transmitter of main station is located in small house at base of tower, and remotely controlled from four points in Charleroi, Pa.



LEFT—Transmitting antenna atop 175-foot steel tower

LOWER RIGHT—Radio hand-set and control panel are conveniently located in cab of each truck. Controls are, left to right: squelch switch, transmitter pilot lamp, receiver pilot lamp, and volume control. Receiver is in operation at all times for emergency calls, and push-to-talk switch on hand-set is the only transmitter control

Components of

By EDUARD KARPLUS

Engineer
General Radio Co.
Cambridge, Mass.

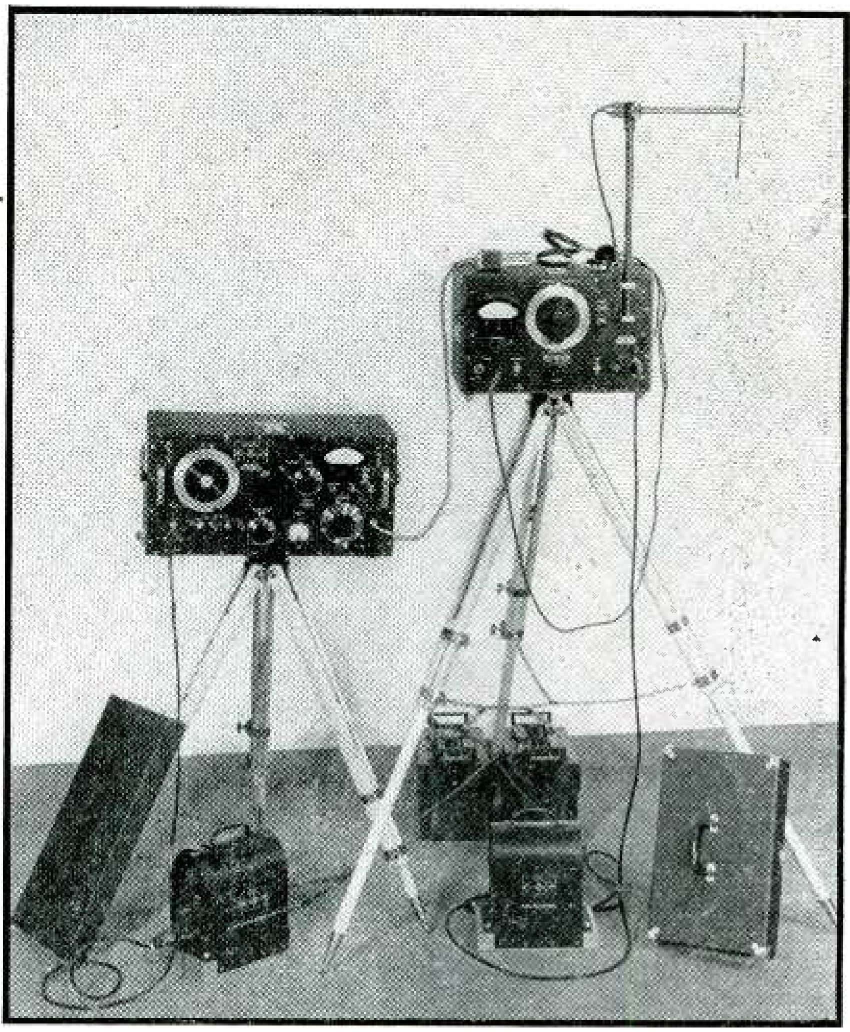


FIG. 1—Field-strength meter and standard-signal generator developed for National Defense Research Committee by General Radio Co. to be used for measurements between 300 and 1,000 mc

FREQUENCY LIMITS of electronic equipment were rapidly pushed into the hundreds of megacycles during war development. To learn about propagation and equipment capabilities a field strength meter was developed for the range from 300 to 1,000 mc. This meter was intended for measurements in the laboratory or field. It had to be quickly tunable to any frequency within its range. A sensitive receiver, which could be calibrated by a standard signal generator, was required to measure the voltage induced by an unknown field in an antenna of known characteristics. The completed equipment for making these measurements is shown in Fig. 1.

Field Strength Measurements

In using the field strength measuring equipment the antenna and receiver are tuned to the incoming signal; the antenna is disconnected from the receiver and replaced by a dummy antenna and a standard signal generator which is adjusted to give the same receiver response. The field strength ϵ in microvolts per meter is related to the standard signal generator voltage E in microvolts by

$$\epsilon = E \frac{1}{h_e}$$

where h_e is the height of the antenna in meters. If the antenna is adjusted to half-wave resonance

$$h_e = 0.636 l = 0.636 \frac{\lambda}{2} = \frac{95}{f}$$

to a first approximation, where f is the operating frequency in megacycles. Therefore the unknown field strength is

$$\epsilon = 0.0105 f E$$

The receiver and the standard signal generator have since found wide application in other fields, and, although the original models are obsolete today, many of their components will be found useful in similar applications.

Tuned Circuits

The butterfly circuit, as well as its application in negative-grid triode oscillators, has been described in detail,[1] but the wide interest shown in this development justifies a few further remarks.

The butterly circuit used in the signal generator has $2\frac{1}{2}$-inch outside diameter and 5 and 6 plates on the rotor and stator respectively, has a tuning range of 220 to 1,100 mc and is equipped with terminals for grid and plate of the oscillator tube. The butterfly circuit can be considered a parallel combination of inductances and capacitances. This combination is seen in the schematic diagram of Fig. 2 where the capacitive branch is represented by two series capacitors and the inductive branch by two parallel inductors between terminals one and two. Variation of both capacitance and inductance is brought about by rotation of the inner, butterfly shaped, member. The capacitive branch is the familiar series-gap tuning capacitor. Variation of the two identical inductive branches is achieved as the rotor progressively blocks out the area through which a magnetic field can pass.

At 220 mc, with the plates fully

UHF Field Meters

Tuning limitations of resonant circuits, tunable doublet antenna, uhf voltmeters, cavity attenuators, power-supply stabilizer of early model of field-strength meter, and standard-signal generator are described

meshed, the effective inductance of the circuit is 0.011 μh, the effective capacitance is 48 $\mu\mu$f, and the effective Q is 650. The corresponding values at 1,100 mc are 0.004 μh, 5 $\mu\mu$f, and a Q of 300.

Common to all butterfly circuits is a series-gap capacitor for capacitance variation across two fixed terminals, which eliminates the necessity of sliding contacts, and the direct incorporation of a parallel inductive path into the structure of this capacitor. This integral design is important in reducing metallic losses at points where capacitive and the inductive paths of the tuned circuit join and makes it possible to use lumped parameter elements at these high frequencies. The eddy-current shielding effect of the rotor plates, which reduces the effective inductance in the high frequency position, helps to obtain very wide tuning ranges, but increases the losses to some extent.

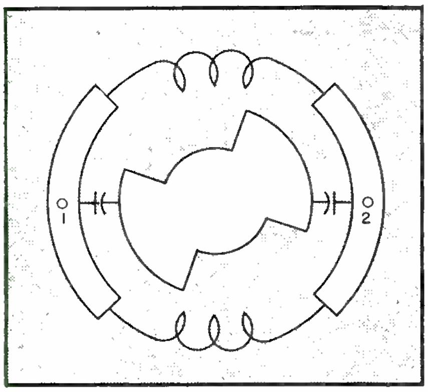


FIG. 2—Left—Schematic diagram of butterfly circuit indicates that high resonant impedance appears across points 1 and 2

If low losses are important, and wide tuning ranges are not required, butterfly circuits should not be used. Better results can be obtained with a cylinder circuit.[2] This circuit can be represented by a diagram similar to Fig. 2 with a single and fixed inductive branch. The tuning ranges of cylinder circuits are considerably smaller than the ranges obtained with butterfly circuits, but their losses are lower and their Q's are practically constant. A cylinder circuit with cylinders one inch in diameter and two inches in length has a tuning range of approximately 500 to 1,000 mc with a Q of 1,200.

In a broadcast receiver a three-to-one frequency variation is ordinarily produced by a 180 degree rotation of the capacitor shaft, but a typical butterfly circuit varies from 220 to 1,100 mc between two rotor positions which are only 90 degrees apart. To compensate for this difference, and for an uneven frequency distribution, the angular precision of the drive has to be about seven times better in the butterfly circuit than in a comparable variable capacitor circuit. The precision required to prevent axial movement of the plates is the same in both cases provided the air gap and the care used in centering the plates are equal. This relation is based on percentage accuracy and has to be multiplied by the ratio of frequencies if frequency increments are considered. In our example this ratio would be 1,000.

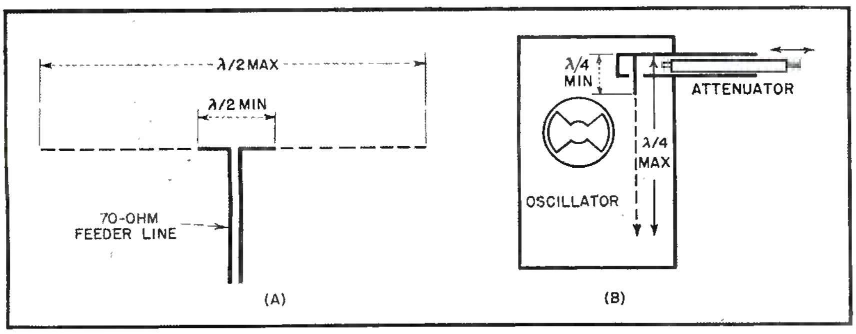


FIG. 3—Below—(A) Tunable antenna and (B) attenuator coupling are principal uhf features of equipment

Frequency Limits

The 220 to 1,100 mc butterfly circuit has an air gap of 0.04 centimeter, which is not adequate for high-power applications. If this air gap were changed to 0.2 centimeter, the maximum capacitance across the terminals would be reduced to one fifth its previous value and the frequency range would be 500 to 1,000 mc, to a first approximation. This large reduction in tuning range cannot be offset by an over-all increase in the size of the unit. A 50 percent increase in diameter would increase both capacitance and inductance by a factor of about 2.3 and would approximately restore the bottom frequency of 220 mc, but the top frequency would have dropped to under 700 mc. An increase in the number of plates would seem to be a possible solution, but unfortunately butterfly circuits with more than a certain number of plates have spurious modes which interfere with their proper operation. It appears, therefore, that the maximum size and the maximum number of plates that can be used in a butterfly circuit are limited by the top frequency, and that the bottom frequency is then determined by the air gap.

In practice it is very hard to compute the top frequency of a butterfly circuit without a good deal of experimental data taken from similar designs because the mechanical shapes determining both capacitance and inductance are too complicated for simple approximations. The bottom frequency can be obtained with reasonable accuracy if the capacitance of the series gap capacitor is computed as in any low-frequency application and the inductance as

$$L = 4.9\, r \log_{10} (r/t + w)\ 10^{-9} \text{ Henry's}$$

where r is the inside radius of the butterfly stator plates and t and w are thickness and width of the stator stack, all in centimeters. To arrive at an estimate of the top frequency of a butterfly circuit, a range factor is used which varies between two and 12 for the circuits that have been built so far. The range factor increases as frequency and air gap are reduced.

Tunable Resonator

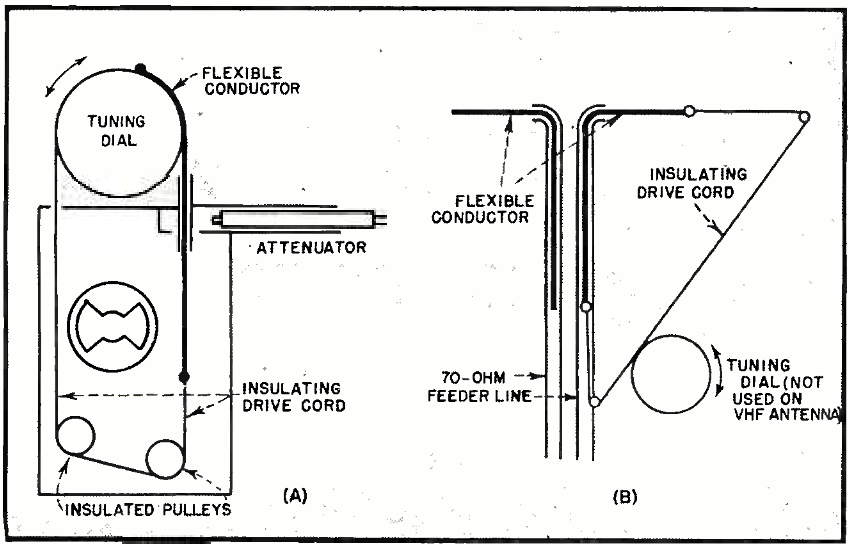
Another component of general usefulness is a tunable resonator which is incorporated in the signal generator and in the receiver of the field strength measuring equipment. In both cases resonators with a five-to-one frequency range were required and adjustment by turning a dial seemed desirable. Figure 3 shows schematically these two applications.

In Fig. 3A a 70-ohm feeder line is connected to a doublet antenna, the length of which has to be λ/2 at the operating frequency. In Fig. 3B a mutual inductance type attenuator is coupled to a 220 to 1,100 mc butterfly oscillator. A quarter-wave resonator with the current loop in the attenuator produces a strong field of the desired mode and reduces in proportion undesirable modes which might otherwise cause errors in attenuation.

This same system was used in a 1,000 to 3,000 mc signal generator to select, in addition, the second and the third harmonics of a 500 to 1,000 mc oscillator. In this particular case the oscillator used a quarter-wave open line and could be driven much harder for harmonic generation than would be possible with a butterfly oscillator.

In both cases conventional telescoping tubes could have been used, but for a five-to-one frequency range at least five joints would have been required. The solution adopted consists, instead, of a short fixed guide and a long flexible conductor which is pushed through the guide by the amount required to produce resonance. In the attenuator, which is illustrated in Fig. 4A, the remaining part of the conductor, which is not required at a particular frequency setting, does not constitute a problem because it passes through the oscillator shield into the outer space and cannot interfere with the components inside the shield. Good contact between conductor and guide is important. As shown, the flexible conductor can be tied to an insulating drive cord and be guided and driven by pulleys operated by a conveniently located dial. By proper choice of the location and size of the insulated pulleys inside the oscillator housing, coupling between the resonator and the oscillator can be adjusted over the frequency range.

FIG. 4—Experimental drive systems for flexible conductors used (A) to couple from oscillator into attenuator cavity and (B) to tune doublet antenna



Conditions in the tunable antenna are somewhat different because no ground plane is available for separating the used and the unused parts of the resonator. In that case, the flexible resonator is fed through a hollow feeder line as shown schematically in Fig. 4B. The feeder line is composed of two tubes spaced to provide the desired characteristic impedance of 70 ohms and bent at the upper end to give the flexible resonator a right angle deflection. The unused parts of the resonators are within the feeder lines and do not disturb the field of the antenna.

To avoid complications, a driving mechanism has been omitted in the 220 to 1,100 mc doublet antenna shown in Fig. 5. The feeder lines are aluminum channels spaced for 70-ohm characteristic impedance by a polystyrene bar. The flexible conductors are self-supporting flat strips of slightly curved spring material, similar to the strips used in the familiar steel rules. Adjustment of antenna length is easily made by hand using pins which are fastened to the conductors and project through the aluminum channels.

Crystal Detectors

After a careful study of uhf voltmeters, it was decided to use a crystal detector as the rectifying element because, in spite of all their shortcomings, voltmeters of this type can be built with lower corrections for frequency than any of the others. A suitable crystal detector had to be developed for this application in 1941, but today completely sealed detector cartridges with standardized dimensions and reliable performance are available.

Up to a few thousand megacycles the action of the detector junction is independent of frequency if precautions are taken in its manufacture and the frequency characteristic of a crystal detector type voltmeter is determined by its resonant frequency. Series resonance of the shunt capacitance of the detector junction and the lead inductance between voltmeter terminals increases the voltage E appearing across the detector junction with respect to the terminal voltage e and causes a corresponding frequency error F such that

$$F = \frac{E}{e} = \frac{1}{1 - (f/f_0)^2}$$

where f and f_0 are operating frequency and resonance frequency of the voltmeter respectively. In any particular voltmeter design the resonant frequency f_0 varies only slightly with individual detector cartridges. In a typical application, using the type 1N21-B detector, which is the most suitable for this purpose, the resonant frequency varies from 3,500 to 3,900 mc, corresponding to a frequency error of 9 to 7 percent at 1,000 mc.

Erratic variation or drift of crystal detectors have been largely reduced by modern design and it has been found that in most cases the drift is independent of frequency. Because this assumption is certainly correct for small drift, detectors can be checked periodically and corrected at any convenient frequency, for instance at 60 cps.

Another peculiarity of crystal detectors which sets them apart from vacuum-tube voltmeters and thermocouples, ordinarily used at lower frequencies, has to be mentioned as it bears on their application. Vacuum-tube voltmeters can be built for a wide range of voltages, and their circuits can be so designed that no permanent damage is done by overloads. Thermocouples can be built for a wide range of currents. They are readily burned out, but this damage is immediately obvious. Most crystal detectors will not stand more than a few volts, and great care has to be taken to prevent overloads which might change the characteristic of their junction before it is made ineffective or burned out.

Attenuator

A voltmeter placed at the input to the attenuator of a signal generator will read independently of attenuator setting, but a voltmeter placed at the output terminal will read only over a limited range of low attenuation. It would seem, therefore, that the first location, which is always used at low frequencies is more desirable, but at ultrahigh frequencies the second method will give more accurate results.

In both cases the accuracy at low output voltages depends on the attenuator calibration, which can be computed precisely for the mutual inductance type attenuator commonly used at ultrahigh frequencies. The quarter-wave resonator described in connection with Fig. 3B is not required, and better results are obtained if the end of the attenuator tube is fitted with a shield to exclude undesirable modes and is pointed toward a part of the oscillator circuit which carries current in the plane of the pickup loop. The field of this current passes the shield and enters the attenuator tube where it is attenuated logarithmically, decreasing by 32 db for each diameter traveled.

If a voltmeter is placed at the output side of a line connected to the pickup loop, a reference point of attenuator output voltage can be established for any position of the pickup loop that provides sufficient voltage to make the meter read, and accurate lower output voltages can be obtained by moving the pickup loop by accurately determined amounts. A complete output system

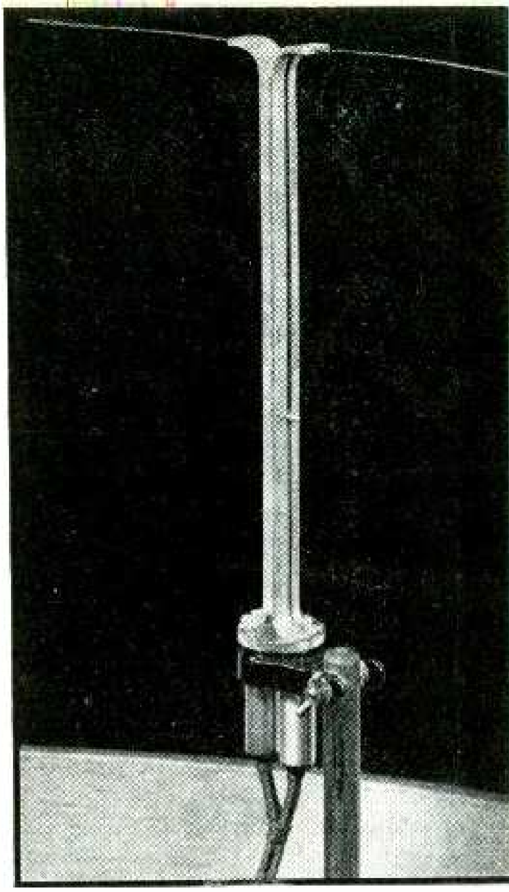


FIG. 5—Doublet antenna can be quickly tuned by sliding flexible tapes in two-wire transmission-line track

of this type includes resistors, R_1 and R_2 and capacitor C, as shown schematically in Fig. 6. Resistor R_1 is required to terminate approximately the short line between pickup loop and voltmeter in order to prevent excessive voltage rise which might overload the crystal detector, if the proper load is not connected. Resistor R_2 is a matching resistor to provide desirable values of output impedance. It will ordinarily be determined by the characteristic impedances of the cable connecting the load and was 70 ohms in the field strength measuring equipment to simulate the radiation resistance of the doublet antenna. Capacitor C is sufficiently large to be

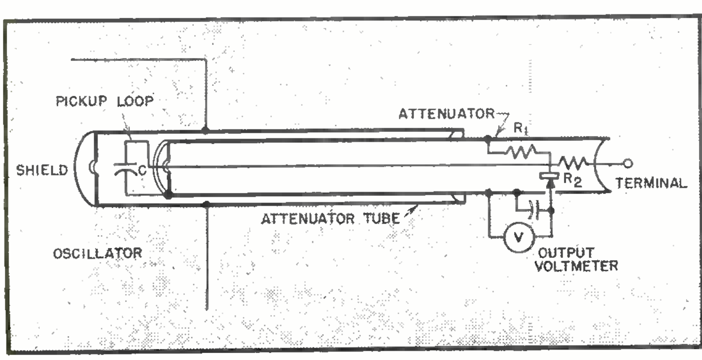


FIG. 6—Output meter of standard-signal generator can be located at output of attenuator

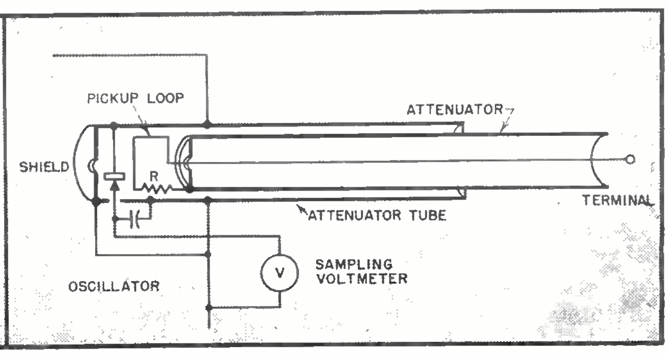


FIG. 7—Output meter of standard-signal generator can be located at input to attenuator

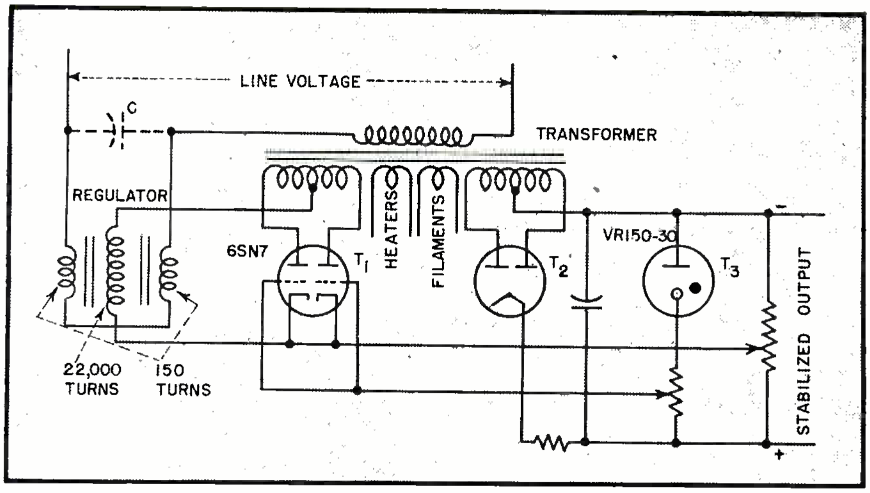


FIG. 8—Power-supply stabilizer, to regulate both filament and heater as well as high-voltage supply, uses controlled saturable reactor in power input circuit

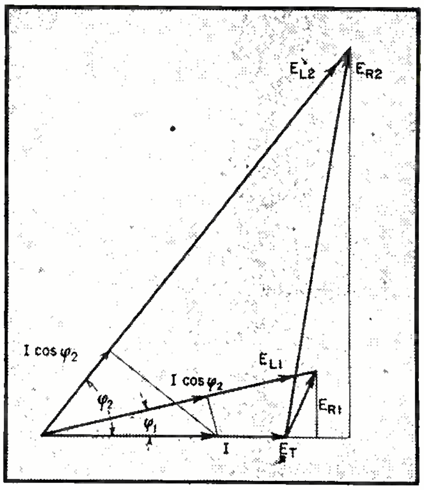


FIG. 9—Vector diagram shows that reactor absorbs the change in input voltage

ineffective at radio frequencies and has been inserted only to facilitate low frequency calibration of the crystal detector.

In this output system, the accuracy of output voltage at the reference point is determined by the voltmeter alone and does not depend on any other circuit elements. The accuracy of the output impedance is determined by R_2 alone because this resistor is immediately preceded by the output voltmeter, which can be considered a zero-impedance source. Obviously no signal generator could have sufficient power to meet this requirement, but as long as its output voltmeter is reset to the same value whenever the load is changed, the terminals of the voltmeter have all the characteristics of a zero-impedance source. In operation, therefore, the reference level of the logarithmically calibrated attenuator has to be established with the load connected, and as we have seen, this has to be done at a high output level to provide a reliable reading of the output meter. If, for some reason, the load changes with the signal amplitude, the attenuator calibration will be in error.

Alternative Output Circuit

To follow the more conventional output system the voltmeter is placed at the attenuator input as shown in Fig. 7 where it samples the field in the attenuator tube. This field decreases within the attenuator according to the same logarithmic law as before. Output voltage depends on the size and position of the pickup loop, the output impedance on the characteristic impedance, and length of the short line connecting the pickup loop with the output terminals. To eliminate a frequency dependent effect, this line has to be terminated at the pickup loop. Resistor R is inserted for this purpose, but because the reactance of the pickup loop itself is included in the termination, an accurate solution of this problem is difficult at uhf.

If an adequate solution is possible at lower frequencies, however, or over a limited range at some high frequency, two advantages are obtained, compared to the output system shown in Fig. 6. That the output meter reads at all attenuator settings is convenient as mentioned before. In addition the generator voltage is now independent of the load because it is determined by field strength in the attenuator tube.

Both these disadvantages of the simpler and more accurate system, which uses the meter at the output terminal, can be overcome. The crystal-detector type output meter has to work at a low level to prevent damage to the crystal junction and will not be able to indicate modulation peaks. By coupling a high-level peak-reading diode voltmeter to the oscillator, modulation can be determined accurately. In addition, a permanent indication of oscillator amplitude is obtained which is useful for monitoring purposes even if it cannot be made proportional to the output voltage. To eliminate errors caused by a load that changes its impedance at high levels, an attenuation pad can be inserted between the terminal of the signal generator and the load, or resistance R_1 and R_2 of Fig. 6 can be rearranged to give a fixed initial attenuation.

No matter which attenuator output system has been used, terminals for connecting the load have to be provided. At uhf this connection is always a matched concentric cable, and no particular advantage is obtained by locating the signal generator output terminal at the end of another cable as is customary at lower radio frequencies. The output terminal, in form of a concentric cable fitting, can be located on the front panel of the instrument.

Regulated Power Supply

Another problem encountered in the design of the field strength measuring equipment concerns the power supply. The equipment was built for 60-cps operation, but for at least part of the time the power required had to be produced by a motor-generator set driven from a storage battery. Under these conditions both voltage and frequency vary widely. Some means had to be provided to regulate filament and plate supplies.

The regulated power supply adopted for the field strength measuring equipment presents a solution of this problem by magnetic and electronic means. The fundamental schematic diagram is shown in Fig. 8.

The two outer a-c windings of the regulator are connected in series with the power transformer. A d-c winding is energized from a twin triode tube T_1 which acts as a grid-controlled rectifier. The reactance of the regulator is determined by the d-c current in the middle winding and automatically varies to maintain the primary voltage of the transformer constant.

Control voltage for the rectifier tube T_1 is derived from the main B-supply. At normal line voltage the grids of tube T_1 are slightly negative with respect to its cathode and allow some current to flow through the d-c winding of the regulator. At higher line voltages the grids become more negative because the voltage across the glow tube T_3 does not change. The rectified current through T_1 then decreases and the impedance of the regulator increases to bring the primary voltage of the transformer back to its previous value.

Regulator Design

Figure 9 shows voltage and current relations of the system for minimum and maximum line voltage E_{L1} and E_{L2}. Line current I and transformer voltage E_T are independent of line voltage. E_{R1} and E_{R2} are the voltages across the regulator which are out of phase with the line current except for a small component which covers the a-c losses in the regulator and increases slightly with line voltage. Input power, therefore, is essentially constant including a regulator loss of about ten percent. The phase angle of the input power varies between ϕ_1 and ϕ_2 and can be corrected for average line voltage by a fixed capacitor across the line terminals.

To compute the regulator characteristics, the power required by the instrument and the expected line voltage variations have to be known. By assuming a minimum voltage drop E_{R1} in the regulator, the operating voltage of the transformer E_T, the line current I, and the maximum volt-amperes IE_{R2} that the regulator has to handle can be established. For good regulation, the flux density in the regulator should be kept low. At high flux densities, considerable distortion of current waveform results, which causes poor regulation in the filament and heater supplies. It should be remembered that the regulation control voltage is derived from the main B-supply, which is proportional to the rms value of heater current only as long as the waveform of the power source remains constant. Depending on filter circuit and load, output voltage of the B-supply will be determined by average or peak values of the power source rather than by its rms value. The flux density of the regulator is determined by its ampere-turns IN_1 and the length of its magnetic path l_1 where N_1 is the total turns of the two outer a-c windings and l_1 is the outer circular path of the core. The maximum regulator voltage E_{R2} is determined by the cross-section of the core, the flux density, and the total turns of the a-c windings.

To reduce the regulator voltage to its minimum E_{R1}, the core material is saturated by d-c current in the middle winding. The ampere-turns required are now determined by the shorter path l_2 through the center leg and the two outer legs in parallel. Because the magnetizing current is furnished by a vacuum tube, the d-c resistance of the middle winding can be high and its number of turns N_2 can be many times larger than N_1. The two halves of the outer winding have to be well balanced because no a-c voltage should appear across the middle winding.

Magnetizing current is produced in the grid-controlled full-wave rectifier T_1. The plate voltage of this tube is derived from the main power transformer and should be high enough to allow the maximum current required for regulator saturation to flow without grid current. Control voltage for this tube is obtained from the glow tube and potentiometer combination across the B-supply of the instrument. Ordinarily the gain in the grid-controlled rectifier T_1 will be sufficient to change the magnetizing current of the regulator over its full range with a very slight variation of the B-supply output voltage, but there is no reason why additional gain could not be inserted between T_3 and T_1.

The characteristic curves of the power supply used in the signal generator are given in Fig. 10. The power requirement of the main instrument transformer is 70 watts, and it operates at 75 volts. It will be seen that the operating range of the regulator is extremely wide at 60 cps and is still adequate at 40 cps. Regulation of the heater supply is not as good as that of the B-supply, particularly at 40 cps. This inadequacy is due to distorted waveform of line current and has been partly corrected by capacitor C of 6 μf across the regulator.

REFERENCES

(1) Karplus, E., Wide Range Tuned Circuits and Oscillators for High Frequencies, *Proc. of I.R.E.*, p 426, July 1945.

(2) Gross, Ervin E., Jr., Coaxial Butterfly Circuits, ELECTRONICS, p 156, April 1946.

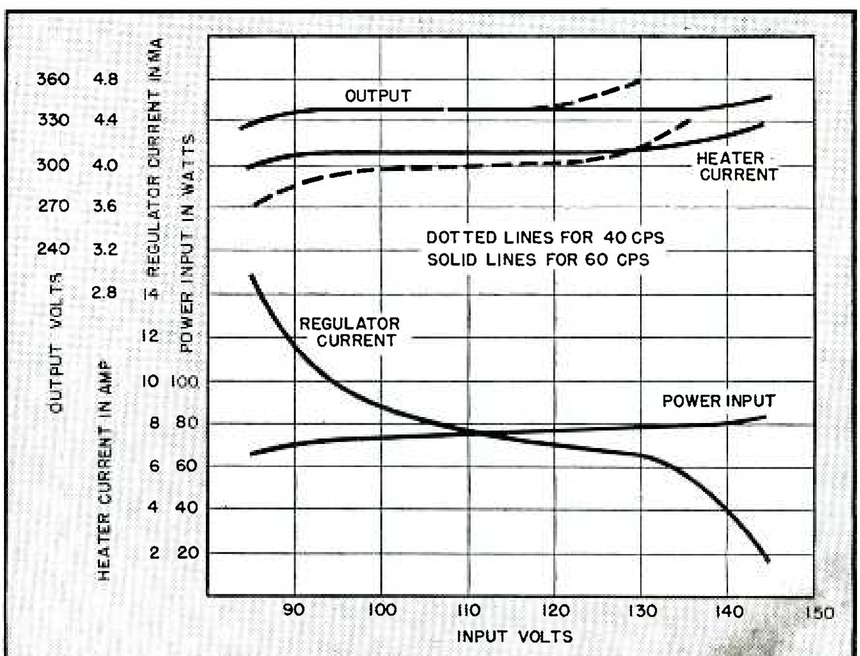


FIG. 10—Measured characteristics of power supply show the wide range over which the stabilizer operates

CONSTANT CURRENT

By O. T. FUNDINGSLAND and G. J. WHEELER
Radiation Laboratory
Massachusetts Institute of Technology
Cambridge, Mass.

Exponential circuits can be made to carry more nearly constant current for longer times if corrective networks are used. Design equations and actions of these circuits are derived, and their advantages in magnetron pulse circuits are illustrated by a numerical example

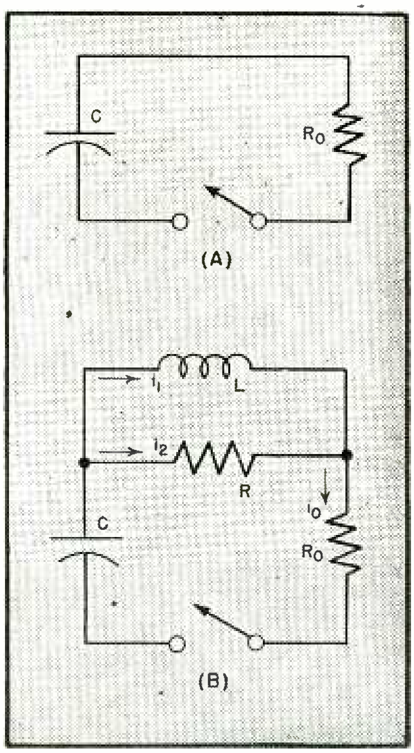


FIG. 1—(A) Exponential circuit, and (B) compensated circuit from which constant current can be obtained

EXPONENTIAL charging and discharging currents in resistance-capacitance or resistance-inductance circuits can be made approximately constant for short durations by inserting low-loss networks. Such networks permit reducing the capacitance by a factor of four or more for a given pulse duration, or increasing the pulse duration four times for a given capacitance and percent drop in current during the pulse. Similar results can be achieved in inductive circuits.

Reduced size of the reactive element made possible by these networks results in reduction of cost, bulk, and weight of the constant-current circuit. In applications where frequency stability of a self-excited magnetron oscillator is dependent upon tube current, the improved uniformity of current from these networks gives more stable operation.

The Problem

When a capacitor is charged or discharged through a resistor, the resultant current is an exponential function of time. However, in sawtooth sweep circuits, discriminating counter circuits, and other circuits involving pulses of constant amplitude, it is sometimes necessary or desirable to maintain constant current through a resistor, or resistive load for an arbitrarily short period of time. This requirement is especially necessary in one type of radar transmitter in which part of the energy stored in a capacitor is periodically discharged into a magnetron oscillator in the form of rectangular pulses. Approximately constant current can be obtained by inserting a parallel resistor-inductor network in series with the resistor-capacitor circuit.

To determine optimum values of these circuit parameters, consider the case of a capacitor C charged to potential E and then discharged through resistor R_0 when the switch of Fig. 1A is closed. It is desired to have the current through R_0 remain constant for a short interval ΔT. An inductor and resistor are inserted as in Fig. 1B. The relationship of the various parameters is determined by the following analysis.

By Kirchhoff's Laws

$$L\frac{di_1}{dt} = Ri_2 \quad (1)$$

$$i_0 = i_1 + i_2 \quad (2)$$

$$\frac{q}{C} + L\frac{di_1}{dt} + i_0R_0 = 0 \quad (3)$$

Because it is assumed that i_0 is constant, that being the desired condition, let i_0 equal I_0, a constant. Then from Eq. 1 and 2

$$L\frac{di_1}{dt} = R(I_0 - i_1)$$

or

$$\frac{di_1}{dt} + (R/L)i_1 = (R/L)I_0 \quad (4)$$

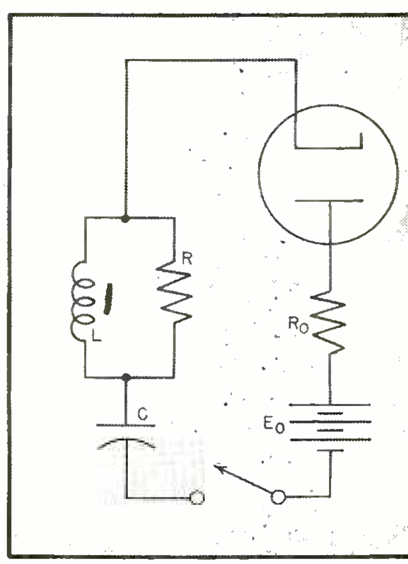


FIG. 2—A biased diode can be a part of the load through which constant current is passed

CIRCUITS

The complementary solution of Eq. 4 is $i_1 = A\epsilon^{-(R/L)t}$ where A is an arbitrary constant. The particular solution is $i_1 = I_0$. The complete solution is therefore

$$i_1 = A\epsilon^{-(R/L)t} + I_0 \qquad (5)$$

Conventionally, this equation indicates that I_0 is a steady-state condition, which is obviously impossible. However, because the time interval under consideration is very short, no steady-state condition is reached, and thus Eq. 5 is legitimate.

When $t = 0$, $i_1 = 0$. Therefore, in Eq. 5, $A = -I_0$, and

$$i_1 = I_0(1 - \epsilon^{-(R/L)t}) \qquad (6)$$

Differentiating Eq. 6 with respect to time and multiplying by L, we obtain

$$L\frac{di_1}{dt} = I_0R\epsilon^{-(R/L)t} \qquad (7)$$

Substituting this equivalent into Eq. 3 gives

$$-\frac{q}{C} + I_0R\epsilon^{-(R/L)t} + I_0R_0 = 0 \qquad (8)$$

Differentiating Eq. 8 and substituting I_0 for dq/dt gives

$$\frac{I_0}{C} - \frac{I_0R^2}{L}\epsilon^{-(R/L)t} = 0 \qquad (9)$$

If L/R is much greater than ΔT, then $\epsilon^{-(R/L)t}$ is approximately unity during the pulse interval. Thus Eq. 9 reduces to the familiar relationship: $R = \sqrt{L/C}$ or $L = R^2C$.

Circuit Modification

It is evident in the foregoing analysis that the value of R_0 does not affect the result. Consequently, if R_0 is replaced by a biased diode as in Fig. 2, it would be expected that for constant current the same relationships of the parameters must hold. In this case capacitor C is given, charged to a potential E, which is to be discharged through a load with constant current for a time interval ΔT after the switch is closed. The load in this case is a diode in series with a battery. Resistance R_0 represents the sum of the diode resistance, the switch resistance, and any other resistance in the circuit. The R-L network is inserted as before and the analysis is similar.

A new term, E_0, will appear in Eq. 3 and 8. However, this term disappears when Eq. 8 is differentiated, resulting in the same Eq. 9 and consequently the same two relationships: $R = \sqrt{L/C}$, and $\Delta T \ll L/R$.

If it is desired to close the switch and maintain a constant current through R_0 for a short period of time ΔT in the series circuit of Fig. 3A, a choke and resistor are again inserted as in Fig. 3B. Equations are again identical with those for a discharging circuit, except that the right-hand side of Eq. 3 and 8 is E_0 instead of zero. This term disappears when Eq. 8 is differentiated. Thus the analysis is the same as before, and the same relationships hold.

Although it is not a resistor-capacitor circuit, the following analysis is included here because it is also a case of maintaining a constant current in an exponential circuit.

In a circuit including resistor, inductor, and battery as shown in Fig. 4A it is again desired to close the switch and maintain a constant current through R_0 for a short time ΔT. This result is accomplished by inserting a resistor and capacitor as shown in Fig. 4B. Just as before, and for similar reasons, ΔT must be short compared to the time constant of the inserted network. That is, $\Delta T \ll RC$.

Although the characteristics of this circuit are comparable to those of the resistor-capacitor circuit previously analysed, the mathematical

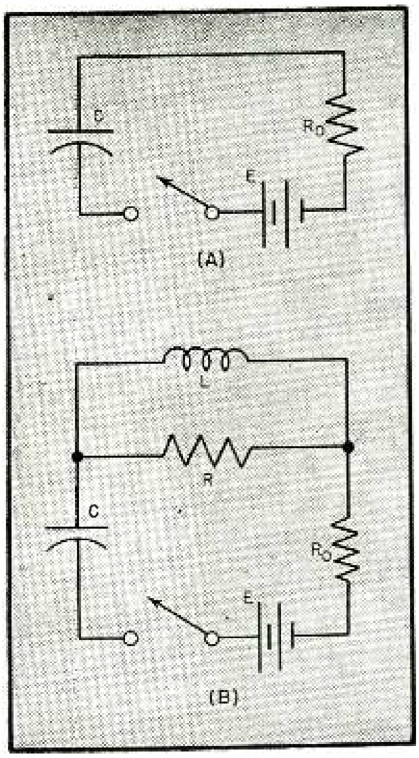


FIG. 3—Instead of discharging a capacitor, as in Fig. 1, the capacitor can be charged in the manner shown here

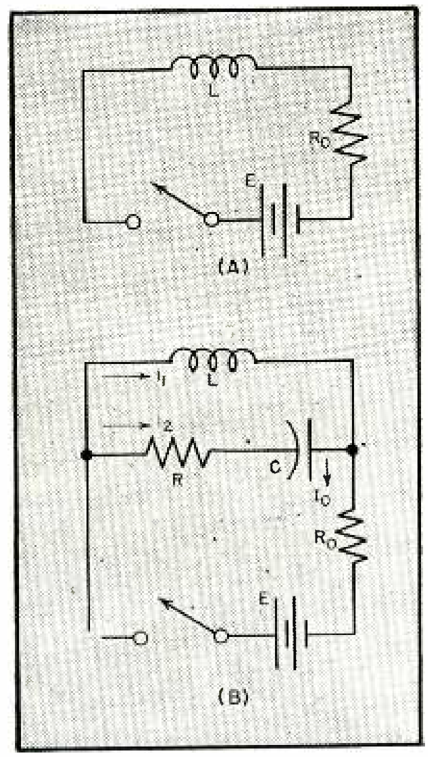


FIG. 4—(A) An inductor can replace the capacitor of Fig. 3. Corrective network (B) contains inductance

analysis for this resistor-inductor circuit is included here. As before, by Kirchhoff's Laws

$$L\frac{di_1}{dt} + I_0R_0 = E \quad (10)$$

$$R\frac{dq}{dt} + \frac{q}{C} + I_0R_0 = E \quad (11)$$

$$i_1 + i_2 = I_0 \quad (12)$$

From Eq. 10

$$\frac{di_1}{dt} = \frac{E - I_0R_0}{L}$$

From which by integration

$$i_1 = \frac{E - I_0R_0}{L}t + A$$

When $t = 0$, $i_1 = 0$, thus $A = 0$, and

$$i_1 = \frac{E - I_0R_0}{L}t \quad (13)$$

Likewise, from Eq. 11

$$q = B\epsilon^{-(1/RC)t} + (E - I_0R_0)C$$

As in the original circuit analysed, this simplification is permissible because $\Delta T \ll RC$. When $t = 0$, $q = 0$, thus $B = -(E - I_0R_0)C$, and

$$q = C(E - I_0R_0)(1 - \epsilon^{-(1/RC)t})$$

But $i_2 = dq/dt$, and therefore

$$i_2 = \frac{E - I_0R_0}{R}\epsilon^{-(1/RC)t} \quad (14)$$

Substituting the values of i_1 and i_2 given by Eq. 13 and 14 into Eq. 12 gives

$$\frac{E - I_0R_0}{L}t + \frac{E - I_0R_0}{R}\epsilon^{-(1/RC)t} = I_0 \quad (15)$$

Diqerentiating Eq. 15 gives

$$\frac{E - I_0R_0}{L} - \frac{E - I_0R_0}{R^2C}\epsilon^{-(1/RC)t} = 0 \quad (16)$$

During the short interval ΔT, $E - I_0R_0$ does not equal zero. Also, if ΔT is very small compared to RC, $\epsilon^{-(1/RC)t}$ is approximately unity. Therefore Eq. 16 reduces to the same relationship as previously obtained: $R = \sqrt{L/C}$. It should be noted that in this case, as before, the result is independent of the value R_0.

Magnetron Application

The circuit in Fig. 2 is similar to a discharge circuit used in some radar transmitters, and the load represented is essentially the equivalent circuit of a magnetron. The magnetron impedance is nonlinear, having a volt-ampere characteristic similar to that shown in Fig. 5. In general, the dynamic impedance is not constant over a wide range of voltage and current. However, over a small operating range the magnetron can be represented to a good approximation by the circuit shown in Fig. 6, consisting of a linear resistance equal to $\Delta E_M/\Delta I$, a perfect rectifier, and a battery E_0, where E_0 is the voltage intercept of a line drawn tangent to the curve at the operating point.

In one application the capacitor is charged between pulses through a resistance from a d-c source. The switch is a vacuum tube which is normally nonconducting but is turned on at regular intervals to discharge part of the stored energy into the magnetron in the form of rectangular pulses. With a constant magnetic field applied to the magnetron, the output frequency of the magnetron is a function of its peak current. Consequently, to prevent frequency shift during the pulse, it is important that the discharge current be maintained very nearly constant.

Of course, the current can be held nearly constant by making the capacitor C very large. However, high-voltage capacitors are physically large and heavy, and therefore present serious difficulty in aircraft sets where space and weight are at a premium. Addition of the resistance-inductance network permits the use of smaller capacitors for a given pulse duration, or with a given size capacitance the pulse generator can produce longer pulses. These advantages are best illustrated by numerical example.

First consider the case without the addition of the resistance-inductance network. The current is found by simple circuit analysis

$$i = \frac{E - E_0}{R_0}\epsilon^{-(1/R_0C)t} \quad (17)$$

Typical values are
E = 14,000 volts
E_0 = 11,500 volts
R_0 = 200 ohms
C = 0.1 microfarad

Thus

$$i = \frac{14,000 - 11,500}{200}\epsilon^{-(10^6/20)t}$$

At the moment of closing the switch the current is 12.5 amp. After one microsecond the current is 11.9 amp. This change represents a current drop of about five percent, which is barely tolerable with some magnetrons.

Now an R-L network is inserted, giving the circuit of Fig. 2 with $L = R^2C$. The resistance might be 50 ohms. The inductance must be 250 μh, and $(L/R) = 5 \times 10^{-6}$. By conventional circuit analysis the current as a function of time is found to be

$$i = \frac{E - E_0}{R + R_0}(1/2\beta) \times [(\beta - \alpha)\epsilon^{-(\beta + \alpha)t} + (\alpha + \beta)\epsilon^{-(\alpha - \beta)t}] \quad (18)$$

where $\alpha = 1/2RC$

$$\beta = \alpha\left[\frac{R_0 - 3R}{R_0 + R}\right]^{1/2}$$

At the moment of closing the switch the current is now ten amperes. After one microsecond it has fallen to 9.96 amp. In this case the current drop is less than 0.5 percent.

If it were desirable to maintain the same magnetron operating point as before with an average pulse current of approximately 12.2 amp, it is only necessary to raise the voltage on C to 14,550 instead of 14,000 volts.

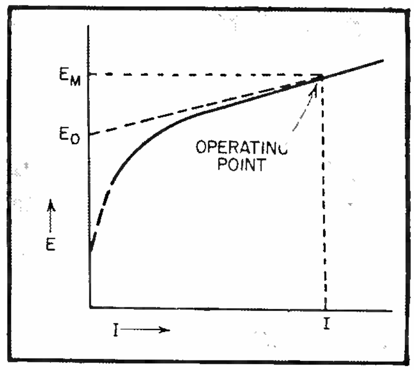


FIG. 5—Load characteristics of d-c anode circuit of magnetron can be simulated by battery and resistor

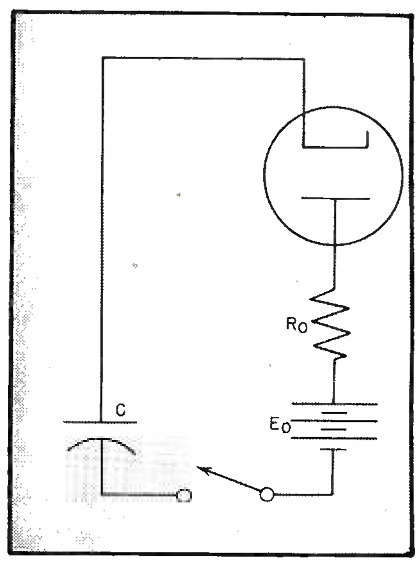


FIG. 6—An equivalent magnetron pulsing circuit containing a storage capacitor

The initial current is then 12.20 amp, and at the end of one microsecond i = 12.15 amp, still less than a 0.5-percent droop.

With the voltage raised to 14,625 volts, the initial current is again 12.5 amp, but it takes four microseconds for it to drop to 11.9 amp, the value reached in one microsecond without the addition of the resistance-inductance network. Thus the *R-L* network permits increasing the pulse length by a factor of four, provided the same percentage droop in current can be tolerated as for the shorter pulse.

If C =0.025 μf and R remains 50 ohms, L must be 62.5μh. Then with E = 14,625 volts, the initial current is 12.5 amp, and at the end of one microsecond, i = 11.9 amp. Thus, for one microsecond pulse duration the capacitance can be decreased by a factor of four without causing a greater droop than was obtained without the *R-L* network.

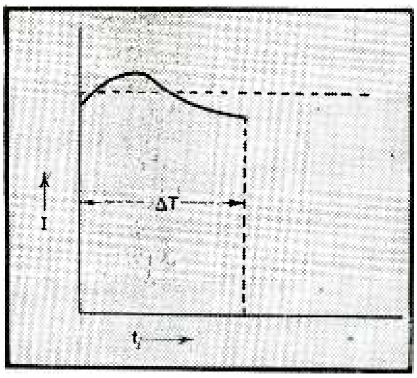


FIG. 7—Percent deviation from a constant level over a given time can be reduced by adjusting the corrective network

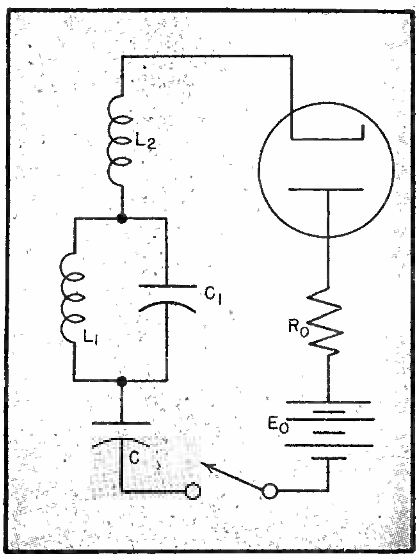


FIG. 8—A corrective network can be made entirely of reactive elements

It may be noticed that the values of L/R in all these examples do not perfectly satisfy the requirement that $L/R \gg \Delta T$, and that the assumption that $\epsilon^{-(R/L)t}$ equals unity for the duration of the pulse is not quite true. As a result, the current pulses are not constant but droop slightly. To fulfill this condition rigorously and also have $L = R^2C$, it would be necessary to choose higher values for R and L. Then this droop would be practically eliminated, but as R is increased, the power supply potential E must be increased, and the power loss in R becomes greater. In practice, the selection of values of R and L is a compromise between minimum current droop and minimum power loss.

The requirement that $L = R^2C$ is also not critical. When the condition $L/R \gg \Delta T$ is rigorously fulfilled, a value of L less than R^2C would cause the current to rise linearly during the pulse, whereas if L were greater than R^2C, the *R-L* network would not be entirely effective in minimizing the current droop. In some cases it may be better to choose L less than R^2C, and L/R of the same order as, or even less than, ΔT so that the current, although remaining within an allowable percentage deviation from a specified mean value, first rises and then falls as shown in Fig. 7.

Practical Design

By more comprehensive circuit analysis or by experimentation, values of R and L can be determined for any given set of conditions which will permit increase in pulse duration ΔT or decrease in the required value of storage capacitance up to a factor of eight or ten, with very small loss of power. To obtain best results, the choice of R and L can also be influenced to some extent by other practical considerations not mentioned here. For example, it is conceivable that under certain conditions stray capacitance across the pulse generator switch and across the magnetron may form a resonant circuit with L and give rise to undesirable postpulse oscillations. A compromise in the choice of R and L may be necessary to produce the necessary damping.

Work was done by B. Chance, R. M. Walker, and others at Radiation Laboratory and elsewhere on improvement in linearity of voltage rise across capacitors used in timing circuits, beginning in 1942. One method employed inductance in series with resistance and capacitance, with appropriate tube switching to select only a small, linearly rising portion of the exponential voltage. However, in these low-level circuits power loss is usually an unimportant consideration and magnitudes of resistance, inductance, and capacitance differ appreciably from those recommended by the preceding analysis.

For a treatment of linear timing circuits the reader is referred to the Radiation Laboratory Technical Series volume entitled "Waveforms" now being edited for publication. For a recent application of the parallel resistor-inductor network to improve linearity of high-speed sweep see Radiation Laboratory Report 1001 by D. F. Winter, and the as yet unpublished Radiation Laboratory Technical Series volume entitled "Cathode Ray Tube Displays".

Dissipationless Circuit

Another method for minimizing magnetron pulse current drop has been suggested both at Radiation Laboratory and elsewhere. A. A. Varela, Naval Research Laboratory, Washington, D. C., described the use of an *L-C* network composed only of passive elements L_1, L_2, and C_1, as shown in Fig. 8. The network is used in place of the parallel *R-L* unit. Such a network will accomplish the desired result but has the disadvantage of requiring one more circuit element including a second capacitor of medium voltage rating. Although this type of pulse-forming network is composed of lossless elements, the voltage drop during the pulse due to the network surge impedance causes an effective loss in pulse power which is comparable to losses in equivalent *R-L* networks. The energy remaining in L_1, C_1, and L_2 at the end of the pulse may be dissipated in post pulse oscillations. Therefore, in view of these considerations, it seems advisable for most applications to use the simpler *R-L* network.

This paper is based on work done for the Office of Scientific Research and Development under contract OEMsr-262 with the Radiation Laboratory, Massachusetts Institute of Technology.

Vhf Antenna For Trains

By E. G. HILLS

Engineer

Belmont Radio Corporation
Chicago, Ill.

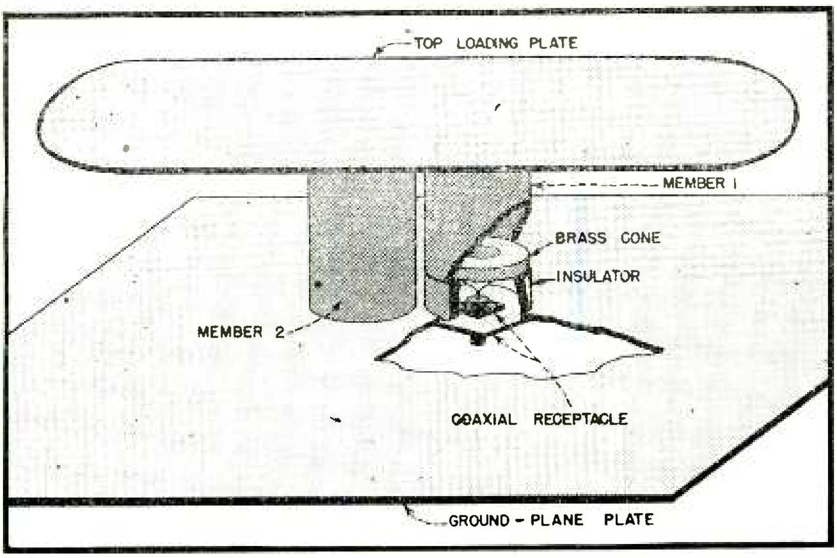


FIG. 1—Cutaway shows method of feeding antenna

An antenna for use in the 158-162 mc band on trains must satisfy several requirements. It should be essentially omnidirectional in the horizontal plane because the train may be oriented in any direction with respect to the various fixed stations with which communication is desired. The angle of radiation of the antenna should be kept as low as possible in order to get a maximum concentration of energy in the horizontal plane because the omnidirectional requirement prohibits concentrating the energy in one horizontal direction at a sacrifice in some other horizontal direction. The antenna should be sufficiently rugged mechanically that men walking along the top of the train can take hold of it for support without causing damage to it.

At the present writing, indications are that train antennas should be vertically polarized as audio modulation caused by the train moving past telephone poles and other structures along the right of way seems to be less troublesome for vertical than for horizontal polarization.[1]

Choice of Antenna Design

In order to get the maximum energy concentration in a horizontal plane, the most desirable type of antenna would be vertical colinear array placed as high on top of the train as possible. Because of the restricted clearances of most railroads this type of array is obviously impossible at these frequencies. The next best type of antenna is one that uses all of the available clearance and is tailored in dimensions and current distribution for the particular installation.

Two possibilities that exist are that of placing a relatively long vertical antenna on some low part of the train such as on the tender, or of placing a short vertical antenna on a high portion of the train such as on the engine cab. The chances are that, with the first possibility, reflections from adjacent parts of the train that are as high as part of the antenna would cause the radiation pattern to be far from omnidirectional and could quite easily cause the radiation to be concentrated in the least desired directions. Following the second possibility, an antenna was designed with such small height that it can be placed on top of a train that has approximately five inches of clearance.

Figure 1 shows the method of feeding the completed antenna. Because of corrosive fumes present behind a steam locomotive, the antenna is constructed of stainless steel. A rather wide base insulator is used to provide a long leakage path across the 50-ohm feed point in order to minimize the effects of soot deposited on the insulator.

The antenna is 5-in. or 24.3° tall and is top loaded by means of an oblong plate so that the current is nearly constant throughout the height of the antenna, being a maximum at the top. As shown, Member 2 is a steel pipe welded to the loading plate and to the ground plane, thus forming the second leg of a folded monopole. The folded type of construction was chosen for its mechanical strength and because it furnished a simple means for increasing the radiation resistance of the rather short antenna in order to facilitate the matching to a 50-ohm transmission line.

Impedance Relations

Figure 2 shows the phase and amplitude of the measured current distribution in the two members of the monopole. By changing the shape of the loading plate on top of the antenna it is possible to control this current distribution within limits. It was found necessary to extend the loading plate slightly farther on the side of the top fed member than on the side of the base fed member in

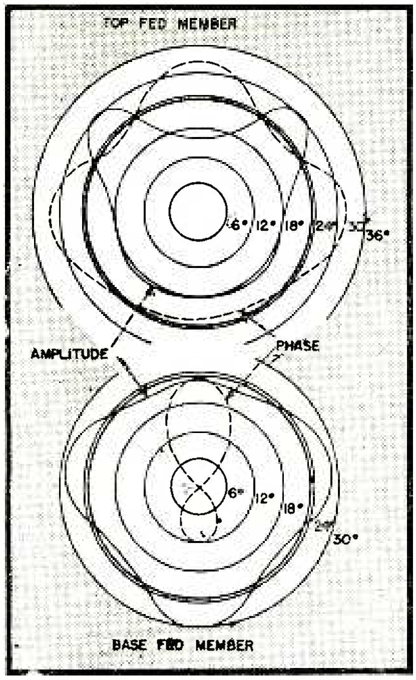


FIG. 2—Current distribution at base of antenna radiators

Top loaded, folded, vertically polarized, monopole antenna concentrates radiation close to the ground in an omnidirectional pattern. Antenna is only five inches high. mechanically rugged. and has an input impedance of fifty ohms. Design techniques are described

order to make the current approximately uniform around the two members.

Assuming that the radiation due to the current distribution is the same as that due to a thin filament of current located midway between the two members of the antenna and equal to the vector sum of an infinite number of filaments of which the actual current distribution can be considered as being composed, the radiation resistance measured at the bottom of the base fed element can be computed quite simply. This assumption is not rigorously correct because of phase differences between radiations of the various filaments in the actual distribution and also because of variations in the top loading of the different filaments, but is close enough to give a useful answer. A graphical determination of the vector sum of the current filaments in the actual distribution gives a current of 13.3 at plus 12.4° for both monopoles together and a current of 8.2 at 11.8° for the base fed member alone. The unit in which these currents are measured is not important as it cancels out in the resistance computations.

Where R_a is the radiation resistance of the imaginary filament at the center of the antenna which is considered as carrying all of the current, the power radiated by the whole antenna is $13.3^2 R_a$. The radiation resistance referred to the current at the feed point is the antenna power divided by the square of the current at the feed point[2] and is

$$(13.3/8.2)^2 R_a = 2.62\ R_a \qquad (1)$$

Antenna Feeding

Figure 3 shows the current distribution in a vertical plane of the antenna. It will be noted that the antenna is not fed at a current loop but is fed below the current loop. There are two reasons for this practice. One is that, by raising the position of the current maximum in an antenna of this type to a point near the top, it is possible to increase the radiation along the horizontal[3]. The other is that, due to the need for a large, rugged base insulator which shunts the feed point with a capacitance, it is desirable for purposes of matching to the transmission line to make the antenna slightly inductive. Feeding the antenna at a point below the current loop not only has the effect of making the antenna inductive, but also causes the radiation resistance to increase by a factor $1/\sin^2 G$ where G is the angular height above the base to the point at which the antenna current would reach a minimum if it were not suppressed by the top loading plate.[4]

The radiation resistance of the current filament referred to a current loop can be computed from the formula[4]

$$R_r = 30 \left\{ \sin^2 B\,[(\sin 2A/2A) - 1] - 0.5 \cos(2G) S_1(4A) + [1 + \cos(2G)] \times S_1(2A) + \sin(2G)\,[0.5\,\mathrm{Si}(4A) - \mathrm{Si}(2A)] \right\} \quad (2)$$

where $G = A + B$, and A is the angular height of the antenna top above the ground plane and B is the angular height of suppressed radiation, and $S_1 = \ln X + 0.5772 - \mathrm{Ci}(X)$.

$$\mathrm{Si}(X) = \int_0^X \frac{\sin x}{x}\,dx$$

$$\mathrm{Ci}(X) = \int_\infty^X \frac{\cos x}{x}\,dx$$

This radiation resistance is 6.77 ohms. Referring this resistance to the base of the antenna gives $6.77/\sin^2 114.3° = 8.15$ ohms. Substituting this value in Eq. 1 gives 21.4 ohms. Because the value of G is greater than 90°, the antenna has an inductive component of 25 ohms at the base. The negative susceptance due to this inductive component is cancelled by the positive susceptance due to the capacitance of approximately 43 ohms across the bakelite insulator at the base of the monopole as seen in Fig. 1. The equivalent circuit of the feed point is shown in Fig. 4. It is the circuit of a parallel resonant circuit of extremely low Q. The input impedance of the antenna is therefore the parallel resonant impedance of this circuit and is a pure resistance of 50 ohms.

In the actual development of the antenna, preliminary calculations were made assuming an increase of radiation resistance due to the folding of the monopole of three over R_a rather than the 2.62 finally obtained. The amount of top loading required to give the desired vertical current distribution was determined experimentally by sliding three metal plates over each other until a value of total current with respect

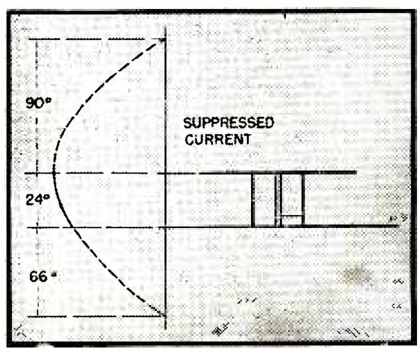


FIG. 3—Vertical distribution of antenna current

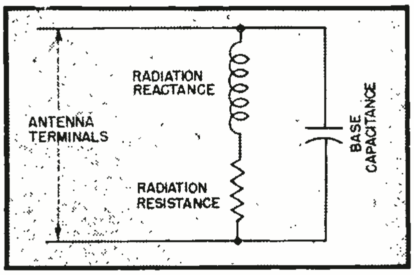


FIG. 4—Equivalent circuit of antenna as seen from its input

to current in the base fed member was found for which there existed a single value of base capacitance that would make the antenna resistive at the same time that its impedance was 50 ohms. The standing wave ratio of the antenna taken on a 50-ohm line is shown in Fig. 5. The impedance match is affected by the size of the ground plane and with the 30- by 30-in. steel plate for ground, the standing wave ratio is 1.1 to 1.0.

Radiation Pattern

As may be expected, the effect of the ground plane is very great on the radiation pattern of the antenna. Figure 6A shows the vertical radiation pattern with only a 30- by 30-in. steel plate as a ground plane. Figure 6B shows the radiation pattern taken with a 6- by 6-ft. screen as a ground plane. Figure 6C shows the radiation pattern with an infinite ground (taken by mounting two identical antennas base-to-base on a rotating pedestal, thus replacing the image of one antenna in the ground by an actual antenna). Also shown on Fig. 6C is the theoretical pattern computed from the current distribution of Fig. 3[4].

The horizontal radiation pattern of the antenna is nearly circular with the radiation in a direction at right angles to a plane formed by the two members of the monopole being ten percent less than that in the direction of their plane.

The problem of obtaining directivity in an antenna to be used atop a train is rather difficult because the least space is available in the direction in which it is the most needed, namely, the vertical. Antennas of the type described in this paper are nice mechanically but their only claim to concentration of energy into the vertical plane is that they get the current maximum as high above the train as possible. The possibility exists of placing several such top loaded antennas atop a train in the form of an array to give greater directivity when communication is to be carried on with a station or stations in a constant direction with respect to the axis of the train. An array of extremely high directivity could be obtained by placing many such antennas along the top of the train in the form of an

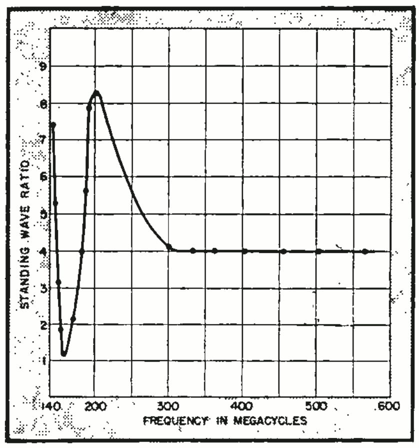


FIG. 5—Standing-wave ratio produced on a 50-ohm line by the antenna

end-fire array and switching the transmitting and receiving equipment to this array when the train is going to be on a stretch of straight track for many miles.

It is difficult if not impossible to predict what the pattern of a single antenna will be when placed atop trains in which space for a ground plane is limited. The most obvious recourse is to investigate, by field measurements on the train itself, the direction in which energy is radiated. The patterns of Fig. 6A and 6B indicate that greater signals are obtained along the horizontal with the smaller ground plane. This result is probably because the 30- by 30-in. ground plane was so small that it did not prevent antenna currents from flowing in the column on which the antenna was mounted during test.

The curve of Fig. 6C is calculated on the assumption that there is no radiation from the top loading plate. This assumption is not valid because the loading plate is an appreciable portion of a wave length long, and even if the current distribution in the plate were symmetrical about the two axes of the plate, radiation from the plate would be zero only in directions normal to the plate. The currents in the vertical members of the antenna as shown in Fig. 2 indicate that the distribution in the loading plate can not be symmetrical so that radiation should be expected even in directions normal to the loading plate.

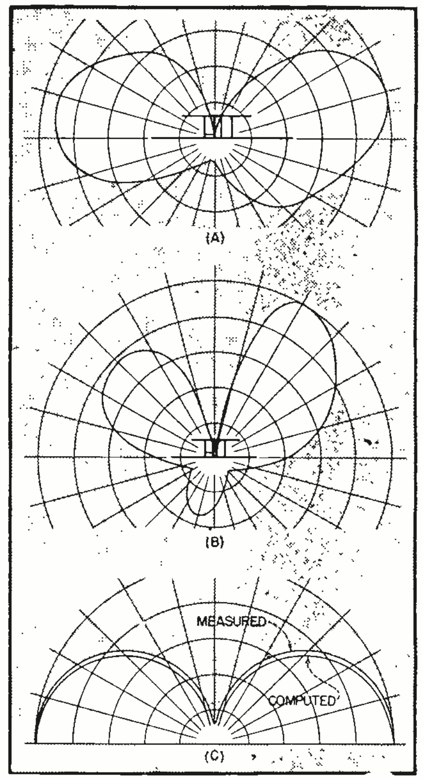
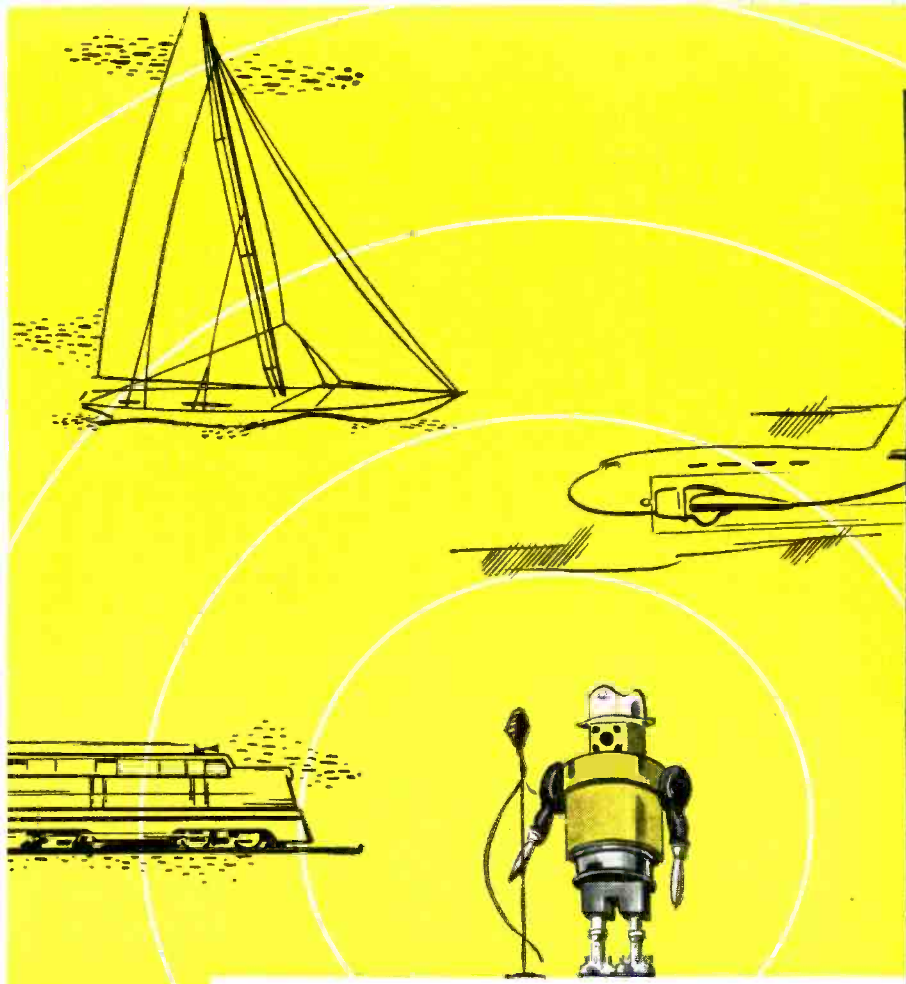


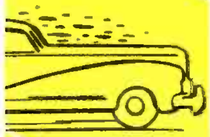
FIG. 6—Vertical radiation pattern of antenna with (A) a 30-in. square ground plate, (B) a 6-ft. square ground plate, and (C) an infinite ground plate

There are of course many manners in which the impedance of an antenna of this type could be matched to the transmission line. One of the most obvious would be to use top loading such that the value of *G* would be 90° and then use a top fed member of such diameter that the radiation resistance of the combination would equal the characteristic impedance of the transmission line.

REFERENCES

(1) Wigton, T. W., Railroad Radio Communication on the V.H.F.'s, *Radio*, Aug 1945, p 36.
(2) Carter, P. S., Simple Television Antennas, *RCA Review*, Oct 1939, p 168.
(3) LaPaz and Miller, Optimum Current Distributions on Vertical Antennas, *Proc. I. R. E.*, May 1943, p 214.
(4) Brown, G. H., A Critical Study of Characteristics of Broadcast Antennas, *Proc. I. R. E.*, *Jan.* 1936, p. 48.





CINCH KNOW HOW

Motion pictures, telephone, airborne radio, broadcasting equipment, electric organs and other electrical equipment need instant replacement when failures in electronic circuits occur at the capacitor connections. Cinch Know How solved this problem. Write for details and samples of our copacitor plug-in sockets.

CAPACITOR PLUG-IN SOCKET

CINCH MANUFACTURING CORPORATION
2335 WEST VAN BUREN STREET • CHICAGO 12, ILLINOIS
Subsidiary of UNITED-CARR FASTENER CORP., Cambridge, Mass.

Mutual Inductance of Concentric Coils

For air-core transformers with greater length than diameter, such as are generally used in r-f service, this nomograph provides pertinent design data in three settings of a straightedge and clearly shows the effects of changes in parameters

By THOMAS C. BLOW

Massachusetts Institute of Technology
Cambridge, Mass.

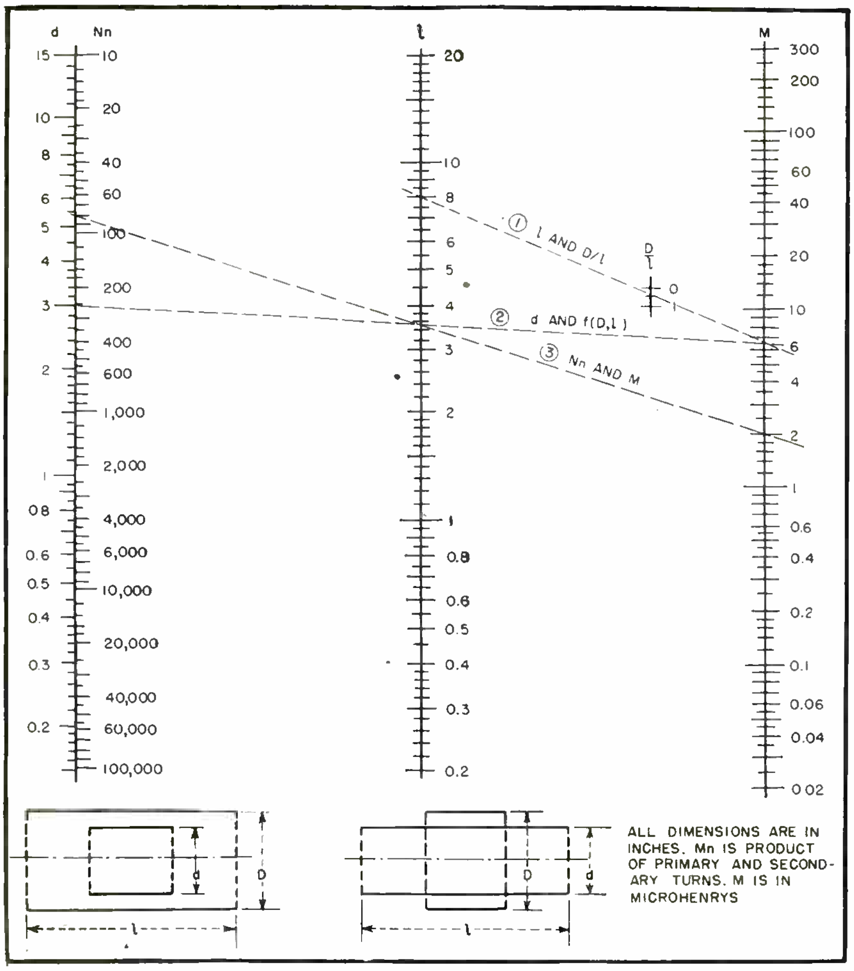
MUTUAL INDUCTANCE between two concentric single-layer air-core solenoids is a circuit value that defies simple analysis. Mutual inductance is dependent on coil dimensions in such an involved manner that design of a radio-frequency transformer is difficult. This nomogram facilitates the design of these transformers.

Examination of the relationship for coaxial solenoids (Circular C74, National Bureau of Standards, Jan. 1937, p 281-282) reveals that for values of D/l less than unity the formula reduces approximately to

$$M = 0.0251 \frac{d^2 Nn}{(D^2 \times l^2)^{1/2}}$$

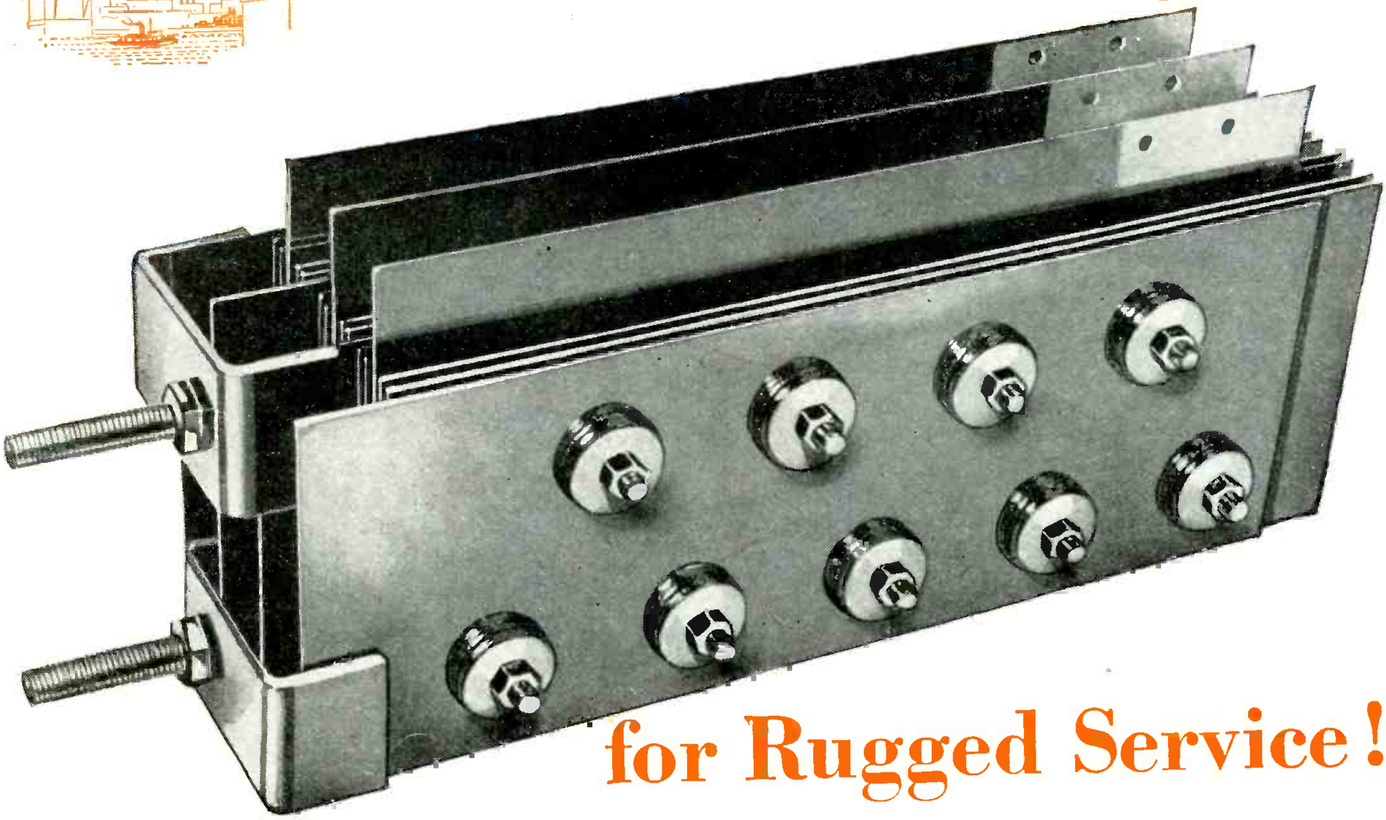
The accuracy of this approximation is within three percent for most conditions. From this formula a simple nomograph, which allows an investigation of the effects of the parameters, can be plotted. For given coil dimensions, M is directly proportional to the product of primary and secondary turns. For a given value of d, the outer diameter D does not greatly influence the mutual inductance, and the length of the shorter coil has no effect on the mutual inductance.

To show the use of the chart, consider a design where the outer coil is to be the shorter. Choosing l as 8 in., d as 3 in., and D as 4 in., draw a line (1) through $l = 8$ and $D/l = 0.5$ extending to the M scale. Connect this intersection on M to $d = 3$ with a straight line (2). Use the resulting intersection with the l scale as a turning point for selecting compatible values of Nn and M, draw a straight line (3). If, as shown, the mutual inductance is to be 2 mh, the turns product should be 80. With 16 turns on the longer coil, 5 turns would be required on the shorter one. It should be noted that the 5 turns can be wound with any spacing without materially changing the value of M. The chart can be used to determine any one of the variables l, d, D, Nn, or M when the others are known as long, as the sequence of operations is preserved, namely 1,2,3 or 3,2,1.



ELECTRONICS REFERENCE SHEET

Built Like a Steel Bridge . . .



for Rugged Service!

THERE are no liquids, bulbs or moving parts in Mallory magnesium copper sulphide rectifiers. There's nothing to give trouble or wear out quickly.

On the contrary, Mallory rectifiers are solid and compact—built of metal throughout. They are practically immune to injury or abuse.

Even should one of the radiating plates accidentally suffer damage, the efficiency of the rectifier would not be affected. That's because all the vital rectifying material is *inside* the rectifier—the outside fins are for radiation only.

Right from the start you can depend on Mallory magnesium copper sulphide rectifiers for extra strength and operating life . . . just two more reasons why they outsell all other types of dry disc rectifiers. See your Mallory distributor or write direct for literature or engineering help.

*Reg. U. S. Pat. Off.

MALLORY
Magnesium Copper Sulphide
RECTIFIERS

- Durable all-metal construction
- Small size, light weight
- No moving parts to wear out
- Output unaffected by temperatures
- Maximum overload range
- Constant output during rectifier life
- Low operation cost

(Above) *The Udylite Mallory Rectoplater** ***UM-1500A****, one of a complete line of DC Power Supply Units manufactured by Mallory. It incorporates Mallory Rectifier 6 SPR 750 illustrated at the top.*

P R MALLORY & CO Inc

MALLORY RECTIFIERS

MAGNESIUM COPPER SULPHIDE RECTIFIERS—STATIONARY AND PORTABLE D. C. POWER SUPPLIES—BATTERY CHARGERS AND AVIATION RECTOSTARTERS*

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

TUBES AT WORK

Edited by VIN ZELUFF

Pulse Time Modulation Circuits

CIRCUIT DATA on pulse time modulation (ELECTRONICS Jan. 1945 p 100) has been released by Federal Telecommunication Laboratories at a recent demonstration. The method of multiplexing involves the transmission of a series of pulses, each about 0.5 microsecond, which are modulated by varying the time interval between pulses. At the receiver, proper selection of the pulses is made by simple timing circuits so that several channels can be transmitted on a single carrier.

The transmitting equipment demonstrated takes eight modulating signals from several studios at line level over an audio-frequency range of 50 to 9000 cycles per second. Eight sequences of pulses, derived from a common pulse generator, are individually time-modulated by the corresponding programs, interleaved with a sequence of marker pulses, and fed to the r-f modulator for further amplification and keying of the 930-megacycle oscillator. The output of the transmitter is approximately 800 to 1000 watts peak and 40 to 50 watts average. This is fed to a vertically stacked loop antenna having a gain of 9 decibels over a dipole throughout 360 degrees in a horizontal plane.

A block diagram of the system is shown in Fig. 1. The multiplex modulator consists of a sawtooth pulse generator, a delay line synchronizer, an audio amplifier for each channel, a time modulator for each channel, a marker pulse shaper, and a mixer shaper.

The 9,000-cycle audio fidelity is assured by the use of a 24-kc sawtooth pulse generator, and the basic timing of the pulse channels is obtained by a series of stable time delay elements, tapped at nine successive points. By this method, nine pulse sequences are produced, each having the basic 24-kc repetition rate, but displaced from the previous sequence by an equal time interval.

One pulse sequence is fed to the marker pulse shaper which generates a double pulse for use as a time reference base in separating the various programs at the receiver. The remaining eight sawtooth pulse sequences are fed to the corresponding time modulators of each program channel where they are converted to rectangular pulses varying in time displacement, relative to the marker pulse, in accordance with the applied audio signal.

After time modulation and marker shaping, the nine pulse sequences are interleaved and fed to the mixer shaper for further amplification and improvement of pulse shape. From here the pulses are transmitted at a peak level of five volts over 70-ohm solid dielectric coaxial transmission line to the r-f transmitter. The repetition rate of the combined pulse sequence is 9 × 24 kc or 216 kc.

R-F Section

The r-f transmitter consists of a modulator and an oscillator. The modulator is a wide-band pulse amplifier raising the time-modulated pulses from five volts to approximately 300 volts for grid keying the 930-mc oscillator. The latter contains an air-cooled uhf triode type 2214-B which is tuned by an auxiliary resonant coaxial-line element. Single-control tuning is provided within the operating range of 920 to 940 mc and pretuning to this frequency range is accomplished by adjustable shorting sections in the resonant transmission line elements. The oscillator has high inherent frequency stability so that further stabilization is omitted in the experimental equipment.

A calibrated frequency meter mounted on the control panel is provided for monitoring purposes, and oscilloscope jacks are available for examining the pulse output characteristics. An output power detector can be used in routine maintenance checks.

Receiver Circuits

The directive receiving antenna consists of a double dipole at the focal point of a parabolic reflector. This has a gain of 17 db in the re-

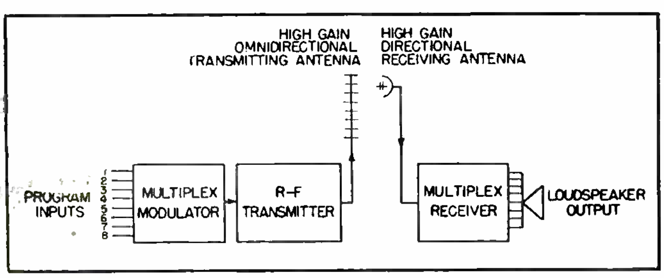


FIG. 1—Basic portions of Federal's pulse time modulation system. Use of the omnidirectional transmitting antenna permits broadcasting services

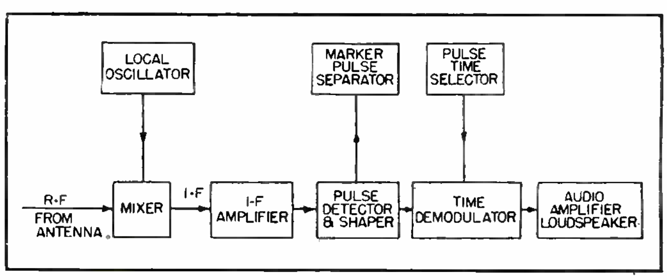
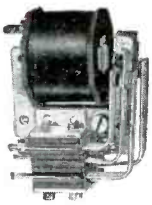


FIG. 2—In the receiver, pulses are separated and sorted to provide eight 9,000-cycle audio channels and/or audio, facsimile, and telegraph services

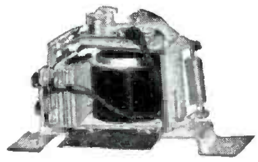
TOMORROW'S

RELAYS

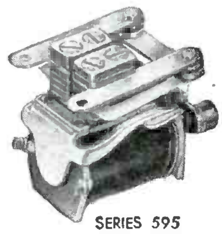
FOR DESIGNS OF TODAY



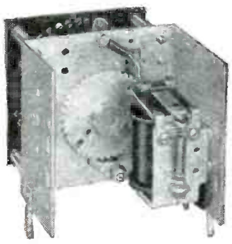
SERIES 40 A C
LAMINATED RELAY



SERIES 150

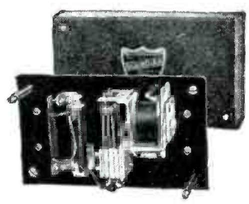


SERIES 595
MIDGET RELAY



SERIES R STEPPER

SERIES 1-A
SOLENOID



SERIES T-110
TIME DELAY RELAY

Behind this view of typical Guardian Relays . . . designed for today and tomorrow . . . is a myriad of modern products that start, stop, count, time, see, hear, talk, fly, select, record . . . each controlled by Guardian Relays. Behind the scene at Guardian Electric, alert, *experienced* engineers are constantly thinking and planning ahead to benefit product designers in every branch of American industry.

Guardian Relays, specified by design engineers because of incredible responsiveness and dependability, operate day and night. Continuously. Unfailingly. *Basic* in type, the majority of Guardian Relays are adaptable to an almost endless number of variations. Where "specials" were formerly deemed necessary, variations of Guardian *basic* type relays have proved better qualified on *performance—price—delivery*. Yet, if a "special" unit or complete control assembly is needed, Guardian's expert engineering is at your command. Write for Bulletin TR-9.

GUARDIAN ELECTRIC

1625-M W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY ceiving direction. The receiver is fixed tuned and, as shown in Fig. 2, its circuit is conventional in the front end with a local oscillator, a mixer, and an i-f amplifier. To these are added a pulse detector and limiter, a marker pulse separator, a pulse time selector, and a time demodulator that acts as the audio detector. A type 1N28 crystal is used in the mixer, and a broad i-f bandwidth is provided to pass the pulse frequencies. This also aids in stability requirements and minimizes regeneration.

The pulse detector is of the conventional amplitude type and includes clipping and shaping of the pulses for further signal-to-noise improvement. The pulses are then passed on to the audio detector which performs two functions, time selection of the desired pulse channel, and its demodulation to give the audio program output.

Delayed Marker Pulse

The marker pulse is separated from the channel pulses by means of its double pulse characteristic and fed to the pulse time selector. Here it is delayed in timing, by an amount which depends upon the setting of the selector switch, so as to coincide with the desired channel pulse sequence. The delayed marker pulse is then fed to the time demodulator along with the combined program pulse sequences. Operation of the time demodulator or audio detector tube is controlled by the delayed marker pulse so that it functions only at those instants of time corresponding to the arrival of the desired program pulse sequence. The detected program signal is then fed to the audio amplifier and loud speaker or associated terminal gear in the case of special services.

Eight time demodulator sections connected to the different switching points in the pulse time selector section permit all programs to be received simultaneously and distributed for ultimate selection by a number of audio speaker sections, and/or terminal equipment for facsimile and various types of telegraphic services.

Since each channel has a bandwidth of 9,000 cycles, and since telegraph circuits require only about 200 cycles for 60 word-per-minute transmission, the use of tone filters enables the number of sub-channels for such use to be multiplied. Therefore either the whole width of each channel may be used for high-fidelity sound, or a considerable number of telegraphic services may be sent over it.

In last year's demonstration of 24-channel ptm, electronic switching involving cyclophon cathode-ray tubes was used to assemble the pulses in correct sequence at the transmitter and sort them out at the receiver. The nonelectronic LC delay lines used in place of switching tubes in the latest demonstration utilize techniques developed during the war for radar pulse circuits, and illustrate emphatically that the efficiency and success of pulse time modulation does not hinge on specially designed switching tubes. Still other ways of assembling and sorting pulses are being tried by I.T.&T. engineers, with many offering promise of future useful application.

Reactance Comparator

Rapid Comparison of inductors, capacitors, or combinations of the two is accomplished by the Mervyn reactance comparator. Basically it consists of two similar circuits containing inductance and capacitance. One circuit forms part of a very stable oscillator while the other is a high-Q resonator, the two being very loosely coupled.

The natural frequency of the resonator is varied about the mean figure in synchronism with a pointer vibrating in front of a scale. At the instant when the resonator's natural frequency equals that of the oscillator, the scale is illuminated by a brief flash of light from a neon lamp. This action is repeated at the line frequency so that when the two circuits are equal the pointer appears to remain still due to the stroboscopic effect.

The basic circuit of the instrument is shown in Fig. 1. A dynatron oscillator is used as the standard since it will oscillate readily with any combination of inductance and capacitance, has high dynamic resistance at its resonant frequency, and does not require a tapped or double-wound coil because it is a negtive-resistance oscillator. The natural stability of the output is increased by coupling it to an amplitude limiter consisting of a diode which rectifies some of the dynatron output and uses it to reduce the oscillator's cathode current to a level determined by the setting of the delay bias on the diode.

The resonator circuit is similar to that of the oscillator except that the amount of negative resistance supplied by the dynatron tube is controlled manually to a point where the Q of the LC circuit is high, but is below the self-oscilla-

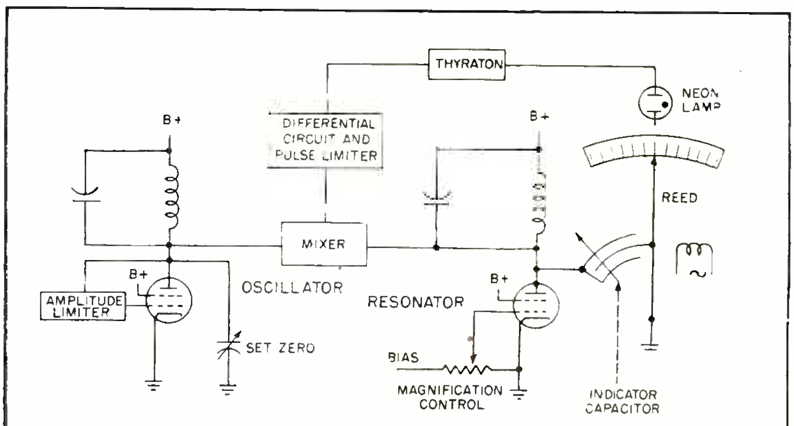


Fig. 1—Essential stages of the reactance comparator. Within its useful range, inductance can be checked against a standard with an accuracy better than one percent, and capacitance within 0.1 percent

All Metal RHEOSTATS

... Increased Quantities Now Available on Short Delivery Cycle!

PR-25

PR-50

PRT (AN3155)

TYPE PR-25—25-watt rating. Temperature rise, 140°C. Standard resistance values, 1 ohm to 5,000 ohms. Diameter, $1\frac{21}{32}$". Depth behind panel, $\frac{31}{32}$".

TYPE PR-50—50-watt rating. Temperature rise, 170°C. Standard resistance values, 0.5 ohm to 10,000 ohms. Diameter, $2\frac{23}{32}$". Depth behind panel, $1\frac{3}{8}$".

TYPE PRT-25—(AN3155-25). 25-watt rating. Fulfills AN3155 specifications. Totally enclosed. Heat-radiating black finish. Rear terminals. Standard values, 10 ohms to 200 ohms. To 5,000 ohms on special order. Temp. rise, 140°C.

TYPE PRT-50—(AN3155-50). 50-watt rating. Same construction as PRT-25, to AN3155 specifications. Standard values, 5 ohms to 200 ohms. To 10,000 ohms on special order. Temp. rise, 170°C.

All IRC Rheostats operate at about half the temperature rise of equivalent units and can be operated at full load on as little as 25% of the winding, with only a slight increase in temperature rise.

PREFERRED FOR PERFORMANCE · IRC · FIXED & VARIABLE RESISTORS

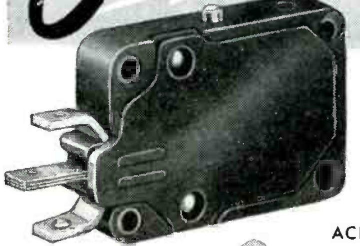
CONTACT YOUR IRC REPRESENTATIVE FOR COMPLETE DETAILS

INTERNATIONAL RESISTANCE CO.

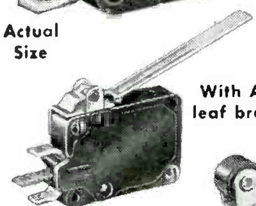
401 N. BROAD ST., PHILADELPHIA 8, PA.

Canadian Licensee: International Resistance Co., Ltd., Toronto

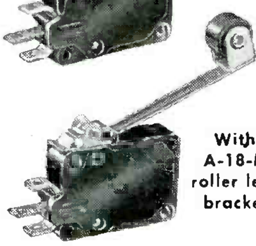
Compact for MODERN DESIGN



Actual Size



With A-18 leaf bracket



With A-18-M roller leaf bracket

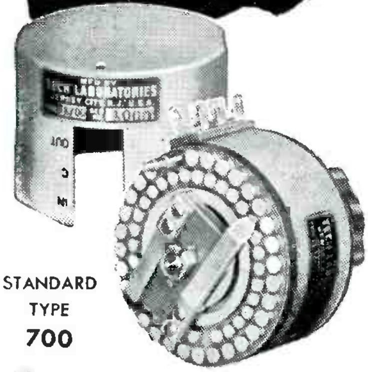
This new, basic Model "M" ACRO Switch is the ultimate in compactness, with overall dimensions only 1 5/8" x 53/64" x 9/32". Four 3/32" mounting holes. Built with ACRO's patented Beryllium Rolling Spring and used by scores of the nation's leading manufacturers of electrical products. Approved by Underwriters' Laboratories. Rating: 10 amps. 125 volts A. C. Contact arrangements, single pole, normally open, normally closed or double throw. Furnished with standard leaf bracket actuators as illustrated or made to special design. For quicker reply on special actuators or characteristics please give full engineering details.

ACRO ELECTRIC COMPANY
1316 SUPERIOR AVENUE • CLEVELAND 14, OHIO

ATTENUATORS by TECH LABS

MIDGET TYPE **600**

"Midget" model is especially designed for crowded apparatus or portable equipment.



STANDARD TYPE **700**

- Solid silver contacts and stainless silver alloy wiper arms.
- Rotor hub pinned to shaft prevents unauthorized tampering and keeps wiper arms in perfect adjustment.
- Can be furnished in any practical impedance and db. loss per step upon request.
- TECH LABS can furnish a unit for every purpose.
- Write for bulletin No. 431.

TECH LABORATORIES
Manufacturers of Precision Electrical Resistance Instruments
337 CENTRAL AVE. • JERSEY CITY 7, N. J.

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, industial 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, Molybdenum,* and OTHER METALS AND SPECIAL ALLOYS; ALL MESHES IN STANDARD WIDTHS, OR WIRE-MESH PARTS FABRICATED TO ORDER.

THE C. O. JELLIFF
MFG. CORP.
123 PEQUOT ROAD,
SOUTHPORT, CONNECTICUT
WIRE CLOTH
DIPPING BASKETS
LEKTROMESH

tion point. The natural frequency of the resonator is varied by a small special capacitor, the moving element of which is carried by a tuned reed vibrating at the line frequency. A pointer is attached to the reed and moves over a short scale. Its movement is magnified by lenses.

Vanes as Capacitor Plates

The shape of the special capacitor vanes is very important and is de-

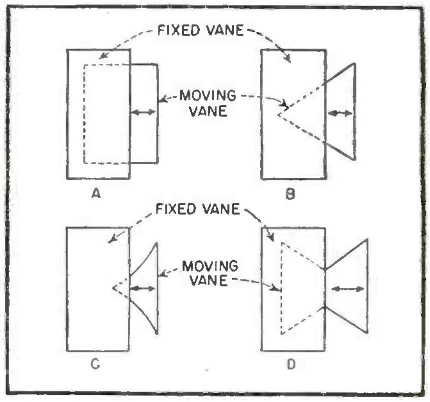


Fig. 2—Different vane shapes determine whether the scale of the special indicator capacitor is linear in frequency and capacitance or exponential

termined by the main use to which the comparator will be put. Figure 2 gives some typical shapes. Shape *A* gives a linear capacitance scale, shape *B* gives a nearly linear scale of frequency if capacitance values are correctly chosen, shape *C* gives an approximately exponential scale and if used with negligible shunt capacitance will give a linear frequency scale, shape *D* gives an inductance or capacitance scale which is open in the middle and closed at the ends so that large tolerances can be indicated.

The oscillator is coupled to the resonator so that an alternating potential appears across the latter, its amplitude varying as the resonator is tuned relatively to the oscillator by the indicator capacitor.

When the resonator frequency is the same as the oscillator frequency, the relative phase angle of the alternating potentials in the two circuits changes suddenly and, as both circuits are connected to the mixer tube, its anode current is partially dependent on the two phase angles and changes sharply when the two frequencies are equal. This change is differentiated to

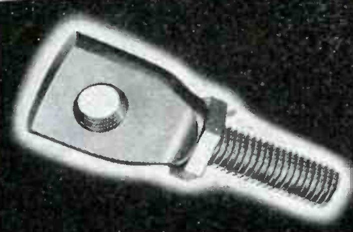
Take this short route for answers to many

FASTENINGS PROBLEMS

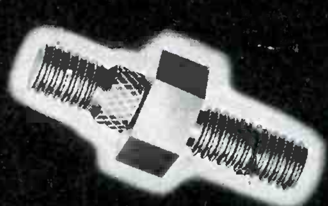
Fill out the coupon below and mail it—for the shortest route to answers to many fastenings problems. Maybe you think that cold-forging wouldn't save for you—but if you use large quantities of fastenings, get the facts on what Scovill can do. You may be surprised at what can be done—economically. For production efficiency, also contact Scovill for SEMS Washer Screw Assemblies, PHILLIPS Recessed Head Screws, and CLUTCH HEAD Screws. Mail the coupon today!

TELEPHONE—This special brass stud is an important part of a telephone transmitter. Do you use fastenings in mass production? Get the facts on Scovill.

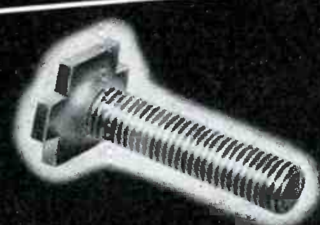
RADIO—Special steel mounting stud used in radio work. Scovill cold-forging often means savings on mass production jobs. Consult Scovill before designing.



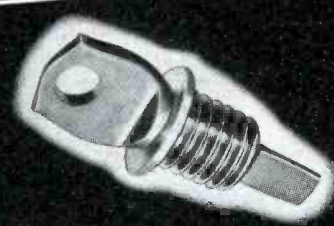
ELECTRONICS—Unusual cold-forged brass component in electronic equipment. Scovill's answer to a manufacturer's problem—solved economically.



AVIATION—Heat treated alloy steel stud molded in plastic for special aircraft electrical use. Scovill cold-forging "know how" may be the answer for you. Take a look at your present fastenings!



HARDWARE—Adjusting screw on a hand plane. Cold-forged by Scovill at a savings to the manufacturer. Scovill may be able to save money for you. Mail the coupon below now!



POWER TRANSMISSION—Special copper transformer stud used in high tension power transmission. Another Scovill cold-forging job that solved a problem—saved money for a customer.

SCOVILL MANUFACTURING COMPANY
WATERVILLE SCREW PRODUCTS DIVISION
WATERVILLE 48, CONN. TEL. WATERBURY 3-3151

NEW YORK, Chrysler Building • DETROIT, 6460 Kercheval Avenue • CHICAGO, 135 South LaSalle Street • LOS ANGELES, 2627 South Soto Street • SYRACUSE, Syracuse-Kemper Insurance Building • CLEVELAND, Terminal Tower Building • SAN FRANCISCO, 434 Brannan Street

SCOVILL MANUFACTURING COMPANY E
WATERVILLE SCREW PRODUCTS DIVISION
WATERVILLE 48, CONN.

Please have your sales engineer call with more information on:

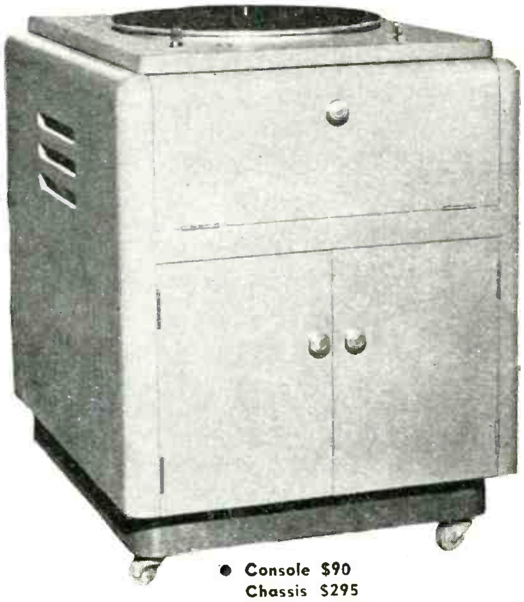
- ☐ Special Cold-forged Fastenings
- ☐ SEMS Washer Screw Assemblies
- ☐ PHILLIPS Recessed Head Screws
- ☐ CLUTCH HEAD Screws

NAME____________________

COMPANY____________________

ADDRESS____________________

Put ROBINSON TONE QUALITY TO WORK FOR YOU!



REVOLUTIONARY FEATURES IN THE ROBINSON PRECISION TRANSCRIPTION TURNTABLE

- With Robinson precision equipment you eliminate "wow," vibration and rumble.
- Many new features including right-angle belt-drive and patented "seismic" sub base motor mounting.
- New micrometer speed adjustment and patented planetary ball bearing transmission.

- Console $90
  Chassis $295
  Duplex Console $150

ROBINSON RECORDING LABORATORIES
35 So. Ninth St., Philadelphia 7, Pa.

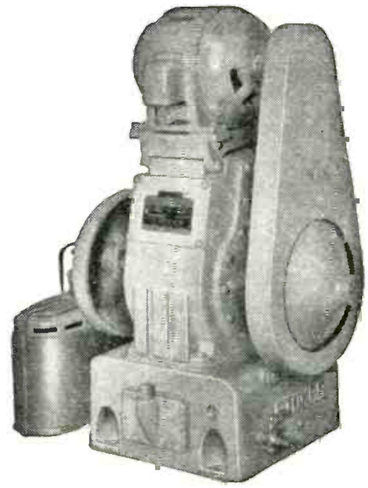
AMERICAN CAPACITORS

All standard types, Write for the new Amcon catalog.

Amcon precision engineering means dependable, unfailing Capacitor performance.

AMCON AMERICAN CONDENSER CO.
4410 N. Ravenswood Ave., Chicago 40, Illinois

Stokes MICROVAC Pumps
HEART OF HIGH VACUUM SYSTEMS



- Higher Vacuum (in the low micron range)
- High volumetric efficiency
- Low power requirement
- Complete discharge of air —no re-expansion
- Continuous dehydration of oil—no moisture to re-evaporate
- Discharges sudden slugs of liquid without injury
- Easily accessible, non-corrosive discharge valve
- Rugged, compact, simple construction
- Long life . . . negligible maintenance
- Five sizes—from 10 to 235 cu. ft. per min.

Stokes VACUUM GAUGES
(Patented McLeod type)
Are Always Accurate

- Require no calibration
- Rapid readings
- Simple to operate — just tip and read
- Two models (AA) 0 to 5000 microns — (BB) 0 to 700 microns, with readings to 1/10 micron.

F. J. STOKES MACHINE CO.
6046 Tabor Road Philadelphia 20, Pa.

Stokes *High Vacuum* PUMPS · GAUGES · EQUIPMENT

Graphite has Everything

YOU WANT IN AN ANODE!

CANNOT DISTORT!

"National" graphite has no melting point! It cannot melt or soften. This, plus the fact that graphite has a low coefficient of expansion and a high heat transfer rate, is the reason graphite will not warp or distort, regardless of operating temperature.

UNMATCHED THERMAL CONDUCTIVITY!

Because "National" graphite has a higher thermal conductivity than other anode materials, it provides greater protection from excess surface temperature — a cause of secondary or back electron emission. It also lessens the danger from local hot spots so often found in other anodes—the result of thin spots or concentrations of the electron stream.

GREATER THERMAL EMISSIVITY!

"National" graphite is almost an ideal black body, making it a nearly perfect heat radiator. Thus, anodes of "National" graphite operate at lower temperatures for a given amount of energy dissipated. All tube parts therefore operate at lower temperatures, resulting in less distortion of other parts and more uniform tube characteristics.

In addition... "National" graphite has exceptional purity... great strength... fine grain structure... high resistance to erosion... is a good conductor, especially at high frequencies... is free from dust and loosely held particles... provides low electron emission... and can be machined into intricate shapes to very close tolerances.

Yes... anodes of graphite have everything you need to turn out finer tubes. For more facts, write National Carbon Company, Inc., Dept. E.

NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide and Carbon Corporation
The word "National" is a registered trade-mark of National Carbon Company, Inc.

UCC

30 E. 42nd St., New York 17, N. Y.
Division Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

produce a positive and negative pulse, one of which is clipped, shortened and then used to fire the thyratron, which in turn passes current to produce a flash in the neon lamp of about 50 microseconds.

It might appear that by utilizing both pulses on the forward and return traces, a brighter indication could be obtained with a given scheme of illumination. In practice, however, this has not been found to be successful, since small phase shifts occurring in the various circuits are liable to cause double images to be produced.

A tuning eye indicator is used to check that the oscillator is working to set the magnification of the resonator. To do this the magnification control is turned until the indicator tube shows that the resonator is actually oscillating, then the control is reversed until oscillation stops.

Under production conditions the instrument permits a comparative check of inductance against any standard from 100 μh to 100 mh, with an accuracy better than one percent. Resonant circuits can be checked and preset for frequency; coils with short-circuited turns and broken strands in Litz wound coils are clearly indicated, thereby giving a ready production check for minimum Q. In addition, a comparative check of capacitance can be made up to 0.001 μf. The capacitance difference, plus or minus, can be read directly in $\mu\mu$f to an accuracy of 0.1 $\mu\mu$f or 0.1 percent, whichever is the greater. The instrument is made in England.

Modulated Arc Lamp

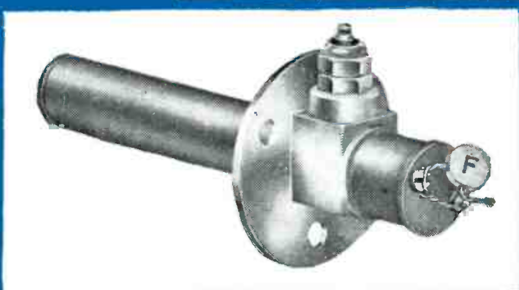
A CAESIUM VAPOR lamp for modulated infrared-ray communication was ready for use at the end of the war for convoy duty and troop landing operations. For peacetime use, it may prove useful for confidential ship-to-shore conversations, plane-to-ground or plane-to-plane communications, or in disaster areas where telephone wires are down and static makes radio communication impractical.

As accepted by the Navy, the

TAMPER PROOF

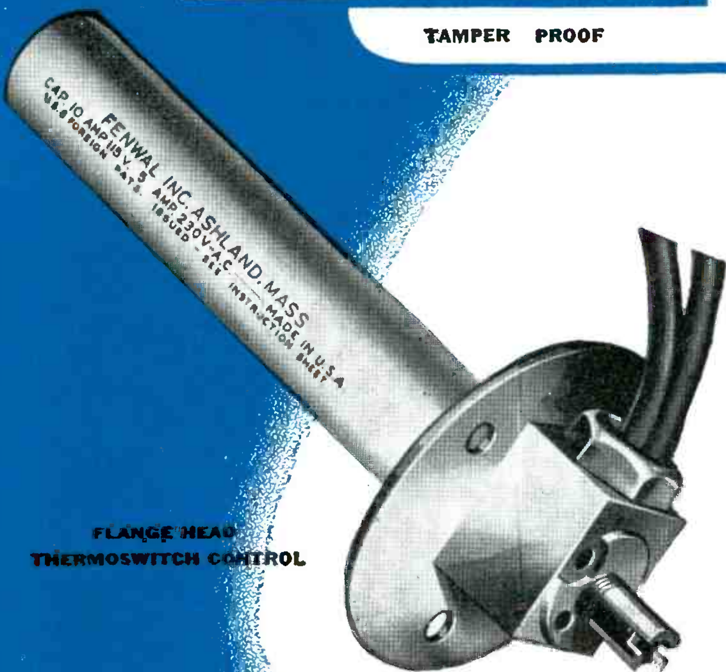
To insure continuous, accurate temperature control, the controlling thermostat should be tamper proof. Unauthorized tampering with the thermostat mechanism or changes in setting may be dangerous and can slow up production and impair quality. The contact assembly of the Fenwal THERMOSWITCH Control is completely protected by the temperature sensitive outer shell. It is impossible to tamper with the internal mechanism of the THERMOSWITCH Control. The only means of changing the temperature setting is by turning the adjusting sleeve. Tampering with the adjusting sleeve may be eliminated by the addition of a tamper proof cap with wire and lead seal.

Illustration shows a THERMOSWITCH Control with tamper proof cap and wire and lead seal. Combining this feature with the completely enclosed electrical assembly of the THERMOSWITCH Control insures all-around protection from unauthorized tampering with the control unit.



TAMPER PROOF

Investigate the modifications and special features available for your use with the Fenwal THERMOSWITCH Control. *Study the "Fourteen Facts in Fenwal's Favor" in our Thermotechnics Booklet. Write for your copy.*



FLANGE HEAD 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

#8 of "14 Facts in Fenwal's Favor"

Fenwal

FENWAL INCORPORATED
43 PLEASANT STREET
ASHLAND MASSACHUSETTS
Thermotechnics for Complete Temperature Regulation

PR CRYSTALS for AIRCRAFT

3105 KCs and 6210 KCs

Temperature coefficient less than 2 cycles per megacycle per degree centigrade. Calibrated within .005 per cent of frequency. Gasket sealed, contamination and moisture free. Octal mounting. Weighs less than ¾ ounce.

Type Z-1 PR RADIO CRYSTALS are ideal for conversion of military aircraft transmitters to civilian frequencies. Frequencies of 3105 and 6210 KCs. are IN STOCK AT YOUR NEAREST JOBBER. They meet FCC and CAC requirements fully. Precision made for utmost in stability, dependability, high activity, trouble-free operation and low drift. Unconditionally guaranteed.

PETERSEN RADIO COMPANY

PR CRYSTALS SINCE 1934

2800 WEST BROADWAY—TELEPHONE 2760

COUNCIL BLUFFS, IOWA

"HARD TO GET"

ELECTRONIC and RADIO SUPPLIES

At Great Saving

We have on hand, a large stock of "hard-to-get" electronic and radio supplies, made to high specifications and at a fraction of manufacturers' cost. Some of the items are as follows:

Ferranti interstage transformers

60 to 9000 cycles I Idb.. Impedance ratio

25 or 10,000 to 25,000 or 100,000

Pr. ind 133 Hys 2VAC 60 cycles

Micro Switches, yellow back, S.P.S.C. Potentiometers; all ohmages; slotted and long shafts

4 Conductor — black plastic covered cable—suitable for intercomms

Motors 24 Volts; D.C. 1/10 H.P. Mica Sheets 36 x 36

Transmitting condensers; a large variety of capacities and voltages

Bathtub condensers; variety of capacities and voltages

Resistors insulated carbon—all ohmages and wattages

Resistors wire wound—all ohmages and wattages

Meters—a large stock of volt and millimeters

We Invite your Inquiries for Requirements

EDLIE ELECTRONICS, INC.

135 Liberty St.
Dept. I
New York 6, N. Y.
Phone BArclay 7-4859

lamp produces its radiation from an arc stream three inches long and more than an inch in diameter. The inner bulb contains the arc in an

Norman C. Beese, research engineer at Westinghouse Lamp Division, demonstrates the caesium vapor lamp he designed for talking over an invisible infrared light beam

atmosphere of argon and caesium vapor. Space between this bulb and an outer bulb is evacuated. The life of the lamp is about 100 hours.

Direct current is used to maintain the arc in the Westinghouse lamp. Modulation of 100 percent is possible at some points in the audio range from 200 to 3,000 cycles. The lamp is mounted in a parabolic reflector on a ship's mast and a similar parabolic unit contains the photoelectric cell used in the receiver. The beam spread is about 25 degrees.

Cooperative Two-Station Antenna System

By LINDSAY MCMANUS

Installation Engineer
Canadian Marconi Company
Montreal, Canada

A BROADCAST STATION that is probably unique has just been completed by Canadian Marconi Company at Sherbrooke, Quebec. It is, in fact, a combination of two stations—CHLT and CKTS.

CHLT has been operated by the

French-language daily newspaper, *La Tribune*, on 1,240 kc. An associated English-language weekly paper, the *Sherbrooke Telegraph* has now taken over this station and the call letters have been changed to CKTS. The *La Tribune*, still retaining its call letters—CHLT—has expanded to 1,000 watts and moved along the dial to 900 kc.

The original CHLT studio has been dispensed with and modern combined studios have been constructed for the two stations. Each station has its own control room facing the main studio with a master control room in between. Local programs and remote pickups are fed through the master control room and thence to either or both transmitters via the separate control rooms.

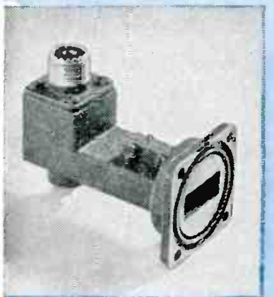
When CHLT was assigned its new frequency, it was with the provision that two other stations on the same frequency be protected at night. Daytime operation could be at 1,000 watts, omnidirectional, but it was necessary to change to directional operation at sunset.

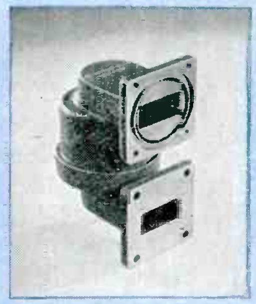
Common Antenna System

It was desirable to use the existing transmitter building for the two transmitters, having them and their associated audio and monitoring equipment in the same room, and to use the same antenna system for both stations. These plans presented problems in meeting all requirements and regulations and particularly to avoid any interaction or cross modulation throughout the entire audio and radio frequency circuits. Adequate shielding of audio components and lines would take care of this section, but r-f interaction between the two transmitters in the same room and using a common antenna could not be so easily avoided.

A new ground system for a two-tower array was put in and a new 196-foot guyed tower was erected. The existing tower of the same height was moved to a new location to form the directional array. The towers were spaced 120 degrees apart at 900 kc, and it was decided that the desired directional pattern could be obtained by a phase difference of plus 141 degrees with a 1.3 to 1 current ratio in the towers. During the entire process of in-

EVERY DE MORNAY-BUDD WAVE GUIDE
is Electrically Tested, Calibrated and Tagged

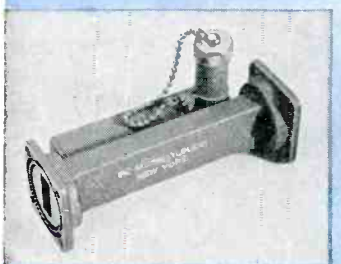

Crystal Mount DB-453

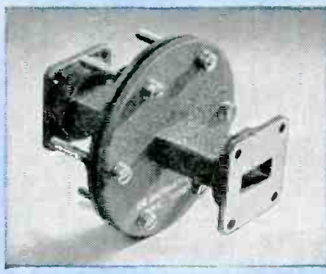

Rotating Joint DB-446

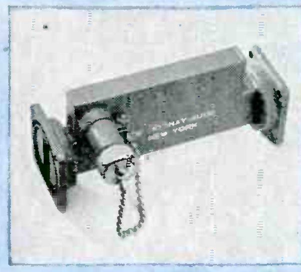

90° Elbow (H Plane) DB-433


Pressurizing Unit DB-452

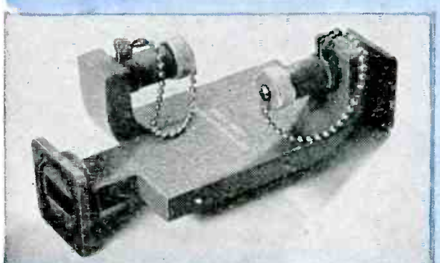

Mitered Elbow (H Plane) DB-439

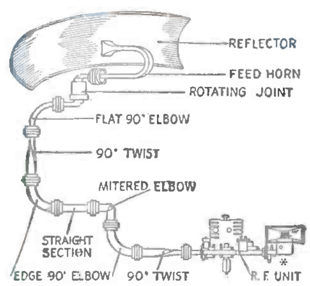

Uni-directional Broad Band Coupler DB-442


Bulkhead Flange DB-451

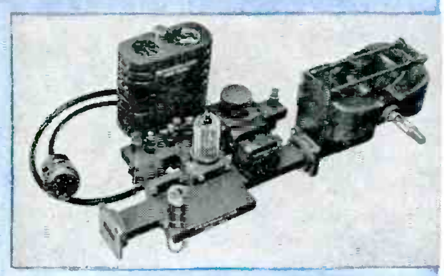

Uni-directional Narrow Band Coupler DB-440


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

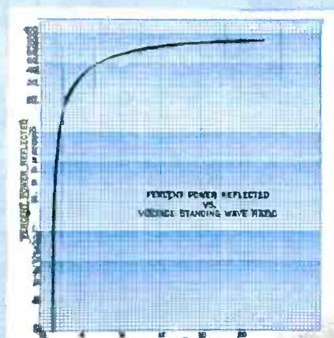
When you use any De Mornay·Budd wave guide assembly, you know exactly how each component will function electrically. You avoid possible losses in operating efficiency through impedance mismatches, or breakdown and arcing caused by a high standing wave ratio. (See chart below.)

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
EQUIPMENT FOR 97% OF ALL RADAR SETS

De Mornay-Budd, Inc., 475 Grand Concourse, New York 51, N. Y.

stalling the new ground system, new antenna and shifting of the existing antenna, the transmitter on 1,240 kc continued daily operation without interruption.

Precise measurements were made of the self and mutual impedances of the new array and from these measurements the operating impedances were calculated. Impedances of the various units and tower lighting transformers were measured and included in the calculations and the network component values were set up. Three conditions had to be satisfied simultaneously for the directional pattern; proper matching to coaxial lines, correct current ratio between the towers and the desired electrical separation between the currents. Any one improper condition would throw the others out.

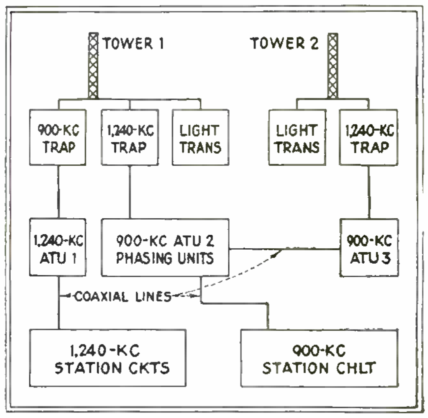


Fig. 1—Two transmitters on different frequencies feed one antenna system

For instance, the self impedance of tower 2 changed radically when the phase difference between towers changed and if the phase difference were not correct the current ratio could not be obtained and the coaxial lines would also be mismatched. Only by precise measurements and careful setting up of the tuning unit components by r-f bridge method could the system be properly adjusted. The final arrangement of the various units is shown in Fig. 1.

Circuit Arrangement

Tower 1 is used during the daytime for both transmitters. CKTS, the 1,240-kc, 250-watt station is fed to this tower through a coaxial gas-filled line, a 1,240-kc antenna tuning unit (ATU1 in diagram) and

INFINITELY LONGER LIFE FOR FLUORESCENT LAMP CAPACITORS...

thanks to SPRAGUE VITAMIN Q

(REG. U. S. PAT. OFF.)

Greatly increased production facilities now permit the application of Sprague's famous Vitamin Q impregnant to ballast capacitors for fluorescent lamps—with truly outstanding results. The tables below tell the story—on severe tests that leave nothing open to question as to the remarkable superiority of these Sprague units. *NO Sprague Vitamin Q Capacitors failed during the life of the tests. ALL of the competing units did!*

SPRAGUE ELECTRIC COMPANY, North Adams, Mass.

POWER FACTOR

550 v. A.C. 85°C.

(as measured on a Schering bridge)

Sprague 0.27%
Mfr. 1 .... 0.62%
Mfr. 2 .... 0.45%

LIFE TEST NO. 1

Tested at 490v. A.C. 85°C. in circulating air

No. Units Tested	Maker	Hours Life at Failure of each unit tested: 1st	2nd	3rd	4th	5th	Impregnant
5	SPRAGUE	NO FAILURES AFTER 750 HOURS!					VITAMIN Q
5	Mfr. 1	37	124	339	498	516	Chlorinated diphenyl
2	Mfr. 2	107	243	—	—	—	Mineral Oil

LIFE TEST NO. 2

Tested at 575v. A.C. 85°C. in still air

No. Units Tested	Maker	Results	Impregnant
4	SPRAGUE	NO FAILURES AFTER 750 HOURS!	VITAMIN Q
3	Mfr. 1	All failed in less than 4 hours	Chlorinated diphenyl
3	Mfr. 2	" " " " " 4 "	Mineral Oil
3	Mfr. 3	" " " " " 4 "	Mineral Oil

Units tested in both cases were standard 3½ mfd. 330v. A.C. Fluorescent Capacitors in 2" d. x 2¼" h. cans.

a rejector unit. The rejector unit is resonated at 900 kc to prevent feedback into the 1,240-kc line from the 900-kc circuit. CHLT, the 900-kc, 1,000-watt station, is fed to the same tower by a coaxial gas-filled line, a 900-kc antenna tuning unit (ATU2), and a rejector unit which is resonated at 1,240 kc to prevent this frequency from feeding back into the 900-kc circuit. Tower 2 also has a 1,240-kc rejector unit and the tower is detuned during the daytime to prevent radiation.

At sunset, a changeover is made at the control unit on the desk at the transmitter building and tower 2 is brought into the 900-kc circuit. This is accomplished by two relays at Tower 1 which change taps on ATU2, disconnect the detuning circuit of tower 2, and also put this tower in the circuit through a phasing unit. The phasing unit matches this junction to the coaxial line running to tower 2, where antenna tuning unit ATU3 matches the line to the tower through the 1,240-kc rejector unit.

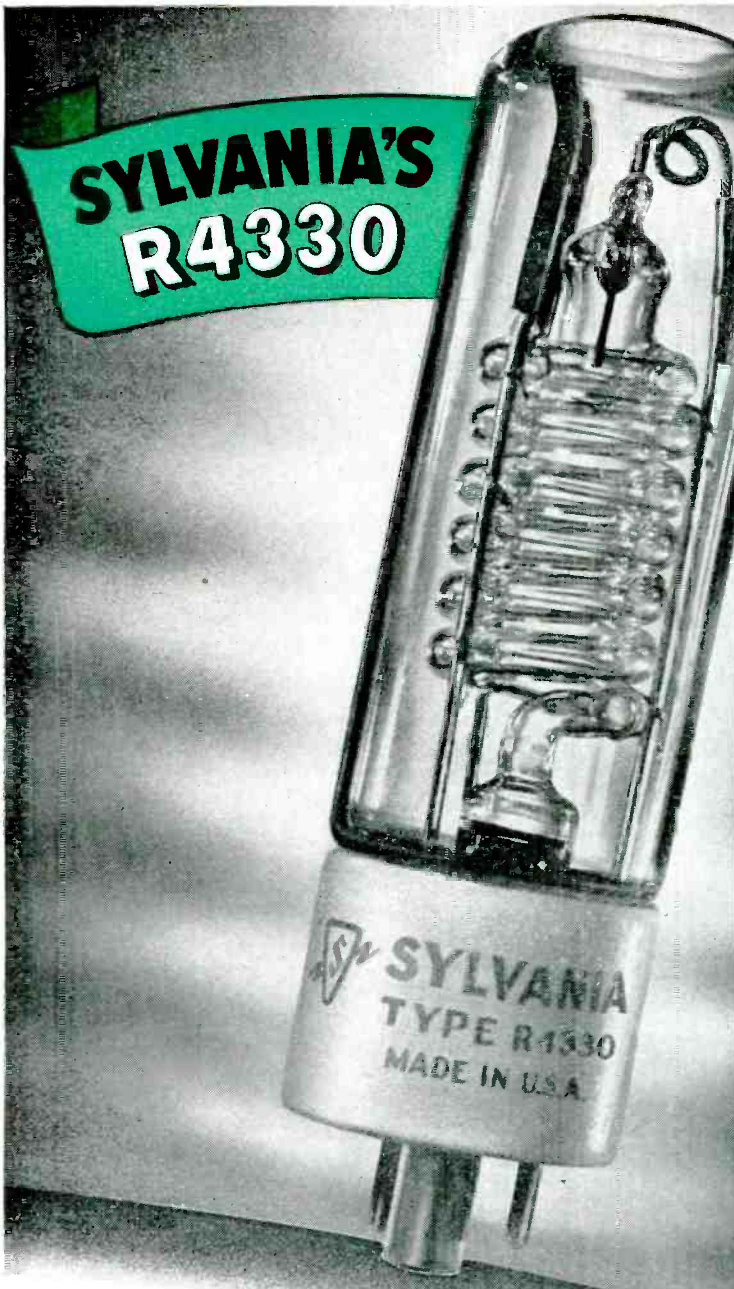
Power Division

In the 900-kc circuit at tower 1, phase changes through the antenna tuning and phasing units cancel each other. The 120-degree coaxial line between towers causes a phase shift of −130 degrees and ATU3 is tuned to shift the phase another −89 degrees. This provides the total of −219 or +141 degrees phase difference required.

The setting of the 1.3 to 1 current ratio between the towers is accomplished at the junction of ATU2 and the phasing unit at tower 1. From the calculated directional operating resistances of the towers, the power required in each tower for correct current was found. The necessary power division to produce these currents is made at the junction by matching ATU2 to tower 1 and the phasing unit to the inter-tower coaxial line so that their parallel input impedances correctly divide the power and also match the surge impedance of the coaxial line to the transmitter.

Operation

In changing from one-tower omnidirectional operation to two-tower directional, the shift is made



NEW ELECTRONIC TUBE *FLASHES* THOUSANDS OF TIMES!

EMITS "DAYLIGHT" FLASHES OF 12,000,000 PEAK-LUMENS INTENSITY

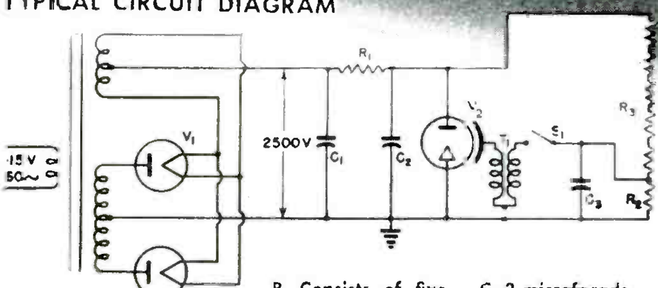
The Sylvania Type R4330 Flash Tube, used with suitable equipment, gives a brilliant flash of excellent photographic quality with a duration of only 1/5000th second.

A major application of the Type R4330 is in newly developed electronic flash units for photographic purposes. Here it permits taking pictures without the need for replacing flash bulbs. Its short flash duration "stops" motion, enabling the photographer to take sharp, clear pictures of moving subjects. Excellent color quality permits use with color film.

Each time the circuit switch is closed, the tube emits a single flash. The tube has a life of several thousand flashes.

Other uses of the R4330 are in beacons, obstruction markers, airport boundary markers and signaling devices. *See your Sylvania Distributor.*

TYPICAL CIRCUIT DIAGRAM



R_1 500 ohms, 100 watts
R_2 150,000 ohms

R_3 Consists of five 200,000 ohm resistors
V_1 High voltage rectifier
V_2 Sylvania R4330

C_1 2 microfarads
C_2 32 microfarads
C_3 1 microfarad
T_1 Ignition coil
S_1 Trip switch

Wabash Portable AC Electroflash Unit — one of the pieces of equipment utilizing Sylvania's electronic flash tube R4330.

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 at sunset in approximately one second during a station break for identification. The tuning units at the towers are so adjusted that the coaxial line impedances at the transmitter for the two modes of operation are identical and no transmitter adjustment or retuning is necessary.

As a visual check on the shape of the night pattern, two field indicators have been installed. These consist of small receivers, containing a diode rectifier and d-c amplifier, set up in the field about 400 feet from the towers, one on each side of a low signal zone. The units are mounted on posts and are powered by a 110-volt a-c line. The output of each unit is taken by cable to d-c microammeters in the control unit on the desk at the transmitter building. Changes in the reading of the meters outside of a predetermined operating tolerance indicate to the operator that the pattern shape has altered. Cables also carry the antenna currents to remote meters in the desk control unit and provide a constant check on the currents in the towers for both transmitters.

To uncover any signs of interaction between the two stations, various tests were carried out. It was found that any switching on or off of one transmitter in no way affected the meter readings or field intensity of the other. Either carrier, fully modulated, did not affect the unmodulated carrier of the other transmitter and no signs of cross modulation could be detected with both stations fully modulated with individual or similar programs.

Microwave Wattmeter

POWER OUTPUT of transmitters and oscillators operating at frequencies from 20 to 1,500 mc and 50-ohm coaxial output terminals is measured by a wattmeter whose wide-band impedance constancy is realized by employing a length of attenuating 50-ohm coaxial cable terminated in a resistor. The basic idea is that the resistor determines the impedance at the lower frequencies and the line determines it

Looking for Something Special?

...IN A 400 CYCLE MOTOR

EAD

SPECIAL DESIGN DIVISION HAS IT ... *or will* *ENGINEER AND BUILD IT!*

3-Phase or 1-phase, induction or even synchronous, self-cooled or not; our engineering department has turned out a wide range of custom-built, war proven, high frequency motor designs which are now available for your needs. Many speeds, horsepowers and voltages as well.

Or perhaps, you want a stator and rotor to be designed into your own equipment. Whatever your needs, let us hear from you. We shall be happy to advise and assist you.

SPECIAL DESIGN EAD DIVISION

EASTERN AIR DEVICES, Inc.
130 FLATBUSH AVENUE
BROOKLYN 17, NEW YORK, N. Y.

A FEW TYPICAL 400 CYCLE MOTORS...

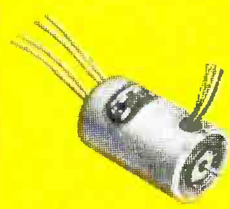
1. **Model J33**
115 volts, 400 cycles, 8000 R.P.M. Synchronous, 3-phase.

2. **Model J31A**
115 volts, 400 cycles, 1/100 H.P., 7200 R.P.M. 1-phase.

3. **Model J72**
115 volts, 400 cycles, 1/15 H.P., 5500 R.P.M. 1-phase.

4. **Model M6B**
200 volts, 400 cycles, 3-phase, High torque actuator motor. Total weight 12 oz.

5. **Model J37**
115 volts, 400 cycles, Motor-generator set. 2-phase servo-motor drives induction generator. 400 cycle output voltage varies with frequency. Used for anticipatory control of electronic servo system.



at the higher frequencies, with a smooth transition. Distribution of power loss changes in the same manner in the instrument made by Bird Electronic Corporation of Cleveland.

In all attenuating coaxial cables so far made, the attenuation increases with frequency. A length of such attenuating line furnishes a constant input resistance equal to its characteristic impedance, regardless of termination of the line, for frequencies sufficiently high so that the reflections produced by an imperfect termination can be neglected.

Constant Resistance

In general, the constant resistance termination over a wide frequency range is obtained in the Bird wattmeter by using the Z_0 of the attenuating lines at the higher frequencies. In order that low frequencies may be handled with a reasonable cable length, the line is terminated in a specially designed coaxial resistor.

As the attenuation of the line increases with frequency, a "transfer of power loss" occurs gradually from the 20-mc condition, in which about 25 percent of input power is dissipated in the terminating resistor, to the 1,000-mc condition, in which 90 percent of the input power is lost in the initial 25 feet of line. The frequency 200 mc may be stated roughly as the upper limit of effects from the terminating resistor and at higher frequencies the line alone determines input resistance.

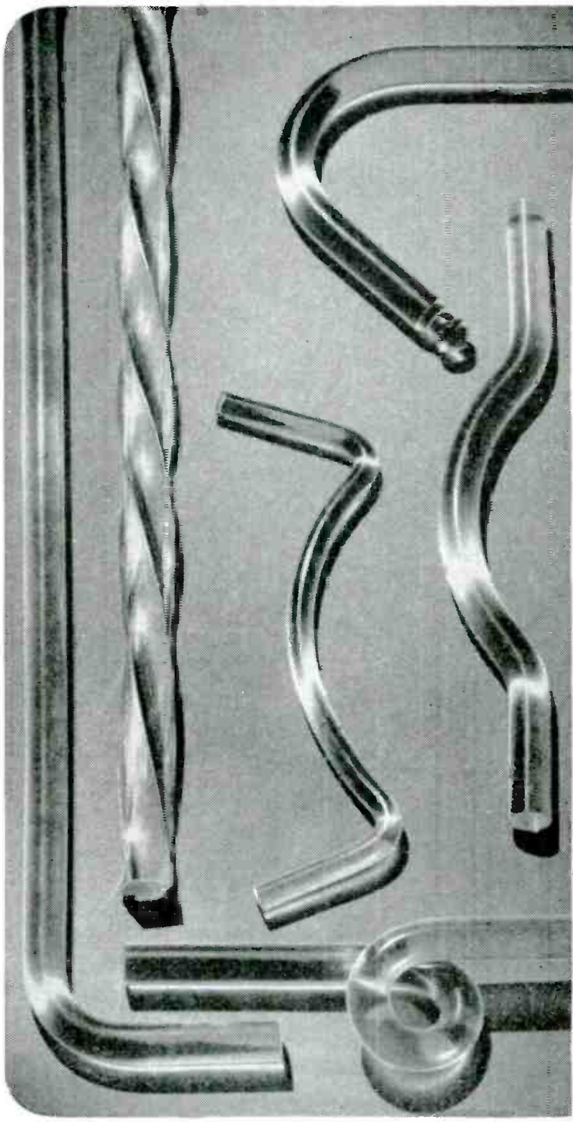
The wattmeter uses one hundred feet of a synthetic rubber dielectric, copper-conductor type of line. The average characteristic impedance of this line is 47 ohms and this fixes the load resistance presented to a thermocouple. The calibration of the individual wattmeter is made so as to include the effects of variation of individual lengths of line from the 47 ohm nominal value.

Measuring Equipment

The coaxial termination is blower cooled and rated 500 watts. A d-c millivolt-meter is used as the power indicator.

Plug-in thermocouples are provided to cover desired portions of the power range from 1 to 500 watts. The thermo junctions of the

HOW TO FORM PLAX POLYSTYRENE ROD



Plax crystal polished polystyrene rod can be heat formed without difficulty into many shapes and intricate bends. Correct forming techniques should be closely observed.

Any conventional heating method may be used. Either a liquid bath or a circulating air oven, at 250°F. to 265°F., is satisfactory. Actual heating time depends on rod diameter. A few simple preliminary timing tests should provide data for use on a production basis, using the table shown below as a guide.

Well sanded and polished hardwood forms serve the purpose of maintaining correct shape until the bend has cooled sufficiently. Preheated forms are even better because polystyrene must be cooled slowly to prevent thermal shock and subsequent crazing due to sudden chilling. The best temperature for a preheated form is about 165°F.

Wiping bent sections after cooling, with an emuslified water-base wax, will restore their original high lustre. Any surface blemish on the finished shape can be removed by buffing.

If possible, machining operations should be performed prior to forming. When necessary to machine after forming, Plax machining instructions should be carefully followed. These instructions call attention to the fact that petroleum base materials, such as oil and kerosene, are deleterious to polystyrene. They name proper coolants and give other helpful information.

Heating Time Guide

Rod Diameter	*Time*	
¼"	5–7 min.	250°– 265°F.
½"	15–18 min.	
¾"	18–20 min.	
1"	22–25 min.	
2"	35–40 min.	

OTHER POLYSTYRENE DATA AVAILABLE

Bulletins on how to machine, what to tell machinists, how to use coolants and how to cement — all on Plax Polystyrene products — are available on request, along with information on standard and special forms of polystyrene offered by Plax.

Literature is also available on Plax Cellulose Acetate, Cellulose Acetate Butyrate, Methacrylate, Polyethylene and other products — including one on plastic bottles. Engineering help covering nearly all plastics materials and methods is available from Plax and the Shaw Insulator Company, Irvington 11, N. J. For literature mentioned above . . . write Plax.

PLAX

FOR PLASTICS

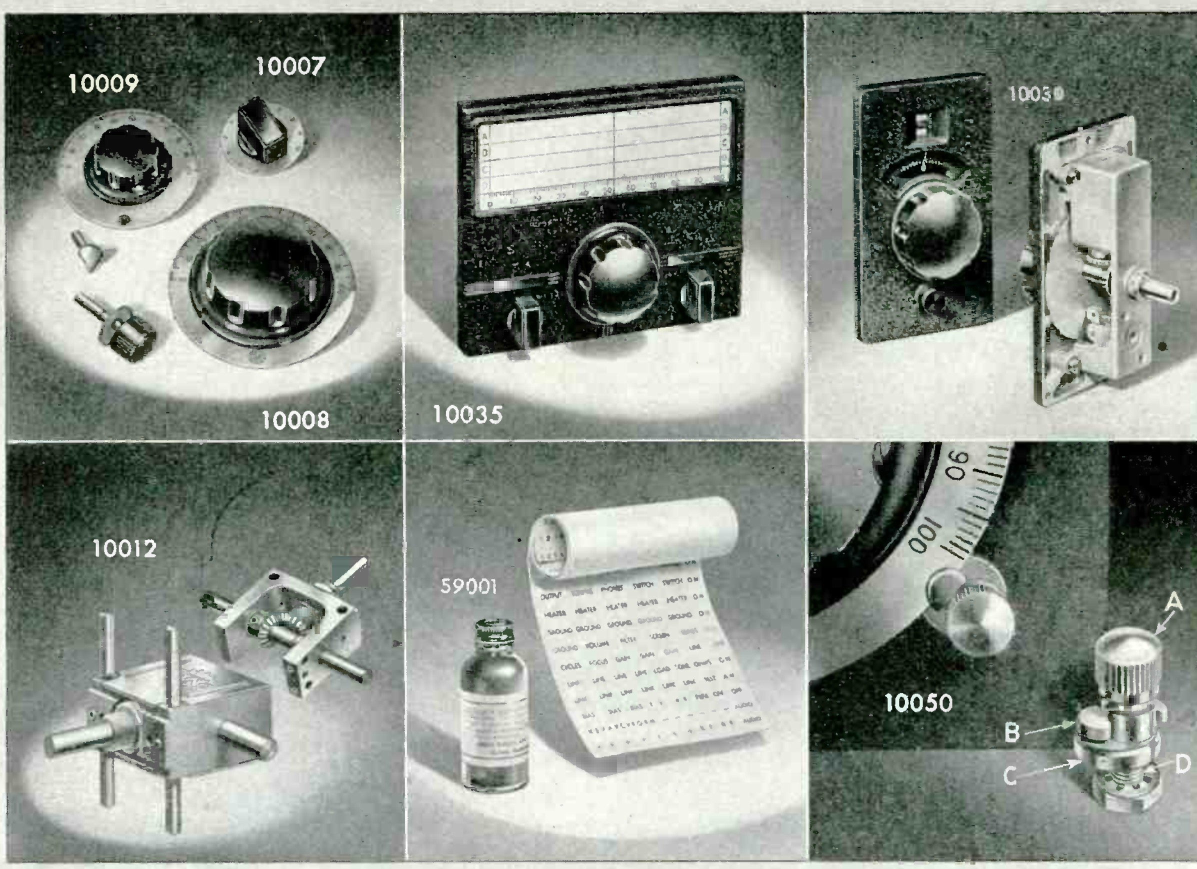
NOT SUBSTITUTES···IMPROVEMENTS

133 WALNUT STREET ★ HARTFORD 5, CONNECTICUT

Designed for

Application

Millen "Designed for Application" components are different! As a designer and manufacturer for many years of complex electronic and communication equipment, we are our own best customer for component parts. Consequently, we have to perform an outstanding job of designing and manufacturing such parts in order to satisfy our own applications. Our parts are "different", also, because as symbolized by the "Gear wheel" of our registered trade mark, they are designed by mechanical engineers working in close cooperation with our electronic circuit group. Below are illustrated a typical half dozen of the thousand-odd items we manufacture.



Illustrated above, left to right; Top row: The No. 10007, 8 and 9 group of nickel silver plain dials with specially designed matching knobs having accurately reamed brass bushings to insure concentricity, the No. 10035 Vernier dial and the No. 10030 multi-revolution Counter-dial. Bottom row: The No. 10012 multi-application right angle drive unit, the No. 59001 panel marking decalcomania kit, and the No. 10050 dial lock.

JAMES MILLEN MFG. CO., INC.

MAIN OFFICE AND FACTORY

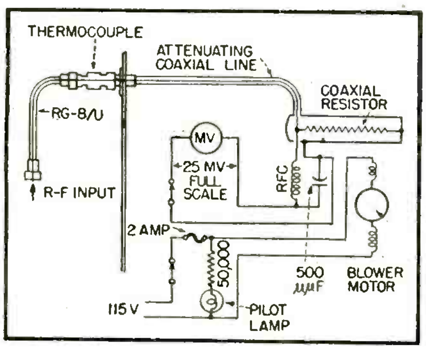
MALDEN
MASSACHUSETTS

SALES OFFICES
IN ALL
PRINCIPAL CITIES

CANADIAN SALES
ASTRAL ELECTRIC CO.
SCARBORO BLUFFS (TORONTO)

7

thermocouples form a short portion of the center conductor of the coaxial line, are heated by the r-f current therein and generate, in series with the center conductor, a d-c voltage proportional to r-f power level. The thermocouple d-c output is proportional to current squared and hence to power, but convenience dictates direct calibration in terms of power.



Complete circuit of the wattmeter for use from 20 to 1,500 megacycles

The wattmeter may be used to measure the power output on transmitters designed for 72-ohm loads. It is preferable to use 50-ohm cables and connectors between wattmeter and transmitter, in the case of 72-ohm transmitters also. The idea here is that the standing wave ratios existing on the cables are determined by the wattmeter impedance and the Z_o of the cables, and are independent of the transmitter. With 50-ohm cables, the impedance presented to the transmitter terminals will depend very little on cable length.

New Station Techniques

As A RESULT OF conditions forced upon it by the war, the British Broadcasting Corporation has developed new conceptions of studio organization which it intends to retain.

Before 1939 the broad tendency was to use a number of simple studios for different classes of programs or scenes in a dramatic production and to centralize in a single control room all technical equipment. Now, however, this has been superseded by general purpose studios, each having its own technical equipment consisting of a control desk and an apparatus cabinet.

Among the technical points changed is the abandoning of mixing of microphone circuits at microphone level. This was done because the high-quality microphones in universal use today are relatively insensitive. When several are mixed, the level is low enough to demand series faders and so the signal level varies according to the number of circuits faded up at one time. Furthermore, the necessary equalizer circuits still further depress the level until it is very near the Johnson noise background and other extraneous noises. The modern practice now is to give each microphone its own amplifier and then to mix after amplification.

Group faders are used as well as individual faders and this facility allows the program engineer to fade out any given combination of microphone channels in one movement, to fade up a single microphone for an announcement, and then to revert to the original arrangement immediately.

Echo Room

All microphone channels are passed through splitting transformers so that some of the program can be passed into an "echo" room and then reintroduced into the "direct" half of the outgoing circuit. Suitable attenuators are introduced and thus a radio play may use several microphones in one studio (as is now common) for various scenes, yet individual outputs can be adjusted for varying degrees of echo.

The program output of a studio is monitored by a program meter and loudspeakers and phones.

The various auxiliary circuits include remote switching of spare amplifiers, loudspeakers in studios for playback apparatus for introducing line-up tone, all interlocked with the microphone circuits to prevent the wrong material being radiated or howling set up.

The control desks associated with each studio are made for use by two persons, a program engineer and a producer. The controls, which are on the inclined face of the desk, are divided among three panels. These panels are arranged to swing forward for maintenance

A deservedly popular 50 watter

The Collins 32RA* was introduced several years ago as a quality designed, quality built radio communication transmitter, broadly adapted to most applications within its power and frequency scope.

It and the d-c version, the 32RB†, were immediately put into service by airlines for control towers, by oil pipelines for emergency systems, by fishing companies for fleet control, and by other widely different types of industrial users.

The 32RA was found to be rugged, simple to operate, easy to service, and so thoroughly and universally satisfactory that a rising commercial demand was halted only by the war.

Now it is again available for peacetime applications. A large number of orders have already been received and filled, and we are able to ship from stock. If you would like specifications and design data, write us for an illustrated descriptive bulletin.

*COLLINS 32RA—Power source: 115 volts alternating current. Power output, 50 watts phone; 75 watts CW. Frequency range, 1.5 to 15 mc. Four frequencies instantly selected by panel control.

†COLLINS 32RB—Power source: 12, 24, 32 or 110 volts direct current. Dynamotor, self-contained. Otherwise identical with 32RA.

IN RADIO COMMUNICATIONS, IT'S . . . COLLINS

COLLINS RADIO COMPANY, Cedar Rapids, Iowa

11 West 42nd Street, New York 18, N. Y. 458 South Spring Street, Los Angeles 13, California

and are quickly demountable. The division of the controls on the panels has been done on a functional basis; thus, the central panel carries all the important controls and is operated by the program engi-

A program engineer and a producer at a new B.B.C. control console. The panel at the right is for use by the producer, the center and left-hand panels contain more technical controls

neer, while the right-hand panel carries such controls as the "talk-back" key and others which the producer might want to use. The left-hand panel carries purely technical controls associated with switching on the equipment, echo mixture, and keys operating relays controlling spare amplifiers. The circuits of the last mentioned have been designed with extreme care and it is virtually impossible to detect that an amplifier has been replaced.

Frequency Modulation

In this regard, the British Broadcasting Corporation has for some time been interested in frequency modulation and has now summarized the results of extensive field trials. On the whole, the engineering executives appear to be pleased with f-m but they are by no means accepting it as perfect. There are so many dependent factors. For example, the actual noise level at the receiver depends, among other things, on any motor vehicles passing the premises being fitted with efficient interference suppressors. Again, the f-m system offers an increased range of modulation but this advantage is cancelled if the receiver does not have sufficient a-f power-handling capacity to utilize the benefit. Similarly, it is

INSULATED WITH Du Pont POLYTHENE

With the home television set, much of the attenuation and distortion of images that sometimes occurs on the screen may arise in the lead-in cable from the antenna to the instrument. But not with the new Type ATV cable shown here. With this cable, attenuation is minimized . . . images are strong and clear.

The unusual design of this new lead-in line deserves much credit for its high effectiveness. But note—what makes this design possible is the excellent electrical properties of the insulation, of Du Pont polythene.

Because of polythene's remarkable dielectric strength, a thin coating of it is all that is needed. Polythene's low power factor makes it unusually effective in every type of high-frequency circuit. Credit also polythene's light weight (specific gravity 0.92) and its ability to retain its toughness and flexibility over a wide range of temperatures.

For complete data sheet on polythene, write to E. I. du Pont de Nemours & Co. (Inc.), Plastics Dept. 1511, Arlington, N. J.

Du Pont manufactures polythene molding powder.
Commercial extruders convert polythene into the form of

SHEETS TUBES RODS FILAMENTS

Type ATV two-wire polythene-insulated cable, for use as television lead-in line between antenna and receiver, made by Anaconda Wire & Cable Co. (Photo 2.5 times actual size.) This rugged, flexible cable, one of the lightest of its type, has an attenuation of 0.75 db/100 feet, and an impedance of 300 ohms at 50 megacycles.

DU PONT
REG. U. S. PAT. OFF.
Plastics
BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

well known that f-m offers the possibility of really high fidelity but what is this worth if the loudspeaker designer ignores what the transmitter engineer can give him?

The question of preemphasis at the transmitter and deemphasis at the receiver has been examined very carefully by the B.B.C. and the judgment is that a preemphasis of 50 μsec would be best for use. But here too the whole matter is tied up with loudspeaker design. Preemphasis, incidentally, is defined as the time constant of a circuit having the required frequency characteristic.

Interference Ratio

Concerning the matter of mutual interference between stations having a common service area, it was found in trials that 10 db(3:1) between two stations gave no intelligible intereference. There was just a rasping sound. But to make a substantial reduction in this, 20 db(10:1) was the figure required and to eliminate completely all mutual interference a 30 db(30:1) difference was wanted.

The tests, however, brought out the immense superiority of f-m in this respect since 30 db gives complete freedom from interference whereas with a-m even 46 db(200:1) does not produce the condition of no interference.

The frequency deviation of an f-m transmitter is judged to be adequate at ± 75 kc and once again dependent factors arise since a narrow deviation band demands receivers with very stable oscillators although it has the advantage of permitting more channels in a given ether space. The amount of deviation is also tied up with the "capture" effect.

The field trials discussed above not only included measurements but a number of tests by ear. From these last tests a certain amount of disappointment emerged—f-m did not seem to some people to produce the expected background of silence.

Alternatives to f-m and a-m have also been tested by the B.B.C. and it has been found that f-m is definitely superior to pulse modulation systems for high fidelity working and high fidelity has always been

Your Cable Problems

stated here

*** ANSONIA ***

Ankoseal

answers here

We have designed many cables which have solved a multitude of problems. When you come to Ansonia for something original in cables, our engineers will turn out a product to meet your specific requirements.

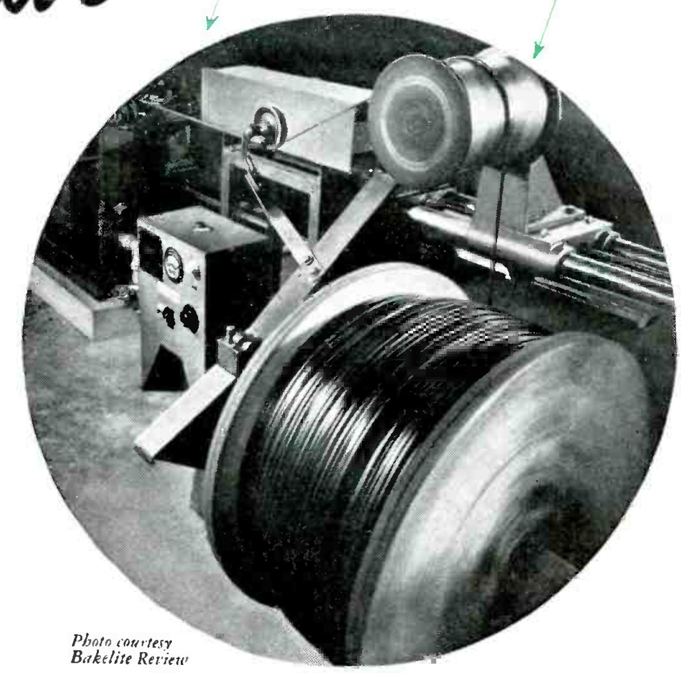


Photo courtesy Bakelite Review

THE ANSONIA ELECTRICAL DIVISION
ANSONIA, CONNECTICUT *of*
NOMA ELECTRIC CORPORATION

a main consideration with the Corporation, which strives to keep its transmitters ahead of receivers.

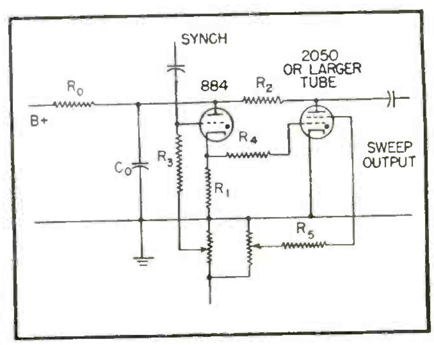
Both these summaries of recent B.B.C. technical work have been made with the permission of the Corporation and fuller details are contained in its new journal, *B.B.C. Quarterly*. —J.H.J.

Speeding up the Return Trace

By A. H. Taylor

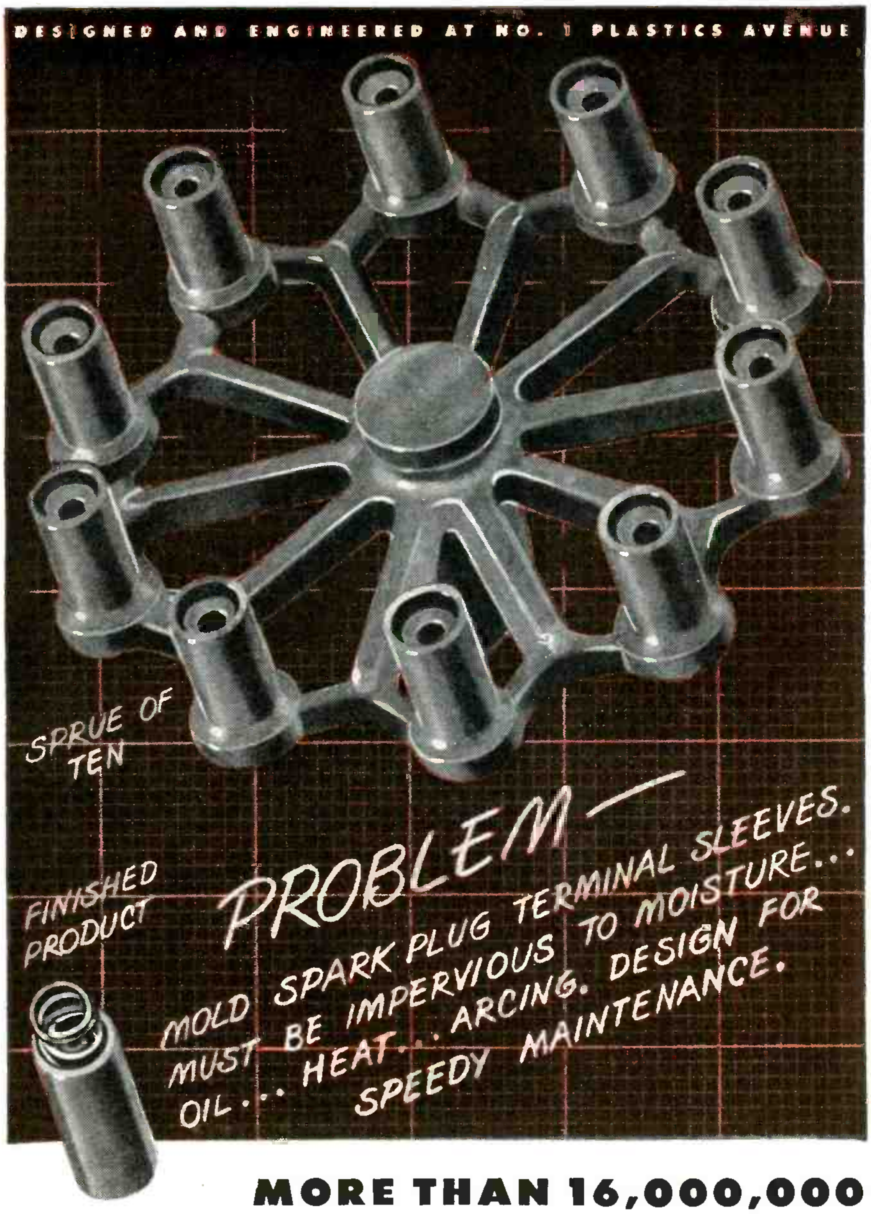
In the conventional sawtooth sweep circuit used in cathode-ray oscilloscopes, the speed of the return trace is limited by the permissible peak current of the gas tube.

Usually the gas tube is fired at 50 volts or less when charging from several hundred volts, to use only the initial, nearly linear part of the exponential voltage curve. The type 884 thyratron is particularly suitable for this because of its linear control characteristic, extending even to low plate voltages. Unfortunately, its permissible peak plate current is but 300 ma. Type 2050, on the contrary, will handle a peak of one ampere but has at low plate voltages an excessively curved control characteristic that makes for unsteady operation.



Sawtooth oscillator circuit combining advantages of 884 and 2050 to obtain rapid return trace of beam in c-r tube

The circuit shown combines the good triggering characteristic of the 884 with the high peak current of the 2050. Other types might be used. Resistor R_1 limits instantaneous peak current through the 884 and supplies a tripping pulse to the 2050; R_2 limits instantaneous peak current through the 2050; R_3, R_4, R_5 limit the grid currents. The combination of R_0C_0 is the sweep circuit.



MORE THAN 16,000,000 MOLDED OF G-E MYCALEX

●Here is an example of precision molding a critical component in G-E mycalex and supplying it by the million. The aircraft engine spark plug terminal sleeve had the advantage of being "self-healing" after exposure to prolonged arcing. It lent itself to ground crew maintenance of our warplanes.

This is but one of the many parts molded in G-E mycalex by General Electric during the war. Why not consult G-E engineers, who have perfected G-E mycalex molding techniques, about your insulation problems? You may heighten the efficiency of your product *and save on over-all insulation costs* by using a G-E mycalex precision molded part.

G-E mycalex, a stone-hard, gray-colored material that is produced by fusing special glass with powdered mica, is now available to you in standard rods and sheets . . . fabricated parts . . . or molded to your own design. A new bulletin tells the whole story of unique G-E mycalex—send for it today. Plastics Divisions, S-15, Chemical Department, General Electric Company, 1 Plastics Avenue, Pittsfield, Massachusetts.

HOW THE G-E MYCALEX SERVICES CAN BENEFIT YOU NOW

You may order fabrication of sample G-E mycalex parts at surprisingly low cost. Test them yourself in your own equipment. Then, if you decide to specify G-E mycalex, your design can be converted to a molding process which permits speedy and economical production runs.

MOLDING SERVICE

FABRICATING SERVICE

Get This Unique Combination of Properties with G-E Mycalex

1. High dielectric strength
2. Low power factor
3. Prolonged resistance to electrical arcs
4. Chemical stability—no deterioration with age
5. Dimensional stability—freedom from warpage and shrinkage
6. Impervious to water, oil, and gas
7. Resistance to sudden temperature changes
8. Low coefficient of thermal expansion
9. High heat resistance

Samples Supplied on Request

MYCALEX

GENERAL ELECTRIC

CD46-M18

INDUSTRIAL CONTROL

Edited by VIN ZELUFF

Testing Automobile Engines

AT THE DODGE automobile main plant, electronically controlled dynamometer test stands provide a new automatic means of testing and adjusting car engines. A novelty of the setup is that each engine drives a generator that feeds electric current into the plant's power line. In one hour, 510 kilowatts are generated by the engines on test.

The dynamometer test stands take the place of the old block test which required an hour and a half, and the old dynamometer test, which took an additional ten minutes, not counting time to transfer the engines between stands. The time required for fully testing an engine has been reduced to 20 minutes. A saving is accomplished also by eliminating the bank of engines manufactured ahead of assembly line needs to offset the uncertainty of the former method of engine testing.

The engine conveyor delivers finished engines directly to the new dynamometer room where sixty dynamometer test stands are arranged in two rows alongside the conveyor line of moving engines. Virgin engines are lifted by overhead cranes directly from the line to the dynamometer stands.

Test Cycle

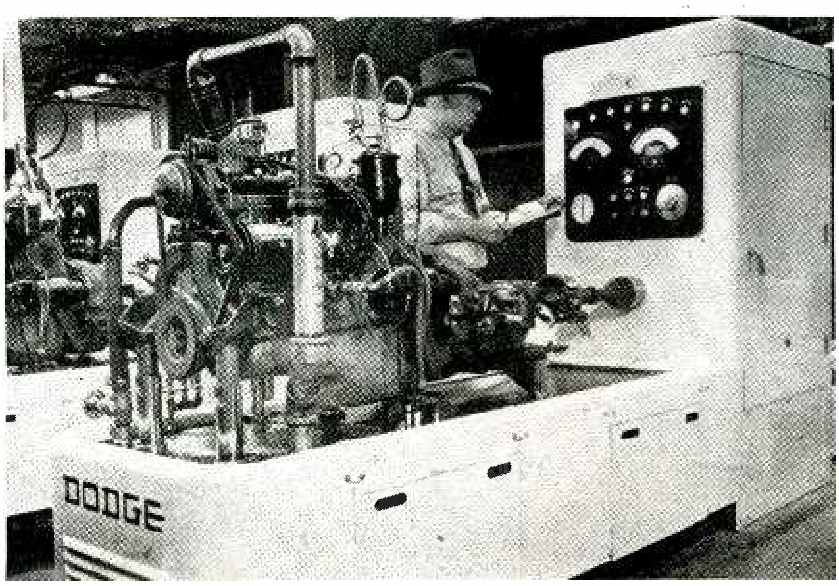
One of the test stands is shown in the illustration. The upright cabinet contains a generator and electronic controls that operate an instrument panel. Adjoining it is the base on which the engine is mounted. Fuel, water, oil, and exhaust-gas lines are concealed underground. A hydraulically operated throttle adjusts automatically as the engine runs from idling speed up to full load. Practically no human error can enter into the testing procedure.

The engine operates for five minutes at an idling speed of 500 rpm, with filtered oil constantly flushing through the crankcase. Then the electronic controls apply a half load on the generator, the throttle opens up, and the engine runs for 12 minutes at half load. During the first seven minutes at half-load, oil continues to flush through the crankcase, while a filtering system takes out any metallic traces remaining from the manufacturing process. The oil drain is then closed automatically, the crankcase is filled to operating level, and the last five minutes of the half-load test is run with oil circulating within the crankcase.

The engine is stepped up to full load at 1250 rpm for the final three minutes of the test. During the run, the operator of the stand gives all connections and cylinder head studs a final tightening, and an inspector checks each engine for power output and every engineering specification.

On the dynamometer instrument panel, flashing lights show instantly that the oil pump, water pump, and thermostats are functioning, and that the ignition timing is correct. At the end of the 20-minute run the engine is shut off and oil and water are drained automatically. Five minutes later, the engine is back on the conveyor, on its way to be installed in a new Dodge.

The technique developed as an outgrowth of experience in testing more than 18,000 engines for B-29 Superfortresses at Chrysler Corporation's wartime-operated Dodge-Chicago plant.



Dynamic testing of Dodge automobile engines is being accomplished by sixty electronically controlled test stands. Above, an inspector checks meters showing rpm, horsepower developed, and 14 other indicators

Radarange for Cooking

MICROWAVE cooking using a magnetron and a horn antenna to direct r-f energy into food is the latest development in the field of electronic heating. Called the Radarange by Raytheon Manufacturing Co., the equipment bakes biscuits and gingerbread in 29 seconds, cooks hamburgers with onion in 35 seconds, and grills a frankfurter and roll in eight to ten seconds. A package of frozen food can be placed in the range, defrosted in a few seconds, and cooked in a few more seconds.

The equipment, shown in the pho-

FRANKLIN AIRLOOPS now covered by basic patent #2,401,472

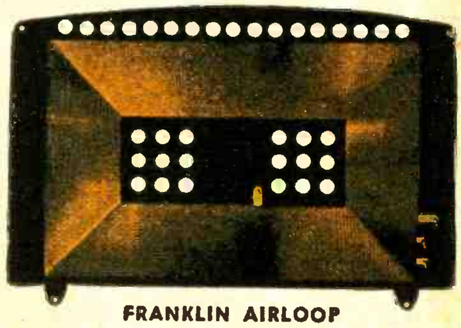
FRANKLIN AIRLOOPS NOW COVERED BY BASIC PATENT

Patent No. 2,401,472 covering the new loop antenna, known as the AIRLOOP, has just been issued by the U. S. Patent Office. The claims issued are basic in scope as is evidenced in claim No. 1 which is typical and follows:

1—An air dielectric inductance comprising a panel of insulating material and a continuous metal strip formed from a metal sheet and attached to one face of said panel in the form of a spiral, the planar width of said strip being equal to the pitch of said spiral and said strip being in channel form to provide a free air space between adjacent turns of said spiral.

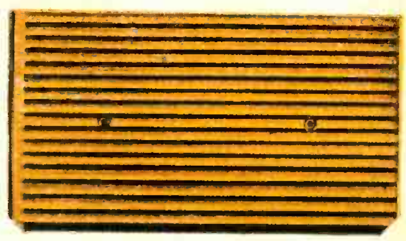
In addition to the above, other patents are pending, domestic and foreign, covering the methods of manufacture and items such as stamped electrostatic shields, stamped disc type commutators, stamped inductance coils, stamped wiring circuits and for the molding of loops and creative metal designs in cabinets which are of plastic or inert materials.

The Franklin Airloop Corp., which has the rights to the use of this patent, offers its experimental laboratories to assist in the development of any item which can be manufactured by the stamping method covered in these patents.



FRANKLIN AIRLOOP

SHORT WAVE INDUCTANCE COIL



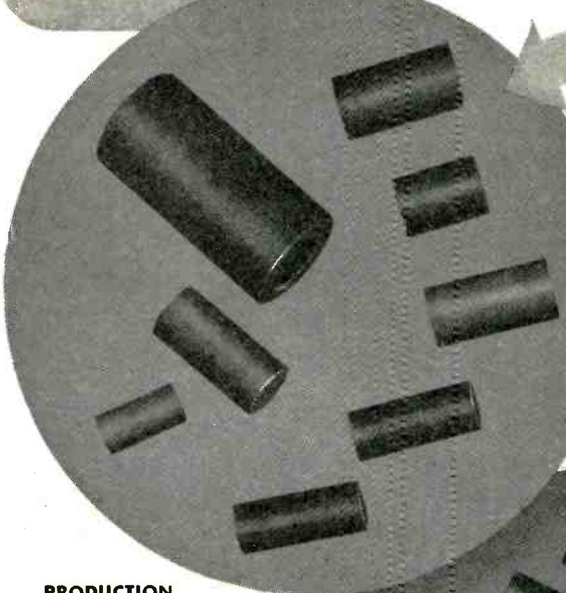
ELECTROSTATIC SHIELD

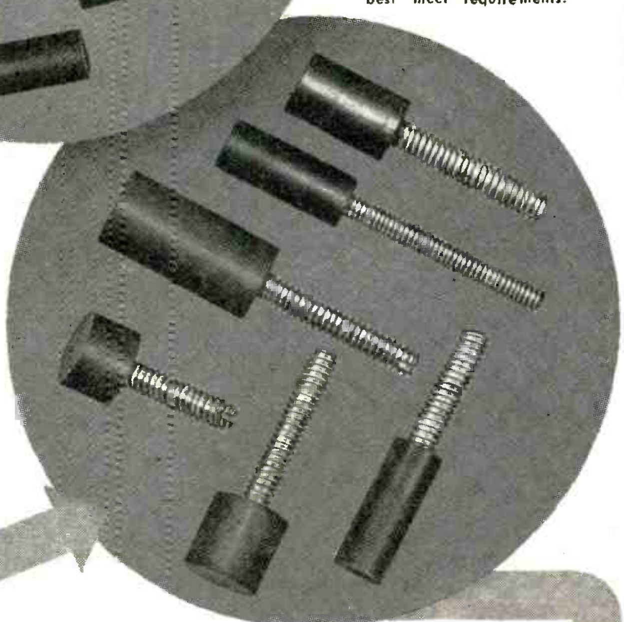
Illustrated are but a few of the items that can be manufactured by the method covered in this patent . . . many others are now in development . . . you, too, may conceive a use for this patented method and in such case the Franklin experimental laboratories will be glad to assist in its development.

DISC TYPE COMMUTATOR
MULTIPLE SWITCH
VARIABLE RESISTANCE

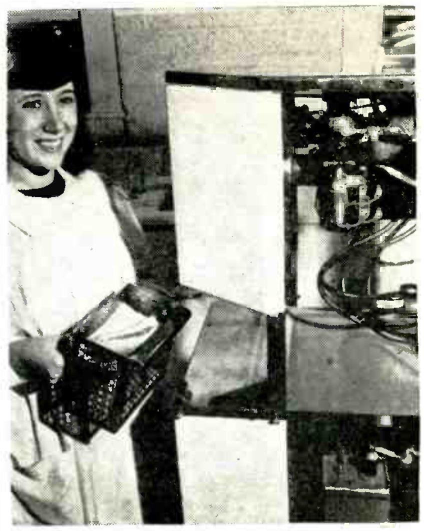
FRANKLIN Airloop CORPORATION

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



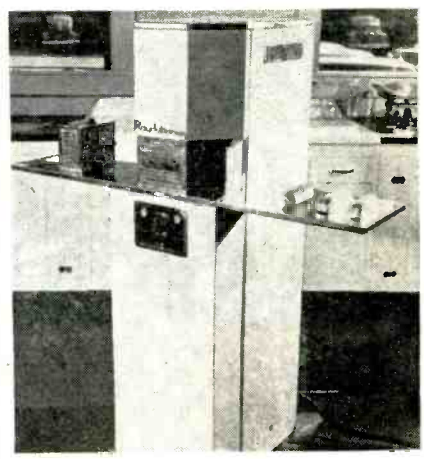


graph, is so arranged that the magnetron and horn assembly are above



Food to be cooked in the Raytheon Radarange is placed in the ventilated "oven" and inserted in the cabinet where r-f is squirted into it from the horn antenna

the cooking area to practically beam the r-f output into the food being cooked. The only controls are two pushbuttons and a timer setting. In operation the timer is set for the desired cooking time and the button pressed. When cooking is completed, the timer automatically



The magnetron and horn assembly are mounted in the top of the Radarange cooker

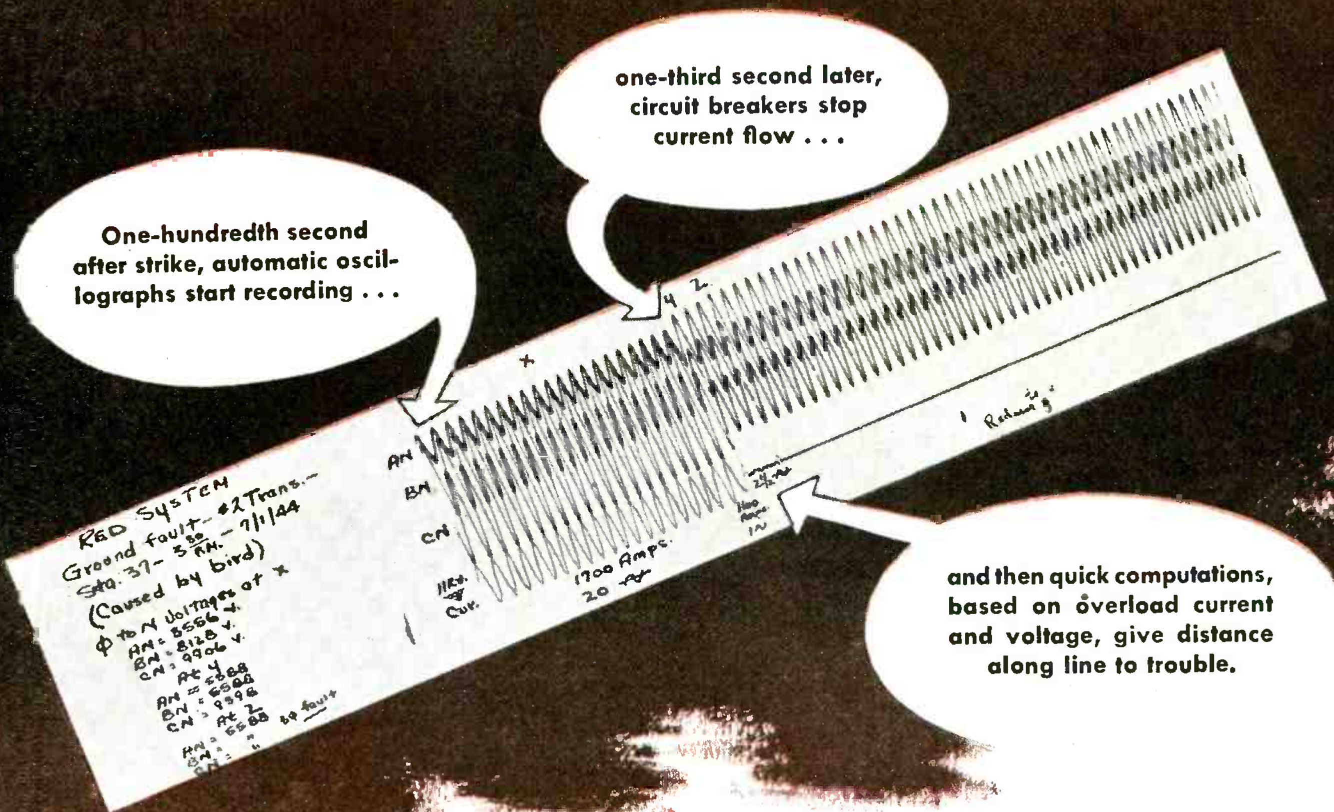
shuts off and the food is ready to eat. The power supply is located in the base of the cabinet.

It is planned to produce several sizes of equipment to meet specific applications, such as in aircraft where space is an important factor.

Phototube Sees X-Rays

AUTOMATIC X-RAY inspection of parts for internal defects is made

When POWER LINES *fail...*



Oscillogram made on Kodak Recording Paper 697

Instrument Recording

...another important function of photography

When windstorms damage power lines . . . when animals or birds "short" a circuit to ground . . . automatic oscillographs click into action and record the current and voltage changes. In less than one-half second it may be all over—the circuit breakers will have opened to stop the flow of current.

Tremendous speed of instrument response, of recording, is essential...and moving mirror oscillographs with photographic recording papers are more than equal to the task—because they can start operating in a hundredth of a second.

In service such as this, and in many other applications of oscillographs to studies of transient phenomena, the quality and dependability of photographic papers and films are factors which control the usefulness of trace data. There is a suitable Kodak paper or film for every type of oscillograph, and Kodak engineers will be glad to help with any work you may be doing with photographic instrument recording.

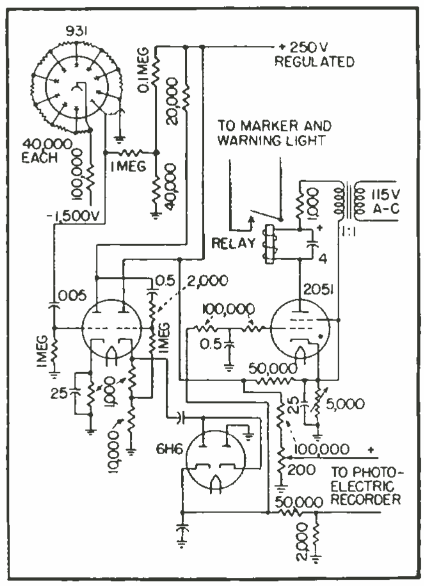
EASTMAN KODAK COMPANY

Industrial Photographic Division, Rochester 4, N. Y.

Kodak

possible in the accompanying circuit by placing a type 931 multiplier phototube in the position normally occupied by film during inspection by the x-ray absorption method, and by using an appropriate phosphor to convert the incident x-radiation into radiation of longer wavelength that can be measured by the phototube. The phosphor, such as silver-activated zinc sulphide or CaWo, may be applied to the glass envelope of the phototube or to a fluoroscopic screen positioned between the tube and the part being inspected.

Negative pulses from the 931 anode are resistance-capacitance coupled to one grid of the 6SN7 tube. The amplified positive pulses are then coupled to the other triode section, which is operated as a cathode-follower impedance converter to supply a comparatively low impedance network. The output of the



A multiplier phototube replaces the usual film for high-speed automatic inspection of parts for internal defects. The thyratron operates a marker and warning light

cathode-follower is rectified by a 6H6 diode and the d-c output is used to trip a 2051 thyratron and relay to operate a marker and warning light when output reaches a certain value. The d-c current also operates a photoelectric recorder of the x-ray intensity.

In one application of the circuit, described by H. M. Smith of General Electric Co., defective fuzes had part of their powder charge missing, and they therefore allowed greater x-ray penetration than


Type TS2A Ceramicon Trimmer
1.5-7 MMF 3-13 MMF 4-30 MMF
3-12 MMF 5-20 MMF 7-45 MMF
Feed-Thru Ceramicons
3 MMF—1,000 MMF
Insulated Hi-K Ceramicons
271 MMF—5,000 MMF
Non-Insulated Hi-K Ceramicons
271 MMF—15,000 MMF
A Directory of Electronic Components by ERIE RESISTOR
ERIE RESISTOR has developed and manufactured a complete line of Ceramic Condensers for receiver and transmitter applications; Silver-Mica and Foil-Mica Button Condensers; Carbon Resistors and Suppressors; Custom Injection Molded Plastic Knobs, Dials, Bezels, Nameplates and Coil Forms. Complete technical information will be sent on request.
High Voltage Double Cup Ceramicons
20 MMF—600 MMF
Type 554 Ceramicon Trimmer
3-12 MMF 5-30 MMF
5-25 MMF 8-50 MMF
Cinch-Erie Plexicon Tube Sockets with 1,000 MMF built in by-pass condensers
Stand-Off Ceramicons
1 MMF—2,500 MMF
Type 680A High Voltage, High KVA Multiple Plate Transmitting Ceramicons
120 MMF—1,800 MMF
Types 504B, ½ Watt—518B, 1 Watt Resistors
10 ohms—22 megohms
Disc Ceramicons
51 MMF—7,500 MMF
Temperature Compensating Insulated Ceramicons
0.5 MMF—360 MMF
Temperature Compensating Non-Insulated Ceramicons
0.5 MMF—1,100 MMF
Button Mica Condensers
15 MMF—6,000 MMF
Custom Injection Molded Plastic Knobs, Dials, Bezels, name plates, coilforms, etc.
Types L-4, L-7, S-5 Suppressors for Spark Plugs and Distributors
ERIE RESISTOR CORP.
ERIE, PENNSYLVANIA
LONDON, ENGLAND . . . TORONTO, CANADA

good fuzes. The 2051 thyratron bias was so adjusted that sufficient signal would be obtained to trip it and operate the relay whenever a defective fuze passed through the x-ray beam. The signal from a good fuze was of insufficient amplitude to trip the circuit. Since the x-ray beam was masked off between fuzes, no x-rays reached the detector circuit except through the fuze under inspection.

To provide a check on the proper functioning of the inspection equipment, every fourth fuze passing through the test position was known to be defective. (These known defective fuzes were left in their positions on the conveyor during the entire test run.) If the equipment failed to reject any of them the test was immediately stopped and the cause of the failure eliminated.

In place of the photoelectric detector, an ionization chamber might have been used. However, the current output of an ionization chamber is usually extremely small, and considerable amplification is necessary, together with a coupling resistance of high value. This high resistance and the associated capacitances of the ionization chamber and the amplifier result in too long a time constant for high speed of response. Furthermore, the complexity and instability of these amplifiers makes it much more convenient to use the photoelectric arrangement. Even for direct-current outputs, the enormous d-c amplification with stability available in the 931 tube makes its use preferable to that of the ionization chamber in most applications.

Electronic Heating Conference

INDUSTRIAL APPLICATIONS of high-frequency heating equipment that ranged from dielectric baking of foundry cores to inhibition of mold on Boston brown bread were discussed recently at a two-day conference of engineers in San Francisco.

Baking of foundry cores was a cooperative venture between Induction Heating Corp. and E. F. Houghton Corp., suppliers of the

WEATHER
Clear with diminishing costs.

TINNERMAN NEWS EXTRA

CLEVELAND, NOVEMBER, 1946

76TH YEAR OF TINNERMAN PROGRESS

76TH YEAR OF TINNERMAN PROGRESS

BUYERS GET HOT TIP

MASS PRODUCTION OF NEW SERIES SPEED NUTS RESPONSIBLE FOR LOWEST PRICES IN HISTORY

Buyers Determine Savings by Checking Present Purchases of Threaded Nuts and Lock Washers

NEW SPEED NUTS HAVE RUST-RESISTING FINISH

Shrewd, alert, cost-conscious John Buyer, speaking today for American Industry, admitted wide affect of latest Tinnerman Announcement. He predicted that, "The new C7000 Series Speed Nuts, costing less than threaded nuts plus lock washers, will save hundreds of thousands of dollars, as well as give impetus to better and faster assembly of mass production products". From Cleveland comes word that large stocks are on hand for immediate delivery. Prices and samples of the new Speed Nuts can be had for the asking.

SPEED NUTS ELIMINATE LOCK WASHERS

Greater Strength is Result of 20 Years of Engineering Experience

FASTEST THING IN FASTENINGS

Speed Nuts* PATENTED

*Trade Mark Reg. U. S. Pat.

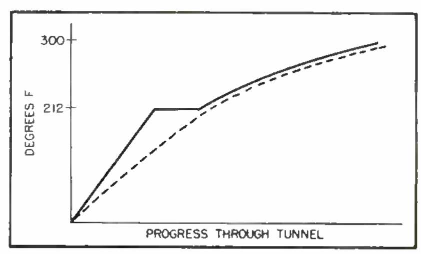
TINNERMAN PRODUCTS, INC. • 2106 FULTON ROAD • CLEVELAND 13, OHIO binder materials used. Where the old oven method required time in the order of hours and produced cores with irregular texture, the new development cut the operation on one particular core to 30 seconds and produced uniform cores with ideal color and texture.

The wet cores were carried through a dielectric heating tunnel by belt and timing was thus removed from the responsibility of the operator. Because of the drying curves, as shown in the accompanying illustration, it became impossible to burn the cores even by repeated passes through the tunnel. The knee in the solid curve, representing the wet pass, is created by the presence of moisture. On a subsequent pass approximately the same ultimate temperature is reached.

It has been found possible to pour alnico and Stellite around cores produced by the electronic process. The reported cost for power is about $1.25 per ton of sand treated and tube cost is eight cents per hour.

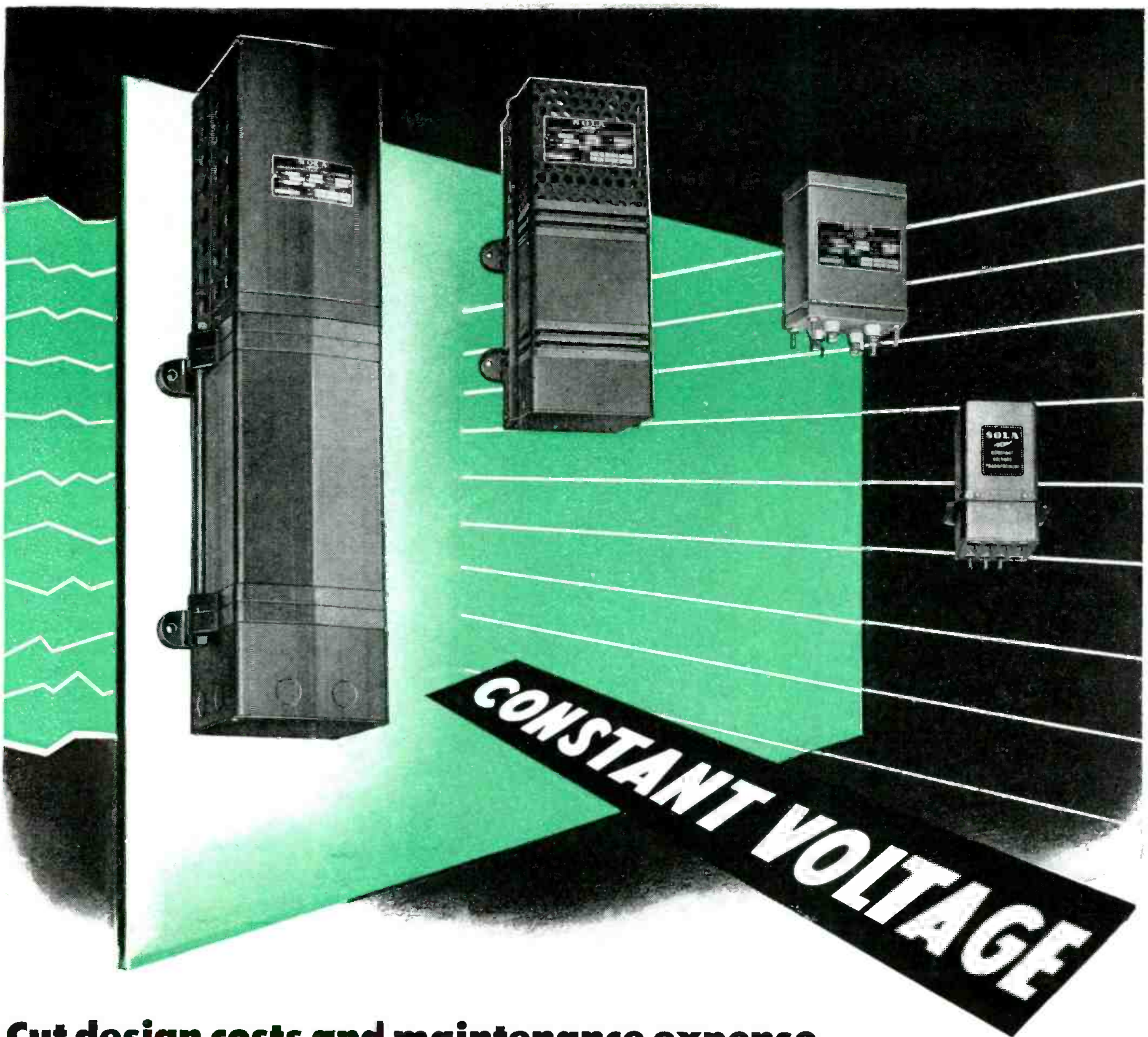
R-F Sterilization

In a discussion on r-f treatment of foods and agricultural products, it was mentioned that such treatment could be uniform only in homogeneous materials where a constant voltage gradient could be expected. Contrary to common expectations, even foods like potatoes present structures organized into discrete areas which make this difficult. Unsolved problems in this field include use of higher frequencies, application of more power, and a better understanding of tissues involved.



Drying curves for dielectric heating of foundry cores show that same ultimate temperature is reached by second pass through heating unit. Knee in solid curve is produced by moisture in initial core. Dashed curve is that of subsequent pass

The proper degree of sterilization required for commercial food



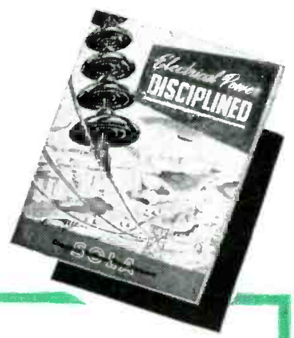
Cut design costs and maintenance expense with CONSTANT VOLTAGE protection

What happens to YOUR product when input voltage varies 10-15% from the value specified on your label?

Commercial line-voltages vary that much—and more! But you will be blamed if your product fails to perform at its best, regardless of those variations.

Be on the safe side. Build a SOLA Constant Voltage Transformer into your equipment and regardless of supply line variations as great as ±15% the voltage that reaches your equipment will be maintained within ±1% of the limits specified on your label.

SOLA Constant Voltage Transformers do their job automatically. There are no tubes or moving parts—nothing that requires manual supervision. Standard designs are available in capacities from 1VA to 15KVA or special units can be built to your design specifications and cost limitations.



Write for Bulletin DCV-102

Here you'll find the answer to a problem that confronts every manufacturer and user of electrical or electronic equipment.

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

products was stated, in one of the 14 papers delivered, to result in destruction of all spoilage microorganisms except a few of the thermophilic bacteria and inactivation of all the well-known enzymes. This may be achieved more readily with acid products than non-acid which require a considerable length of treatment in the range 240 to 260 F to destroy the heat-resistant spores of spoilage bacteria.

One speaker contrasted the possibility of using a lethal effect from electronically produced radiation without heat against the practice of using electronic means to generate heat within the product. The latter he dismissed as economically infeasible, stating that necessary equipment might very well approach in investment the entire cost of a conventional cannery. Admitting that the prospect of achieving sterilization by radiation without heat is most attractive to the industry because it would permit the production of fresher foods with uncooked characteristics, he questioned the present possibility of gaining commercial sterilization in this way.

Research Needed

Naming as possible types of radiation, ultraviolet, x-rays, electromagnetic radiation, and cathode rays, he listed barriers to the application of research work referred to in the current literature. For instance, where r-f radiation has been shown to be 100 per cent effective in killing E. coli, this was only possible in a salt-free medium. Presence of only a few hundredths of one percent of sodium chloride prevented such action and indicated that the presence of electrolytes in many foods would make them unsuited to such treatment. His conclusion was that the canning industry would find it necessary to await the outcome of further research being conducted at a number of institutions before going further in this development.

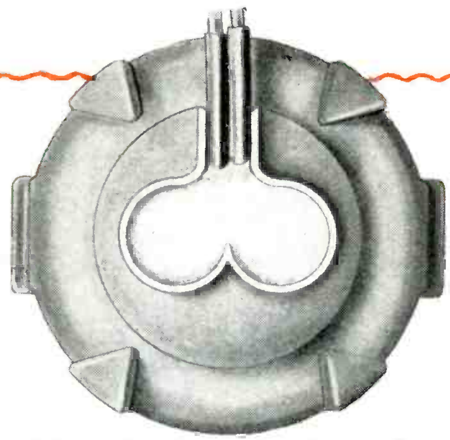
In another paper, it was disclosed that work conducted in the microbiological laboratory of the University of Southern California may indicate that there is an r-f effect on microorganisms beyond the

Here is another application where this improved Irvington formulation . . . Fibron #5373 . . . solves an electrical insulation problem involving high temperatures. Hot cement, used to seal the #5373-covered heating elements, has no effect on the flexibility of this unusual plastic. When the heater is in use, the tubing withstands continuous operating temperatures as high as 85° C. #5373 possesses the electrical, mechanical, and chemical properties which distinguish all Fibron tubings. Some of these are:

Dielectric Strength (.020″ wall)	wet	1000 V.P.M.
	dry	1000 V.P.M.
Tensile Strength, P. S. I.		3000
Life at 105° C.		2000 hours

Fibron #5373 tubing is available in all standard B & S wire gauge sizes, in six brilliant colors, in heavy wall thicknesses if required—in 36″ lengths, coils, or cut pieces.

Test this unusual product now. Generous samples and additional technical information gladly sent on request.



**Approved by Underwriters' Laboratories for this application*

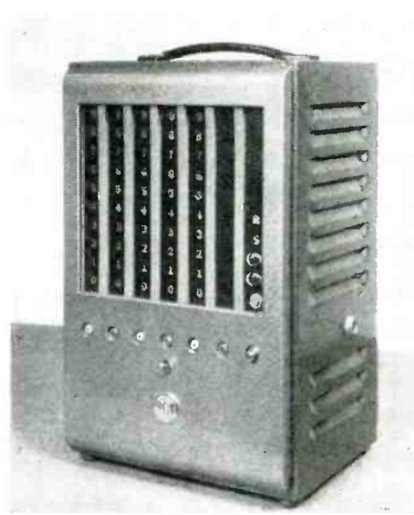
Short lengths of Fibron #5373 are used to protect the conductor leads on the heating element of the Electra-Serve, manufactured by Electrical Industries, Inc., Newark, N. J. This bottom view of the unit shows where the hot cement seals over the #5373 insulation. Withstanding this heat and high operating temperatures, #5373 tubing retains its flexibility and high dielectric strength.

IRVINGTON *Varnish and Insulator Company* IRVINGTON 11, NEW JERSEY, U.S.A.

Authorized distributors in: BALTIMORE · BLUEFIELD, W. VA. · BOSTON · CHARLOTTE · CHICAGO · CLEVELAND · DALLAS · DENVER · LOS ANGELES · MINNEAPOLIS · NEW HARTFORD, N. Y. · NEW YORK · NEW ORLEANS · PHILADELPHIA · PITTSBURGH · ST. LOUIS · SAN FRANCISCO · SEATTLE · HAMILTON, ONT., CANADA purely thermal one and that the mechanism of cell destruction under such conditions where the walls are punctured has been observed. That there is a specific frequency for each organism or group seems probable. As a practical application of the laboratory activities, successful inhibition of the growth of mold on the surface of commercial Boston brown bread with a treatment by r-f induction heating was described. The conference was sponsored by fifteen local organizations, including IRE, AIEE, and the West Coast Electronic Manufacturers Association.

High-Speed Counter

COUNTING OBJECTS at rates as fast as 1,000,000 per second, the RCA time interval counter is now for the first time being produced in quantities for science and industry. The unit was developed by RCA during the war and used for measuring projectile velocities at the Army's Aberdeen Proving Grounds. Redesigned for peacetime applications, it can be used to measure velocities and accelerations for intervals up to one second in steps of one microsecond, or to count at



Neon-lit figures on the panel of the time interval counter can show b velocities and accelerations for intervals up to one second in steps of one millionth of a second

speeds as high as 1,000,000 per second.

For industrial control, the instrument may be used as an integral

A NEW

VACUUM-TUBE VOLTMETER

- INCREASED SENSITIVITY — with the addition of a 0 to 0.5 volt scale, sensitivity is extended by a factor of 3
- CALIBRATED FOR DC AS WELL AS AC
- WIDER VOLTAGE RANGES — 0.1 to 150 volts for ac; 0.01 to 150 volts for dc; both in six ranges
- ACCURACY OF ±2% FOR D-C AND SINUSOIDAL A-C VOLTAGES
- EXTENDED FREQUENCY RANGE — as low as 20 cycles with error of less than 2% — up to 300 Mc maximum error is ±12% — useful for voltage indication up to 2,500 Mc
- IMPROVED PROBE — much smaller — natural frequency increased to 1050 Mc — much better shielding — can be used with a variety of standard probe fittings, three of which are supplied
- A SINGLE ZERO ADJUSTMENT GOOD FOR ALL SIX RANGES
- NEW METER — easier to read — mirror for greater precision — no parallax — knife-edge pointer for upper scales, broad pointer for lower — face illuminated to eliminate reflections from glass
- EFFECTIVE INPUT RESISTANCE 25 MEGOHMS AT LOW FREQUENCIES
- VERY LOW PROBE INPUT CAPACITANCE — about 3.1 micromicrofarads
- PLATE VOLTAGE SUPPLY EQUIPPED WITH ELECTRONIC STABILIZER
- INSTRUMENT CAN BE USED WITH PANEL VERTICAL, INCLINED OR HORIZONTAL

THE Type 1800-A Vacuum-Tube Voltmeter is a new instrument based on the fundamental designs of the Type 726-A, introduced by G-R in 1937. With greater sensitivity, increased ranges, improved probe construction, both d-c and a-c voltage calibrations, and housed in a much more compact and convenient-to-use cabinet, the useful upper-frequency limit of this meter is extended just about as far as present-day vacuum-tube construction will permit.

TYPE 1800-A VACUUM-TUBE VOLTMETER - $305.00

- ***Write for complete information***

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

unit of selective counting machines, which automatically start, stop, or shift operations when a predetermined number of items has been counted. By this means, any process can be controlled on the basis of a preselected figure. A dial is set, and when the preselected figure is reached, the counter triggers an electrical impulse which stops the operation, shifts the package to another conveyor, and starts the counting operation all over again.

Time intervals longer than one second can be measured by using an external timer to record the number of times the counter repeats its operation.

Industrial X-Ray Building

THE FIRST REPORTED use of a 2,000,000-volt x-ray machine for examining welds in pressure vessels will be that at Babcock and Wilcox Company of Barberton, Ohio. The company manufactures steam generating equipment and is a pioneer in the use of x-ray to detect flaws in pressure vessel welds, having 11 such machines now in use.

A special building to house the new machine will be erected adjacent to the location of a present 1,000,000-volt x-ray unit.

The building will be 35 feet wide by 31 feet high, and 81 feet in length. Double walls of 42 inches of sand solidly packed between quarter-inch steel plates will prevent radiation from the unit. An overhead floor-operated crane will support the x-ray unit and move it around within the building.

The building will accommodate drums up to 13 feet in diameter and 75 feet in length, which are the dimensions of the largest vessel likely to be shipped by rail. Vessels that weigh up to 150 tons can be tested. Two cars with drum turners will bring the drums into the building. One car and one drum turner will be motorized.

The equipment was purchased from General Electric X-Ray Corporation, and is capable of operating at any voltage from 1,000,000 to 2,000,000.

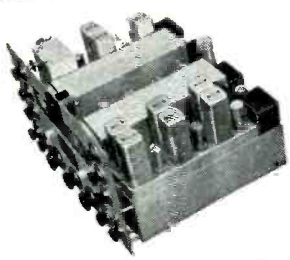
A Triumph in

COMMUNICATIONS ENGINEERING

The New Improved

KP - 81

Receiver



- New Automatic Noise Silencer
- Two Pre-Selector Stages
- Turret Band Change
- Four Gang Tuning and Band Spread Condensers
- Series Parallel Crystal Filter
- Calibrated Band Spread
- Built-In Crystal Calibrator
- Single Signal At All Times
- Variable Hi and Lo Pass Audio Filters
- 550 Kilocycles to 40 Megacycles

DESIGNED by Karl E. Pierson, creator of the famous PR series of receivers, the new KP-81 is now in production. We promise you this receiver will establish new standards of excellence in the field of radio communications. KP-81 incorporates many of the advanced features born of wartime research, and is years ahead in design, engineering and performance.

We are making every effort to meet the heavy demand for the new KP-81 receivers. However Pierson Electronic Corporation will adhere to their policy of precision construction, and suggest that you place your order well in advance.

PIERSON ELECTRONIC CORP.

533 EAST FIFTH STREET • LOS ANGELES 13, CALIF.

Manufacturers of Communication and Commercial Radio Equipment

"Export Department: FRAZAR & HANSEN, 301 Clay St., San Francisco 11, Calif., U. S. A."

THE ELECTRON ART

Edited by FRANK ROCKETT

Analysis of Linear Sweep Generator

By EUGENE L. LANGBERGH

Randal Morgan Laboratory
University of Pennsylvania
Philadelphia, Pa.

THE CIRCUIT herein described is designed to take advantage of current feedback to cause a capacitor to charge very linearly through a vacuum tube. The basic circuit is shown in Fig. 1. Capacitor C is charged by current flowing through V_1 and R from the B-supply. Tube V_2 is a switch used to discharge C;

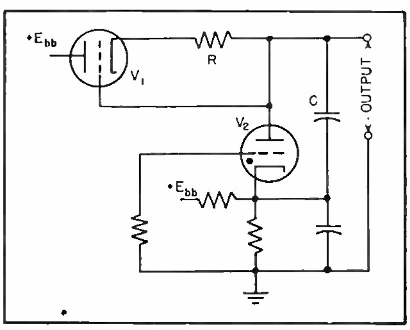


FIG. 1—Basic circuit of relaxation sweep generator to which current feedback has been added to improve the linearity

in this case a gas tube as in the usual relaxation oscillator. Current feedback upon which the circuit's linearity depends occurs in resistor R.

Mathematical Analysis

For considering the circuit mathematically, it can be simplified to that shown in Fig. 2A. From this circuit we can draw the equivalent circuit shown in Fig. 2B. We will take as $t = 0$ the time at which the switch opens and consider what happens for one cycle, all others being the same.

Assuming that negligible current is drawn by the load on the output, the mesh equation for the circuit is

$$E_{bb} - \mu E_g = r_p i + Ri + \int (i/C)\, dt$$

but $E_g = Ri$ so we have

$$E_{bb} - \mu Ri = r_p i + Ri + \int (i/C)\, dt$$

Transposing, multiplying through by C and gathering terms, we have

$$CE_{bb} = C(R + \mu R + r_p)i + \int i\, dt$$

Because $i = dq/dt$ and $i \int dt = q$, we can write an equation in q, the charge on the capacitor

$$CE_{bb} = C(R + \mu R + r_p)\frac{dq}{dt} + q$$

Let $C(R + \mu R + r_p) = A$ and rewrite the foregoing equation as

$$\frac{dq}{dt} + \frac{q}{A} = \frac{CE_{bb}}{A}$$

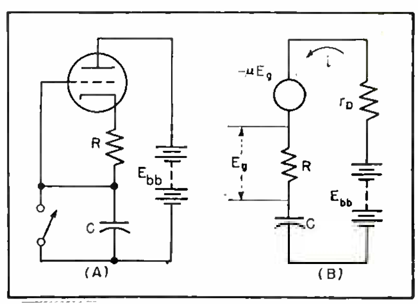


FIG. 2—(A) Simplified circuit of linear sweep generator (B) equivalent circuit of generator

This equation is in the well known form

$$\frac{dy}{dx} + Py = Q$$

the solution of which is

$$y\epsilon^{\int P\,dx} = \int \epsilon^{\int P\,dx} Q\,dx + C_1$$

We have $P = 1/A$, $Q = CE_{bb}/A$, $y = q$, $dx = dt$. Making the proper substitutions and carrying out the indicated integrations, we have

$$q = CE_{bb} + C_1\epsilon^{-t/A}$$

at $t = 0$, $q = E_oC$ where E_o is the voltage at which the gas tube goes out, therefore $C_1 = C(E_o - E_{bb})$ and the solution is

$$q = CE_{bb} + C(E_0 - E_{bb})\epsilon^{-t/A}$$

Taking the derivative, we have

$$\frac{dq}{dt} = -\frac{C}{A}(E_0 - E_{bb})\epsilon^{-t/A}$$

$$= \frac{C}{A}(E_{bb} - E_0)\epsilon^{-t/A}$$

Putting in the value of A, our result becomes

$$\frac{dq}{dt} = \frac{E_{bb} - E_0}{R + \mu R + r_p} \exp \frac{-t}{C(R + \mu R + r_p)}$$

It is evident that for dq/dt to be constant, $C\,(R + \mu R + r_p)$ must be large. This fact controls the selection of the tube V_1. It should be a high-μ tube with large r_p. High-μ pentodes fulfill this condition best. However, the circuit worked fairly well even with a low-μ triode but large R.

Degree of Nonlinearity

The question of just how badly nonlinear the sweep may become can be answered in the following manner. The maximum value of t per cycle will be the period of the sawtooth determined by the potential at which the gas tube ignites. If E_i is the voltage on the capacitor at ignition, then $q_i = CE_i$. Putting this value into the equation for q and solving for the maximum value of $t = T$

$$CE_i = CE_{bb} + C(E_0 - E_{bb})\epsilon^{-T/A}$$

$$(E_{bb} - E_i) = (E_{bb} - E_0)\epsilon^{-T/A}$$

$$\epsilon^{-T/A} = \frac{E_{bb} - E_i}{E_{bb} - E_0}$$

$$T = -A \ln \frac{E_{bb} - E_i}{E_{bb} - E_0}$$

Note that $\ln(E_{bb} - E_i)/(E_{bb} - E_o)$ is always negative because $(E_{bb} - E_i)/(E_{bb} - E_o)$ is always less than unity, hence T is always positive.

Solving for A gives

$$A = -\frac{T}{\ln \dfrac{E_{bb} - E_i}{E_{bb} - E_0}}$$

then

$$\frac{dq}{dt} = \frac{C}{A}(E_{bb} - E_0) \exp \frac{T}{t} \ln \frac{E_{bb} - E_i}{E_{bb} - E_0}$$

The maximum value of t/T is unity at $t = T$. The charging rate at $t = T$ is

$$\left.\frac{d}{dl}\right|_T = \frac{C}{A}(E_{bb} - E_0) \exp \ln \frac{E_{bb} - E_i}{E_{bb} - E_0}$$

which represents the worse possible condition of nonlinearity. Because it is reasonable to expect the sawtooth to be amplified before being placed upon the cathode-ray tube, the sweep generator need put out a voltage no greater than 10 volts. This condition means that $E_i - E_0 = 10$ volts. Using reasonable values of $E_{bb} = 350$ volts, $E_0 = 15$ volts, and $E_i = 25$ volts, exp ln $(E_{bb} - E_i)/(E_{bb} - E_0)$ has a value of 0.970 at the most nonlinear part of the cycle. For all practical purposes then, the charging current is linear through the whole cycle.

Returning to the period of oscillation and putting in the value of A, we have

$$T = -C(R + \mu R + r_p) \ln \frac{E_{bb} - E_i}{E_{bb} - E_0}$$

the ln $(E_{bb} - E_i)/(E_{bb} - E_0)$ is a negative constant so we can write $T = C(R + \mu R + r_p)k$. It is evident that we can change C for coarse frequency selection and vary R for fine frequency control. However, because of the large current feedback, good values of μ are not easily obtainable, hence the period cannot be accurately calculated. It is also evident from the circuit that synchronization can be accomplished in the normal fashion by applying synchronizing voltage to the grid on the gas tube V_2.

Laboratory Sweep Generator

The circuit put into use is shown in Fig. 3. The 50,000-ohm resistor

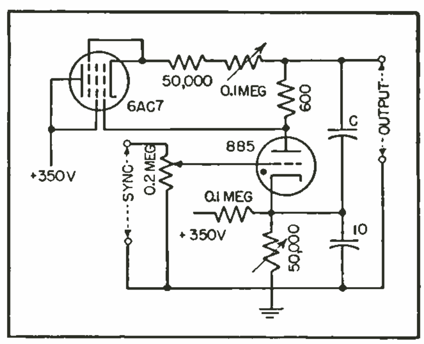
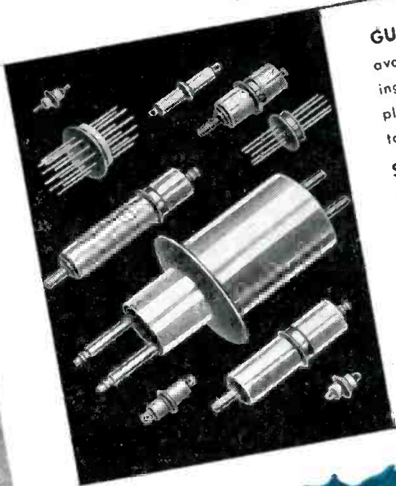


FIG. 3—Complete circuit of laboratory sweep generator whose output is linear

in series with the cathode of the 6AC7 gives a minimum value of R. The 0.1-meg rheostat is the fine frequency control. The value of C is changed in five steps from 0.1 μf to 0.0001 μf giving a wide frequency

FOR HIGH EFFICIENCY—

SEALEX BUSHINGS



GUARANTEED HERMETIC SEALS: Sealex Bushings are available in a diversity of standard types capable of meeting most equipment design requirements. For unusual applications, special types can be produced on short notice to exact specifications.

SPECIAL BONDING: The steatite dielectric is chemically bonded to the metal electrode and collar; matched coefficients of expansion assure the permanency of the bond through a wide range of temperature. All metal parts are hot-tinned to reduce wiring and installation time on the job.

INDIVIDUALLY PRESSURE TESTED: Each bushing is subjected to an air pressure test of 50 psi prior to shipment, a test that has proven effective in disclosing even microscopic defects in the seal.

RANGE OF SIZES
0.5 TO 20 AMPS
★
FLASHOVER VOLTAGE
2000 TO 40,000
★
LOW LOSS FACTOR
0.7% AT 1000 KC
★
TEMPERATURE RANGE
55° C to 978° C
★
NUMBER OF TERMINALS
UP TO 16 MAXIMUM

...specify General Ceramics steatite!

GENERAL CERAMICS AND STEATITE CORP.
KEASBEY, NEW JERSEY

General Ceramics Steatite insulators and Sealex bushings are used by leading manufacturers of every type of equipment. This reliance upon steatite is due to the fact that design engineers are well aware of steatite's physical and electrical characteristics . . . a short-cut to lower manufacturing costs and better equipment performance. For assistance in applying steatite insulators or bushings to your product, or for collaboration in the development of special types for unusual conditions, call or write our engineering department today. An informative 48-page catalog is available on request on company letterhead.

GENERAL CERAMICS AND STEATITE CORPORATION — STEATITE INSULATORS

MAKERS OF STEATITE, TITANIA, ZIRCON PORCELAIN, ALUMINA, LIGHT-DUTY REFRACTORIES, CHEMICAL STONEWARE

STEATITE INSULATORS

LOW LOSS FACTOR OF 0.7% AT 1000 KC: General Ceramics Steatite insulators, bushings, and coil forms have high surface and volume resistivity, as well as high tensile strength. Steatites low loss factor of 0.7% at 1000 KC results in high efficiency in both medium and high frequency applications.

EXTRUDED, PRESSED AND CAST FORMS: Practically any shape or size can be produced to close dimensional accuracy by automatic pressing, extrusion or casting. Surfaces can be supplied glazed or unglazed, or with coatings of silver, copper or tin.

GENERAL TOLERANCES: Unglazed surfaces, ±1% of the dimension involved but not less than ±.005". Glazed surfaces, ±2% of the dimension involved but not less than ±.012". Thickness dimensions are normally held to ±.010" unless otherwise specified.

PILLAR INSULATORS
★
BUSHINGS
★
COAXIAL CABLE INSULATORS
★
LEAD-IN INSULATORS
★
SPREADER & STRAIN INSULATORS
★
COIL FORMS
★
MISCELLANEOUS TYPES

—AT ANY FREQUENCY

range. Table I shows obtainable ranges. The 600-ohm resistor protects the 885 from excessive currents and improves the charging to discharging time ratio. It does so by developing a large negative bias on the 6AC7 during the discharge of C through the 885. This bias permits the voltage across C to drop

Table I—Frequency Ranges

Capacitance in μf	Frequency range in cps
0.5	40– 165
0.1	70– 450
0.2	300– 1,900
0.005	1,200– 7,500
0.001	4,000–25,000
0.0001	22,000–50,000

more rapidly than it would if current were allowed to flow from the B-supply during discharge.

The fixed bias was so adjusted that the output voltage was about 10 volts. The generator was found to make possible very high sweep frequencies with good front to back trace ratio and little change in amplitude with frequency.

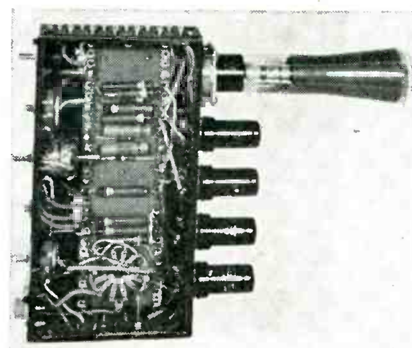
The circuit as described is a relaxation oscillator which generates a very linear sweep. However, the principle developed can be used to produce high-speed linear sweeps of low repetition rates or even sweeps for transient observation. If the gas triode V_2 is replaced by a vacuum tube at zero bias, the vacuum tube will short the capacitor C. The sweep is then generated only when a negative pulse is applied to the grid of this vacuum tube thus cutting it off. The length of the sweep will be determined by the length of the pulse. The only precaution necessary is that the pulse should not be made so long that the sweep amplitude $E_t - E_0$ will become large and make exp ln $(E_{bb} - E_t)/(E_{bb} - E_o)$ take on values so much less than unity that the sweep will become intolerably nonlinear.

Instrumentation: State of the Art

THE INSTRUMENT SOCIETY, youngest among those societies whose interests touch the field of elec-

tronics, held its first national technical conference and product exhibit at Pittsburgh, Pa., September 16-20. Concurrently with the conference, the Industrial Instruments and Regulators Division of the ASME and the Physical Society of Pittsburgh held meetings.

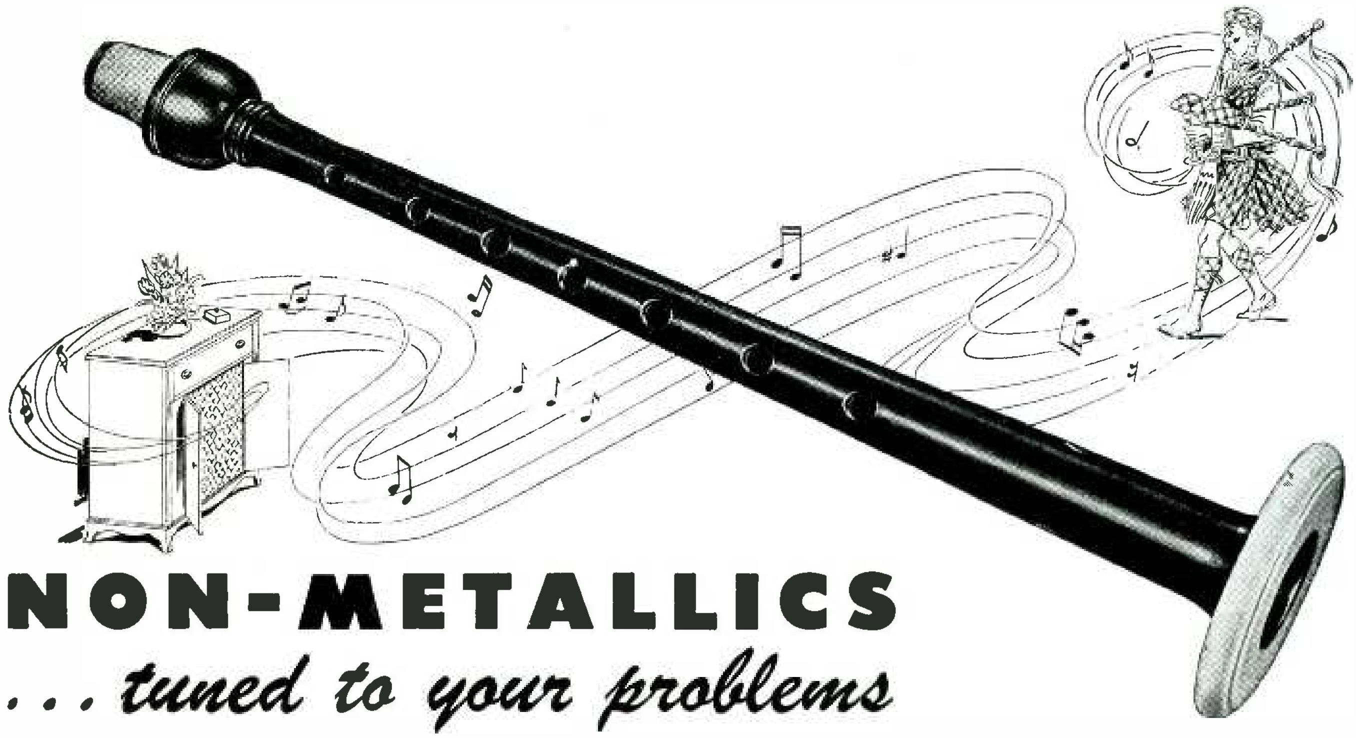
Use of instruments for production and product control including material on computers, gaging, pressure and vibration metering, aviation instrumentation, and controls for atomic research was described. To those attending the meeting, several overall impressions were clear. Although this was a meeting of operating engineers, much of what was said is of interest to design engineers. Several chairmen and speakers stressed the need for greater collaboration between instrument designers and the users. In fact, there is considerable delay, six to eight years in some instances, between the time the design of electronic equipment is described and the time the equipment is used to an appreciable extent. Although evaluations of the utility of electronic instruments differed from field to field, it was universally voiced that what is needed is a high gain, wide band, d-c amplifier that is free from all forms of drift.



One channel of the six channel, cathode-ray oscillograph developed at the Naval Ordnance Laboratory and described at the "Instrumentation for Tomorrow" conference of the Instrument Society of America. The two-inch cathode-ray tube is driven by a resistance coupled, balanced amplifier. Continuously moving film records trace

The Donutron

A SQUIRREL-CAGE MAGNETRON, called a donutron, provides a simpler, less



NON-METALLICS

. . . tuned to your problems

WHETHER you play the bagpipe or the radio . . . you want the music to sound natural . . . so do your customers. Your product must be able to compete for their ears, eyes and pocketbook.

C-D NON-metallics can help you attain those ends. C-D NON-metallics are engineered to meet specific design, production and performance problems, involving mechanical and electrical insulating properties.

The bagpipe valve-stopped tube illustrated is an excellent example of a C-D product designed to meet specific production and performance problems. It is made of Black Grade XX molded DILECTO tubing. In addition to the machining plainly visible, the inside diameter of the tube has three distinctly different stepped tapers. The tube must of course retain its dimensions in spite of moisture conditions.

The ease with which C-D Dilecto can be machined, its dimensional stability combined with its good electrical insulating properties, its light weight and its great strength make it a material that may be the answer to one or more of your "What Material?" problems.

C-D NON-metallics offer a wide combination of desirable properties. Booklet GF gives specific design and engineering data on all of them. Write for a copy today.

C-D PRODUCTS

The Plastics

DILECTO—Thermosetting Laminates.
CELORON—A Molded Phenolic.
DILECTENE—A Pure Resin Plastic Especially Suited to U-H-F Insulation.
HAVEG—Plastic Chemical Equipment, Pipe, Valves and Fittings.

The NON-Metallics

DIAMOND Vulcanized FIBRE
VULCOID—Resin Impregnated Vulcanized Fibre.

MICABOND—Built-Up Mica Electrical Insulation.

Standard and Special Forms

Available in Standard Sheets, Rods and Tubes; and Parts Fabricated, Formed or Molded to Specifications.

Descriptive Literature

Bulletin GF gives Comprehensive Data on all C-D Products. Individual Catalogs are also Available.

Continental-Diamond
C-D
Engineered Non-Metallics

EL-46

BRANCH OFFICES

NEW YORK 17 • CLEVELAND 14 • CHICAGO 11 • SPARTANBURG, S. C. • SALES OFFICES IN PRINCIPAL CITIES
WEST COAST REPRESENTATIVES: MARWOOD LTD., SAN FRANCISCO 3
IN CANADA: DIAMOND STATE FIBRE CO. OF CANADA, LTD., TORONTO 8

SEE OUR CATALOG IN SWEET'S

Continental-Diamond FIBRE COMPANY

Established 1895.. Manufacturers of Laminated Plastics since 1911—NEWARK 16 • DELAWARE expensive construction than cavity magnetrons, is less subject to mode jumping, and operates over its tunable range at a single anode voltage. The interleaved finger construction of the anode is shown in Fig. 1.

The donutron can be made to oscillate in a variety of modes, however only the resonant cavity mode

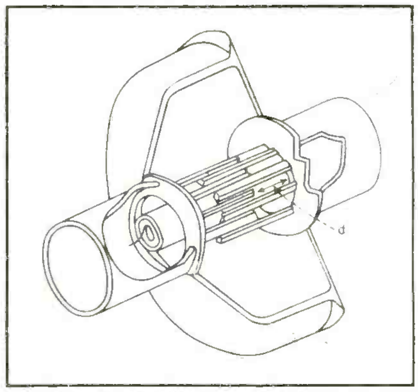


FIG. 1—Squirrel-cage magnetron is tuned by varying the distance by which the two sets of interleaved bars overlap each other

and the capacitively loaded re-entrant line modes are currently important. Further investigation of these and other modes may increase the realizable frequency and power output of the tube. In the re-entrant line mode, a standing wave forms circumferentially about the anode. In this mode, about 50 watts at 45 percent efficiency have been obtained; anode current ranges from 100 to 200 ma, static impedance from 700 to 1,500 ohms. The tube can be tuned over a 1.5 to 1.0 frequency range.

Field Pattern

The two end rings, from which the fingers of the squirrel-cage extend, form the re-entrant line. The fingers provide the capacitive loading. Thus the main radio-frequency current flows in the rings themselves, only enough current flows in the fingers to charge them to the potential of the ring at their individual points of attachment. The wavelength is twice the electrical circumference of the anode ring.

The out-of-phase radio-frequency currents in the two rings are accompanied by magnetic fields that form closed loops interlacing the squirrel-cage bars as shown in Fig. 2. Voltage nodes appear where the maximum lines of magnetic flux pass between pairs of teeth. This

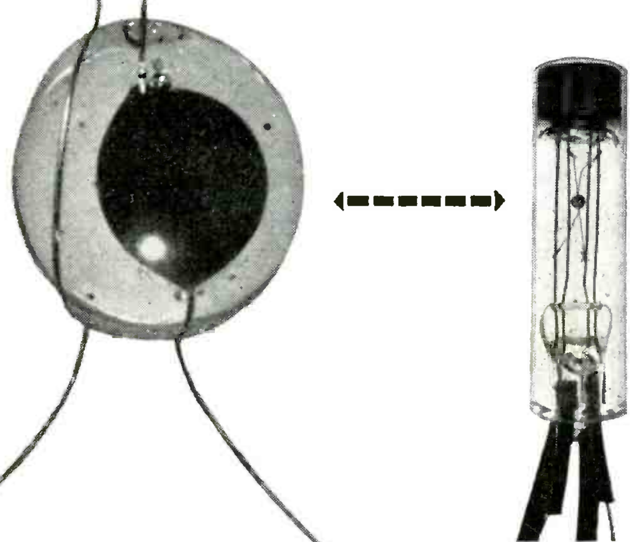
The Eye That Never Closes

You are looking at a thermistor — a speck of metallic oxide imbedded in a glass bead hardly larger than a pinhead and mounted in a vacuum. The thermistor was developed by Bell Telephone Laboratories to keep an eye on the amplification in long-distance telephone circuits.

When a thermistor is heated, its resistance to electric current changes rapidly. That is its secret. Connected in the output of repeater amplifiers, it heats up as power increases, cools as power decreases. This change in temperature alters the resistance, in turn alters the amplification, and so maintains the desired power level. Current through the wire at the left provides a little heat to compensate for local temperature changes.

Wartime need brought a new use for this device which can detect temperature changes of one-millionth of a degree. Bell Laboratories scientists produced a thermistor which could "see" the warmth of a man's body a quarter of a mile away.

Thermistors are made by Western Electric Company, manufacturing branch of the Bell System. Fundamental work on this tiny device still continues as part of the Laboratories program to keep giving America the finest telephone service in the world.



BELL TELEPHONE LABORATORIES

EXPLORING AND INVENTING, DEVISING AND PERFECTING FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE distribution was verified by exploring the field of the cold, externally excited tube with a probe from a dummy cathode. When the tube is being excited by an electron stream, two such patterns that are

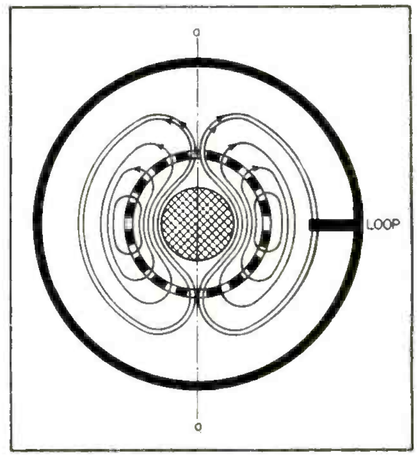


FIG. 2—Because the magnetic field links the squirrel cage, the size of the tube shell cavity does not appreciably affect the resonant frequency

mutually perpendicular are established in the radial plane of the tube. Were it not for unavoidable irregularity of the tube construction, the two fields would be degenerate. Additional overlapping extensions are added to further remove the one field from the other. (A Tunable Squirrel-Cage Magnetron by F. H. Crawford and M. D. Hare, Radio Research Laboratory, Harvard University, an unpublished report.)

Stenotrone

A GAS TUBE having a stricture in the path of the discharge between cathode and anode produces high-frequency, high-powered oscillations. The tube is called a stenotrone. The electric discharge itself, independent of a resonant circuit, generates undamped electric oscillations. Under these conditions the tube becomes very hot.

Characteristics

Frequency, amplitude, and waveshape of the generated oscillations are affected by the tube's geometry, type and density of the gas, current, and external circuit. The oscillation consists of a periodic variation in current, during which

A *Special* FABRIC

might solve your problem

Cloth Bound

A cloth bound book is bound to be kept — bind your CATALOG — SALES MANUAL — INSTRUCTION BOOK, ETC. in HOLLISTON Book Cloth — durable, impressive, hard-to-soil, easy-to-clean.

Write for samples.
Consult your printer.

SPECIAL FINISH

HOLLISTON special finish cloths meet special needs — TRACING CLOTH — PHOTO CLOTH — RUBBER (PROCESSING) CLOTH — BOOK CLOTH — SHADE CLOTH — SIGN CLOTH — TAG CLOTH.

Cloth combined with special compounds, filled, impregnated, coated — to form a material with characteristics of a plastic and the flexible strength of a woven fabric.

HOLLISTON Special Purpose Fabrics can be produced with almost any wanted properties: they can be made waterproof and resistant to certain solvents, acids and alkalis, or made to withstand moderately high temperatures; their dielectric characteristics can be tailored to your requirements. The wide range of tensile strength, stiffness, tear strength and caliper makes them ideally suited to a lot of very unusual manufacturing and industrial applications. And new uses are constantly being found. Perhaps your problem is another new use for a HOLLISTON Special Purpose Fabric — write our Research Department, we'll gladly co-operate.

By filling, impregnating or coating various fabrics (from sheer cambric to coarse burlap) with plastics, resins, starch and pyroxylin we can produce a cloth with almost any wanted properties.

HOLLISTON

Special Purpose Fabrics

THE HOLLISTON MILLS, INC., NORWOOD, MASSACHUSETTS the current may become zero but never reverses. There is a maximum degree of pulsation for a critical vapor pressure, and for tube temperature. The greater the external resistance or the supply potential, the greater the strength of oscillations. The larger the aperture placed in the path of the discharge, the higher the upper limit to which the current swings. There is a critical position between cathode and anode for the aperture (which is necessarily a dielectric) at which weakest oscillations are produced — of significance for designing mercury rectifiers.

The observed phenomena can be explained as interruption of the current in the arc by rarefaction of gas in the neck of the discharge. Theory indicates that the current strength that causes interruption is proportional to the product of the aperture area and the gas pressure, which is confirmed by measurements.

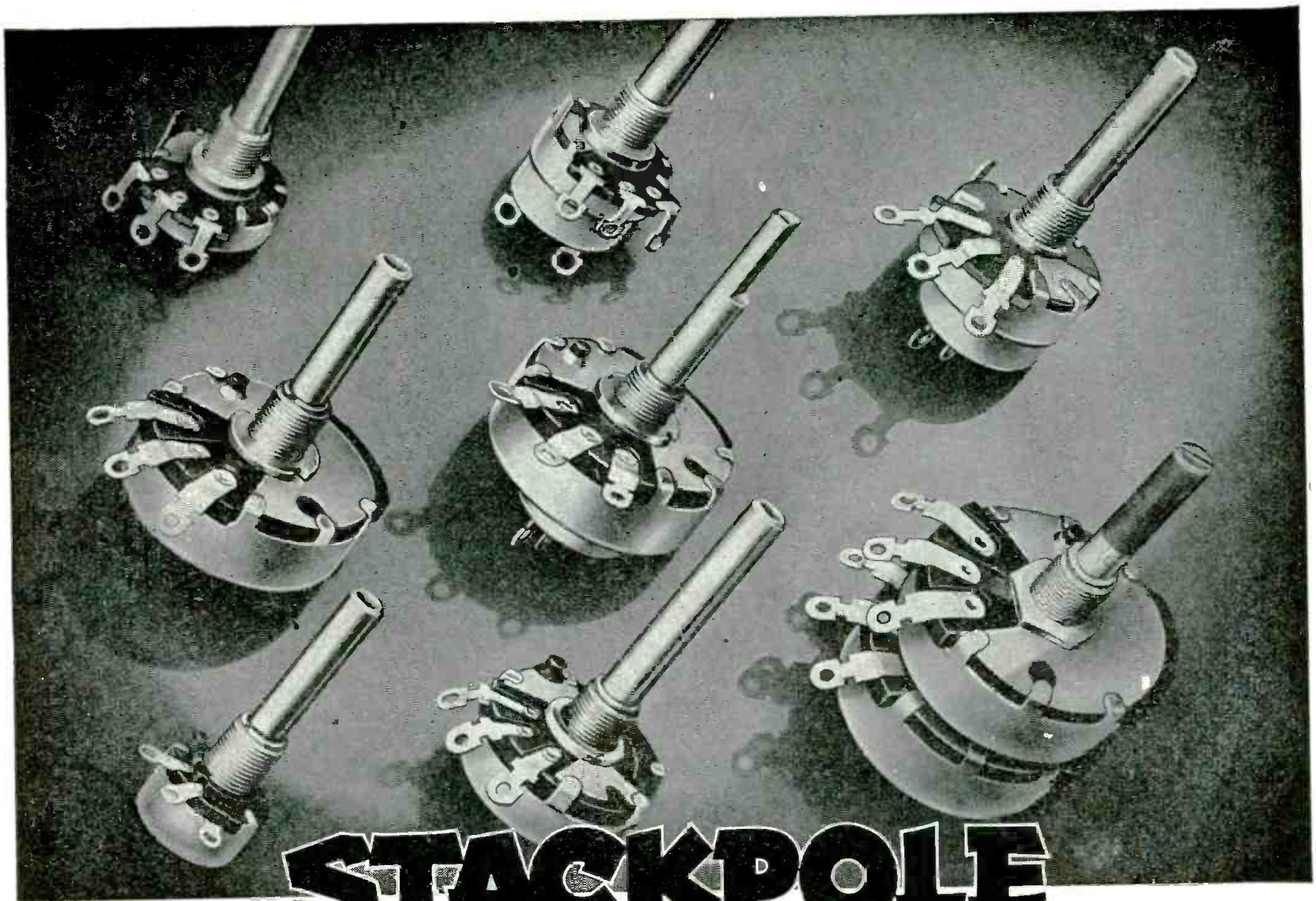
To utilize the oscillations, a load can be either inductively or capacitively coupled to the external circuit, inductive coupling being preferred. Using mercury vapor at a pressure of about one millimeter of mercury and at a temperature around 20 C, oscillations between 15 and 100 kc were obtained. One kilowatt of output power was obtained at approximately 65-percent efficiency from a 240-volt source. (The Generation of High-Power Electric Oscillations by a Low Pressure Discharge, by B. L. Granovsky and T. A. Suetin, *Comptes Rendus*, 1945 No. 6, p 410.)

Cathode Follower of Very Low Output Resistance

A POSITIVE SQUARE WAVE applied to the input of a conventional cathode follower has its leading edge well reproduced, but its trailing edge is badly distorted. A two-tube circuit that overcomes this fault has an output impedance of 30 ohms at frequencies up to 30 mc and an output voltage that is higher than with a single-tube circuit.

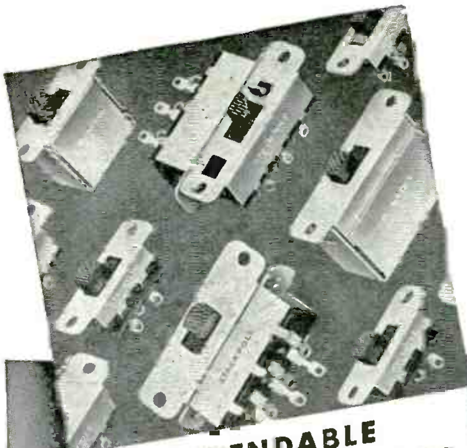
Circuit Operation

To develop the two-tube circuit, consider a two-stage, resistance-



STACKPOLE

FIXED AND VARIABLE RESISTORS

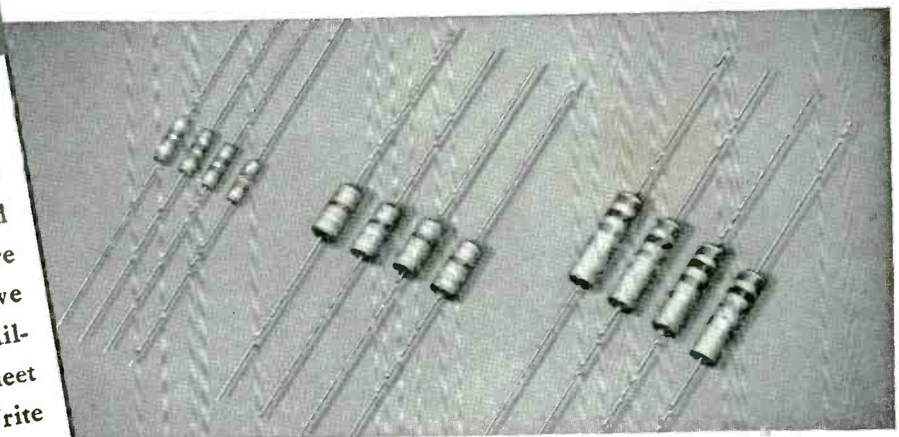


DEPENDABLE LOW-COST SWITCHES

Line, Slide, Rotary Action Types

Ideal for radios, toys and all electrical equipment where high-grade but inexpensive switching is required. Available in standard types to meet almost any requirement. Write for Catalog RC6.

One of the nation's largest producers, Stackpole offers a dependable source of supply for both fixed and variable resistors for a wide variety of applications. Fixed types include ½- and 1-watt insulated units in smallest sizes consistent with modern performance demands. Variables include standard-size units, midgets, sealed designs and numerous special types. Write today for Stackpole Electronic Components Catalog RC6.



STACKPOLE CARBON COMPANY
(Electronic Components Division)
ST. MARY'S, PA.

coupled amplifier with 100-percent feedback from the second tube to the first as shown in Fig. 1A. The cathode resistor R_k must be large

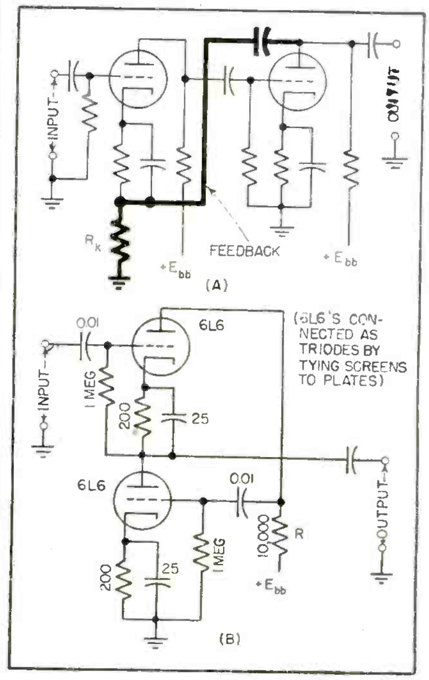


FIG. 1—By rearranging a two stage feedback amplifier (A) the plate resistance of the second tube can serve as the cathode resistor in the stage of the first tube (B)

not to unduly decrease the gain of the second stage. The cathode degeneration in the first stage is therefore large. If R_k is of the order of the plate resistance of the tubes employed in the circuit, one of the tubes could be substituted for R_k as at Fig. 1B, which is the new circuit under discussion.

The equivalent circuit for that of Fig. 1B is shown in Fig. 2. Analysis of this circuit indicates that the ratio of output to input voltages is

$$\frac{E_{out}}{E_{in}} = \frac{\mu^2 + \mu\,(r_p/R)}{(\mu^2 + \mu + 1) + (\mu + 2)\,(r_p/R)}$$

and the output conductance is

$$G_{out} = \frac{1}{R_{out}} = \frac{\mu + 1}{r_p + R} + \frac{1 + \dfrac{\mu\,(\mu + 1)}{(r_p/R) + 1}}{r_p}$$

When R is large compared to r_p the first term of the conductance equation becomes negligible and the second term becomes approximately equal to the product of the amplification factor of the tube and the transconductance

$$G_{out} = (\mu^2 + \mu + 1)/r_p \approx \mu g_m$$

The value of output conductance represents an improvement over

the conventional cathode follower by the factor μ. However, in driving low load impedances from this circuit, the signal must be small enough not to overdrive the lower tube.

Circuit Characteristics

The circuit with the values shown in Fig. 1B was examined at various frequencies from 10 kc to 30 mc. The output approached

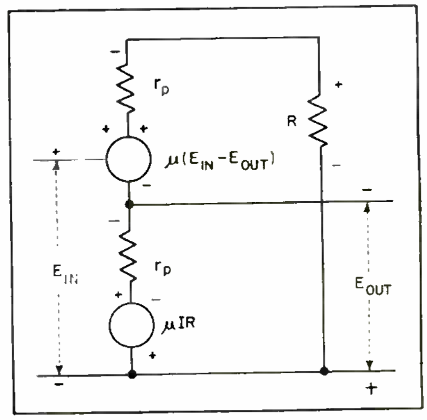


FIG. 2—Equivalent circuit of the low output impedance cathode follower

unity as the output load approached 1,000 ohms. The output was essentially uniform to about 10 mc, but fell above that frequency, falling faster with lower load resistances. A pronounced rise in output (an actual voltage gain) was obtained with a capacitive load of 0.0001 μf at approximately 10 mc. The rise occurred at lower frequencies as the capacitive load was increased. With 0.01 μf there was a slight rise at about 800 kc and practically no response at 1,000 kc. The fidelity of response to a pulse was definitely superior to that of a single-tube circuit and the effect on sine waves was also good. (Cathode Follower by Calvin M. Hammack, Report 469, Radiation Lab., MIT, Cambridge, Mass.)

Extending Thyratron Life

HYDROGEN CLEANUP in such hydrogen thyratrons as the 5C22 shortens the life of the tube. To reduce this loss of gas, tube parts are made from as pure nickel as is obtain-

"We need Precious Metal Performance . . .
But Low Cost too"

"Then the Solution is GENERAL PLATE LAMINATED METALS"

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, lined, or covered in a wide range of diameters and odd shapes.

WIRE . . . Shaped, solder filled, channel, solder flushed, squares, flats, ovals and irregular shaped.

Economy . . . that is one of the many advantages why General Plate Laminated Metals should be given prime consideration whenever your designs call for precious metal performance.

These permanently bonded laminations of precious to base metal combinations give you actual precious metal performance . . . yet their cost is a fraction more than base metals.

In addition, General Plate Laminated Metals . . . sheet, wire or tube . . . give you such advantages as better workability, better spring properties, corrosion resistance, better electrical conductivity, long life, ease of fabrication, ease of soldering and mechanical and structural properties not found in single solid metals.

Better check into the advantages of General Plate Laminated metals, today. Our engineers will gladly help you with your problems. Write:

GENERAL PLATE DIVISION

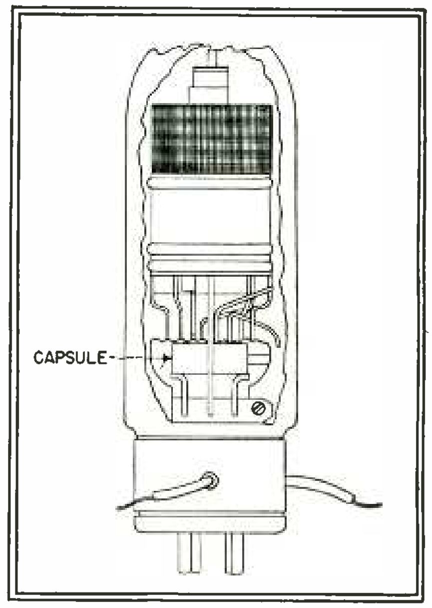
of Metals & Controls Corporation

ATTLEBORO, MASSACHUSETTS

50 Church Street, New York, N. Y.; 205 W. Wacker Drive, Chicago, Ill.; 2635 Page Drive, Altadena, Calif.; Grant Bldg., Pittsburgh, Pa.

able. However, as cleanup proceeds, the gas pressure is lowered and the tube characteristics change.

To maintain the gas pressure despite absorption by nickel parts, a titanium hydride powder hydrogen generator was developed. The powder is placed in a heated capsule.



With a hydrogen generating capsule located inside 5C22 thyratrons, greater life and higher pulse rates were possible

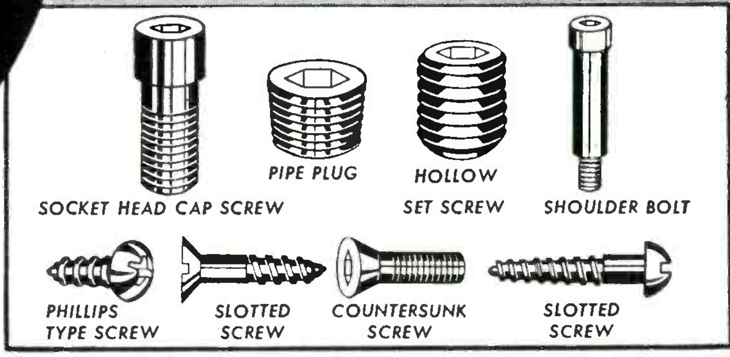
As hydrogen is absorbed throughout the tube, the capsule makes up the loss, giving satisfactory thyratron operation for a life of at least 2,000 hours. In addition, the hydrogen generator enables the tube to be made of impure nickel (Hydrogen Generator for Electron Tubes, by Harold W. Gerlicher, Evans Signal Laboratory, Belmar, N. J.—Report of development, characteristics, and preparation of capsule, and tube characteristics obtained with its use).

Projection Television

TELEVISION IMAGE projection systems have been suggested by Manfred von Ardenne of Berlin, Germany (U.S. Patent 2,277,008 issued March 17, 1942; and U.S. Patent 2,297,443 issued Sept. 29, 1942—this patent is vested in the Alien Property Custodian, see ELECTRONICS, 1945, July, p 306), and by Karl Martin and Johannes

BITS

FOR DRIVING ALL THESE SCREWS



Contained in this Handle

Handle is molded of sturdy Celanese* plastic; tools are of high grade alloy steel.

HALLOWELL

"SOCKET SCREW" KIT

with interchangeable bits

For men who like to have a complete supply of tools, yet dislike bulk and confusion, the Hallowell "Socket Screw" Kit is the answer. It is one of the neatest tricks of the year. The hollow Celanese* plastic handle holds interchangeable bits for most all purposes . . . Phillips, Hex and Flat. There is a swivel bit-chuck, which locks securely in position, and makes it possible to twirl a screw using the vertical position, and then snapping the chuck to an angle or ell position, to get the final tightening pull.

Not illustrated: "Socket Wrench" Kit; the "Auto" Kit; the "Home" Kit. Write for our 8-page booklet that fully describes these handy Tool Kits. Obtainable at Suppliers throughout the country.

If your Supplier does not carry these Kits, send his name to us, along with yours, and you will be taken care of promptly.

AN IDEAL CHRISTMAS GIFT.

Kits: Patents Pending — *OVER 43 YEARS IN BUSINESS* — *Reg. U. S. Pat. Off.

STANDARD PRESSED STEEL CO.

JENKINTOWN, PENNA., BOX 596 • BRANCHES: BOSTON • CHICAGO • DETROIT • INDIANAPOLIS • ST. LOUIS • SAN FRANCISCO

Flugge, Rathenow, and Hans Georg Roll of Germany (U.S. Patent 2,229,302 issued Jan. 21, 1941). This latter patent refers to lens systems for projecting and enlarging phosphorescent images. A lens, both surfaces of which are ground to the required contours, projects the image to a back-surfaced concave mirror, the front surface of which is also ground. The mirror focuses the enlarged image either directly or by a flat mirror to the viewing screen.

The other two patents cited above describe the use of zinc blend and other crystals as electronically controlled polarizing gates. When placed in a high-potential gradient and scanned by an electron beam, these high resistance crystals become charged thereby changing their rotation of polarized light. Light is projected through such a gate as shown in Fig. 1A, or re-

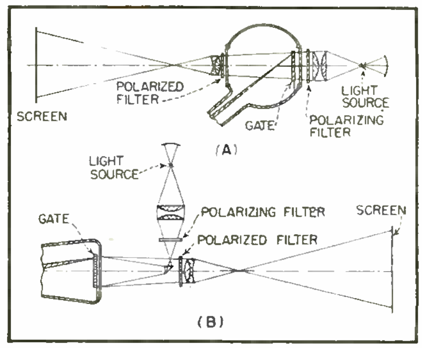


FIG. 1—Charge placed on gate by electronic scanning changes the angular rotation of the polarized light passing through the gate

flected from the crystal as shown in Fig. 1B. The reflection technique is the better both because the light passes twice through the crystals and because optical and electrical systems can be isolated.

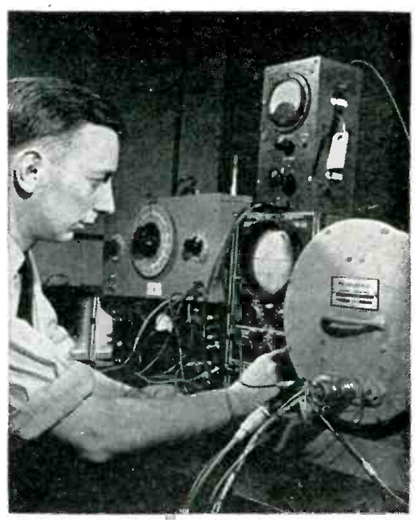
Polarized light produced by filtering is projected on the charged crystal; it is reflected, its plane of polarization being altered in accordance with the electrical charge produced by electronic scanning. The reflected light is transmitted through a second polarizing filter to obtain the image. Because the system modulates an auxiliary light source and possesses image storage, it is capable of producing large, bright images. By interrupting the image mechanically, as in motion picture projection technique,

von Ardenne observes, in U.S. Patent 2,276,750 issued March 17, 1942, that flicker can further be reduced so that slower frame rates and hence narrower transmission bands can be used.

UHF Measurement

STANDING WAVES are used to indicate the impedance match in high-frequency circuits. To measure these standing waves, a coaxial transmission line is formed into a circle, slotted, and combined with a probe. A probe is rotated around the loop of line and at the same time a sweep voltage is generated, by an auxiliary circuit. The rectified voltage detected by the probe, and the sweep voltage are applied to the plates of a cathode-ray tube. The tube display indicates the standing wave as a function of angular position along the line. The system can be used for continuously observing the standing waves on a transmission circuit while the circuit is adjusted. (No. 2,400,597, granted May 21, 1946 to Donald W. Peterson, Radio Corp. of America).

ATOMIC TEST AMPLIFIER



Signals from hydrophones on the hull of the target ship, increased by the Westinghouse preamplifier at the right, are transmitted by radio to a recorder miles away from Operation Crossroad. High-speed cameras in the recorder make a permanent record of pressure fluctuations

ADDITIONS and CORRECTIONS

to the

JUNE 1946–1947 ELECTRONICS BUYERS' GUIDE

The following listings are to be used in conjunction with the June 1946–1947 ELECTRONICS BUYERS' GUIDE for information on manufacturers' names, addresses, and products omitted or incorrectly listed in that issue. Product classification numbers and names are the same as used in the June Guide.

2. AUDIO FREQUENCY AMPLIFIERS

Cook Laboratories, 139 Gordon Blvd., Floral Park, N. Y.
Furst Electronics, 800 W. North Ave., Chicago 22, Illinois
Langevin Co. Inc., The, 37 West 65th St., New York 23, N. Y.
Rek-O-Kut Co., 146 Grand St., New York 13, N. Y.

5. BROADCAST STUDIO SPEECH INPUT CONTROL EQUIPMENT

Langevin Co. Inc., The, 37 West 65th St., New York 23, N. Y.

13. FACSIMILE COMMUNICATION SYSTEMS

The Western Union Telegraph Co., 60 Hudson St., New York 13, N. Y.

20. HEARING AIDS

Tayburn Equipment Co., 120 Greenwich St., New York 6, N. Y.

24. MEGAPHONES, ELECTRONIC

Tayburn Equipment Co., 120 Greenwich St., New York 6, N. Y.

25. MONITORS, BROADCAST

Langevin Co. Inc., The, 37 West 65th St., New York 23, N. Y.

31. ELECTRIC PHONOGRAPHS and RECORD PLAYERS

Aviola Radio Corp., Phoenix, Ariz.
Rek-O-Kut Co., 146 Grand Street, New York 13, N. Y.

35. RADAR NAVIGATIONAL DEVICES

Sperry Gyroscope Co., Manhattan Bridge Plaza, Brooklyn, N. Y.

39. AM COMBINATIONS

Aviola Radio Corp., Phoenix, Ariz.

42. AM TABLE MODELS

Aviola Radio Corp., Phoenix, Ariz.

76. FACSIMILE RECORDERS

The Western Union Telegraph Co., 60 Hudson St., New York 13, N. Y.

77. FILM RECORDERS

Electronic Chemical Engineering Co., 1235 E. Olympic Blvd., Los Angeles 21, Calif.

81. RECORDING AND TRANSCRIPTION TURNTABLES

Rek-O-Kut Co., 146 Grand St., New York 13, N. Y.

84. COMPLETE SOUND SYSTEMS

Audio Products Co., 2101 W. Olive Ave., Burbank, Calif.

90. U.H.F. TRANSCEIVERS

Electronic Associates Inc., 61 Brighton Ave., Long Branch, N. J.

95. BROADCAST TRANSMITTERS

Western Electric Co. Inc., 120 Broadway, New York 5, N. Y.

99. FACSIMILE TRANSMITTERS

The Western Union Telegraph Co., 60 Hudson St., New York 13, N. Y.

101. FIXED STATION COMMUNICATION TRANSMITTERS

Western Electric Co. Inc., 120 Broadway, New York 5, N. Y.

102. FM TRANSMITTERS

Western Electric Co. Inc., 120 Broadway, New York 5, N. Y.

119. COUNTERS

Electronic Associates Inc., 61 Brighton Ave., Long Branch, N. J.
Furst Electronics, 800 W. North Ave., Chicago 22, Illinois

137. PHOTOELECTRIC CONTROLS

Furst Electronics, 800 W. North Ave., Chicago 22, Illinois

138. PHOTOGRAPHIC EXPOSURE CONTROLS

Electronic Mechanical Prods. Co., 13-15-17 N. Virginia Ave., Atlantic City, N. J.
Furst Electronics, 800 W. North Ave., Chicago 22, Illinois

144. SERVO CONTROLS

Electronic Associates Inc., 61 Brighton Ave., Long Branch, N. J.

145. SMOKE DENSITY COMBUSTION and CONTROLS

Furst Electronics, 800 W. North Ave., Chicago 22, Illinois

153. WELDING CONTROLS

Raytheon Mfg. Co., Electronic Equip. Div., Waltham 54, Mass.

174. INDUCTION and DIELECTRIC HEATING

Raytheon Mfg. Co., Electronic Equip. Div., Waltham 54, Mass. (Dielectric)
Westinghouse Electric Corp., East Pittsburgh, Pa. (Induction and Dielectric)

200. ELAPSED TIME METERS

Cramer Co., R. W., Centerbrook, Conn.

207. ELECTRONIC MICROMETERS

Wilmotte Mfg. Co., 1713 Kalorama Rd. N.W., Washington 9, D. C.

222. COMBUSTION RECORDERS

Furst Electronics, 800 W. North Ave., Chicago 22, Illinois

235. AUTOMATIC INTERVAL TIMERS

Electronic Associates Inc., 61 Brighton Ave., Long Branch, N. J.
Furst Electronics, 800 W. North Ave., Chicago 22, Illinois

246. WELDING TIMERS

Weltronic Co., 19500 W. 8 Mile Rd., Detroit 19, Mich.

274. CAPACITOR ANALYZERS

Cornell Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.

285. BRIDGES

Measurements Corp., Boonton, N. J.

294. CHRONOGRAPHS, INERTIALESS

Furst Electronics, 800 W. North Ave., Chicago 22, Illinois

298. CAPACITY DECADE BOXES

Cornell Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.

309. FM SIGNAL GENERATORS

Measurements Corp., Boonton, N. J.

317. GEIGER COUNTER INDICATORS

Condenser Products Co., 1369-1375 North Branch St., Chicago 22, Ill.

321. VOLUME INDICATORS

Audio Products Co., 2101 W. Olive Ave., Burbank, Calif.

326. AMMETERS

Rek-O-Kut Co., 146 Grand Street, New York 13, N. Y.

373. CATHODE-RAY INSTRUMENTS

Furst Electronics, 800 W. North Ave., Chicago 22, Illinois

392. INSULATION TESTERS

Measurements Corp., Boonton, N. J.

401. CURVE TRACERS

Wilmotte Mfg. Co., 1713 Kalorama Rd. N.W., Washington 9, D. C.

447. RAILROAD ANTENNAE

Buggie & Co., H. H., Madison Ave. & 22nd St., Toledo 1, Ohio

450. TELEVISION & FM ANTENNAE

Buggie & Co., H. H., Madison Ave. & 22nd St., Toledo 1, Ohio

451. U.H.F. & V.H.F. ANTENNAE

Buggie & Co., H. H., Madison Ave. & 22nd St., Toledo 1, Ohio

463. BELLOWS

Cook Electric Co., 2700 Southport Ave., Chicago 14, Illinois

471. CARBON & GRAPHITE BRUSHES

National Carbon Co. Inc., 30 East 42nd St., New York 17, N. Y.

472. METAL-GRAPHITE BRUSHES

National Carbon Co. Inc., 30 East 42nd St., New York 17, N. Y.

477. METAL CABINETS

Walter Co., S., 144 Centre Street, Brooklyn 31, N. Y.

481. CABLE ASSEMBLIES

Buggie & Co., H. H., Madison Ave. & 22nd St., Toledo 1, Ohio

494. FIXED CAPACITORS

Condenser Products Co., 1369-1375 North Branch St., Chicago 22, Ill.
Cornell Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.

496. MICA TRANSMITTING CAPACITORS

Cornell Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.

499. OIL IMPREGNATED CAPACITORS

Condenser Products Co., 1369-1375 N. Branch St., Chicago 22, Ill.

502. PLASTIC DIELECTRIC CAPACITORS

Condenser Products Co., 1369-1375 N. Branch St., Chicago 22, Ill.

505. SMALL HIGH VOLTAGE CAPACITORS

Condenser Products Co., 1369-1375 N. Branch St., Chicago 22, Ill.
Cornell Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.

511. WAX IMPREGNATED CAPACITORS

Condenser Products Co., 1369-1375 N. Branch St., Chicago 22, Ill.
Cornell Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.

513. AUTOMATIC RECORD CHANGERS
Aviola Radio Corp., Phoenix, Ariz.

517. ALUMINUM CHASSIS
Olympic Tool & Mfg. Co., 37 Chambers St., New York 7, N. Y.
Walter Co., S., 144 Centre St., Brooklyn 31, N. Y.

518. AUDIO and POWER CHOKES
Langevin Co. Inc., The., 37 W. 65th St., New York 23, N. Y.

519. FILTER CHOKES
Langevin Co. Inc., The., 37 W. 65th St., New York 23, N. Y.

520. HERMETICALLY SEALED CHOKES
Airdesign Inc., 241 Fairfield Ave., Upper Darby, Pa.

522. TEST & TUBE CLIPS and CLAMPS
Fahnestock Electric Co. Inc., 46-44 Eleventh St., L. I. City 1, N. Y.

529. MULTIPLE WOUND COILS
Airdesign Inc., 241 Fairfield Ave., Upper Darby, Pa.

531. POWER and A.F. COILS and WINDINGS
Burnell & Co., 10-12 Van Cortlandt Ave. East, Bronx 58, N. Y.

532. R.F. and I.F. RECEIVING or TRANSMITTING COILS
Burnell & Co., 10-12 Van Cortlandt Ave. East, Bronx 58, N. Y.

538. CABLE CONNECTORS and COUPLINGS
Buggie & Co., H. H., Madison Ave. & 22nd St., Toledo 1, Ohio

540. CERAMIC CABLE CONNECTORS
Buggie & Co., H. H., Madison Ave. & 22nd St., Toledo 1, Ohio

541. COAXIAL CABLE CONNECTORS
Buggie & Co., H. H., Madison Ave. & 22nd St., Toledo 1, Ohio

543. RECEPTACLE CONNECTORS
Buggie & Co., H. H., Madison Ave. & 22nd St., Toledo 1, Ohio

572. IF FILTER CRYSTALS
Bliley Electric Co., Erie, Pa.

576. QUARTZ CRYSTAL ULTRASONIC
Bliley Electric Co., Erie, Pa.

577. RECEIVER CONTROL CRYSTALS
Bliley Electric Co., Erie, Pa.

579. SUPERSONIC CRYSTALS
Bliley Electric Co., Erie, Pa.

599. BAND PASS FILTERS
Electronic Associates Inc., 61 Brighton Ave., Long Branch, N. J.

602. EQUALIZER FILTERS
Burnell & Co., 10-12 Van Cortlandt Ave. East, Bronx 58, N. Y.

609. COIL FORMS
Buggie & Co., H. H., Madison Ave. & 22nd St., Toledo 1, Ohio

621. WIRE HARNESSES
Buggie & Co., H. H., Madison Ave. & 22nd St., Toledo 1, Ohio

622. HEADPHONES and HEADSETS
Tayburn Equipment Co., 120 Greenwich St., New York 6, N. Y.

623. HEADS, RECORDING
Rek-O-Kut Co., 146 Grand St., New York 13, N. Y.

633. SPEAKER PROJECTOR HORNS
Langevin Co. Inc., The, 37 West 65th St., New York 23, N. Y.

637. PUBLIC ADDRESS SYSTEM HOUSINGS
Langevin Co. Inc., The, 37 West 65th St., New York 23, N. Y.

650. INSULATING FOIL
Buggie & Co., H. H., Madison Ave. & 22nd St., Toledo 1, Ohio

654. MOLDED INSULATION PARTS
Buggie & Co., H. H., Madison Ave. & 22nd St., Toledo 1, Ohio

655. PLASTIC INSULATION PARTS
Buggie & Co., H. H., Madison Ave. & 22nd St., Toledo 1, Ohio

707. LUGS and TERMINALS
Patton-MacGuyer Co., 17 Virginia Ave., Providence 5, R. I.

716. METAL STAMPINGS, Small
Olympic Tool & Mfg. Co., 37 Chambers St., New York 7, N. Y.
Walter Co., S., 144 Centre St., Brooklyn 31, N. Y.

724. MICROWAVE TRANSMISSION LINES and ACCESSORIES
Buggie & Co., H. H., Madison Ave. & 22nd St., Toledo 1, Ohio

726. FRACTIONAL H.P. MOTORS
Alni Corp., 10 E. 52nd Street, New York 22, N. Y.

729. SERVO MOTORS
Transicoil Corp., 114 Worth St., New York, N. Y.

731. TIMING MOTORS
Cramer Co., R. W., Centerbrook, Conn.

751. PANELS
Langevin Co. Inc., The, 37 West 65th St., New York 23, N. Y.
Walter Co., S., 144 Centre Street, Brooklyn 31, N. Y.

754. FACSIMILE RECORDING PAPERS
The Western Union Telegraph Co., 60 Hudson St., New York 13, N. Y.

755. INDUSTRIAL PICKUPS
Rek-O-Kut Co., 146 Grand St., New York 13, N. Y.

758. TRANSCRIPTION and PHONOGRAPH PICKUPS
Rek-O-Kut Co., 146 Grand St., New York 13, N. Y.

761. PLUGS and JACKS
Buggie & Co., H. H., Madison Ave. & 22nd St., Toledo 1, Ohio

764. POSTS, BINDING
Fahnestock Electric Co. Inc., 46-44 Eleventh St., Long Island City 1, N. Y.

765. POWER SUPPLIES
Audio Products Co., 2101 W. Olive Ave., Burbank, Calif.
Electronic Associates Inc., 61 Brighton Ave., Long Branch, N. J.
Furst Electronics, 800 W. North Ave., Chicago 22, Illinois

766. ELECTRONICALLY REGULATED POWER SUPPLIES
Furst Electronics, 800 W. North Ave., Chicago 22, Illinois

768. VOLTAGE REGULATED POWER SUPPLIES
Furst Electronics, 800 W. North Ave., Chicago 22, Illinois

771. RACKS, RELAY
Audio Products Co., 2101 W. Olive Ave., Burbank, Calif.

777. VOLTAGE REGULATORS and STABILIZERS
Audio Products Co., 2101 W. Olive Ave., Burbank, Calif.
Furst Electronics, 800 W. North Ave., Chicago 22, Illinois

785. GENERAL PURPOSE RELAYS
Adams & Westlake, Michigan St., Elkhart, Indiana

787. INDUSTRIAL CONTROL RELAYS
Adams & Westlake, Michigan St., Elkhart, Indiana

789. KEYING and BREAK-IN RELAYS
Buggie & Co., H. H., Madison Ave. & 22nd St., Toledo 1, Ohio

802. SNAP ACTION RELAYS
Adams & Westlake, Michigan St., Elkhart, Indiana

804. TELEPHONE RELAYS
Adams & Westlake, Michigan St., Elkhart, Indiana

806. TIME DELAY RELAYS
Electronic Associates Inc., 61 Brighton Ave., Long Branch, N. J.

807. TRANSFER RELAYS
Adams & Westlake, Michigan St., Elkhart, Indiana

817. POTENTIOMETERS and RHEOSTATS
Electronic Associates Inc., 61 Brighton Ave., Long Branch, N. J.

818. WIRE WOUND RESISTORS
Audio Products Co., 2101 W. Olive Ave., Burbank, Calif.

829. HERMETIC SEALS
Buggie & Co., H. H., Madison Ave. & 22nd St., Toledo 1, Ohio
Hermetic Seal Products Co., 414 Morris Ave., Newark 3, N. J.

849. SOLENOIDS
Alni Corp., 10 E. 52nd St., New York 22, N. Y.

852. SPRINGS
Instrument Specialties Co. Inc., 254 Bergen Blvd., Little Falls, N. J.

PRODUCTS INCORRECTLY LISTED

The following firms have advised us that the products which are listed below are not manufactured by them.

230. STROBOSCOPES
Audio Products Co., 2101 W. Olive Ave., Burbank, Calif.

308. A.F. SIGNAL GENERATORS
Measurements Corp., Boonton, N. J.

463. BELLOWS
Technographics Inc., 1457 W. Diversity Blvd., Chicago 14, Ill.

551. RADIO REMOTE CONTROLS
Langevin Co. Inc., The, 37 West 65th St., New York 23, N. Y.

774. TUBE RECTIFYING UNITS
Electrons Inc., 127 Sussex Ave., Newark, N. J.

912. RF and IF TRANSFORMERS
Airdesign Inc., 241 Fairfield Ave., Upper Darby, Pa.

NAME and ADDRESS CORRECTION or CHANGE

Biddle Co., Jas. G., 1316 Arch St., Philadelphia 7, Pa.
Communication Products Co. Inc., Keyport, N. J.
Fairchild Camera & Instrument Corp., 88-06 Van Wyck Blvd., Jamaica 1, N. Y.
Franklin Airloop Corp., 43-20 34th St., Long Island City, N. Y.
Franklin Mfg. Corp., A. W., 43-20 34th St., Long Island City, N. Y.
Gulow Corp., 62 William St., New York 5, N. Y.
Hardwick, Hindle Inc., 40 Hermon St., Newark, N. J.
Instrument Resistors Co., 1036 Commerce Ave., Union, N. J.
Kay Electric Co., 47 North Grove St., East Orange, N. J.
King Laboratories, Inc., 127 Solar St., Syracuse 4, N. Y.
Robinson Aviation Inc., Teterboro Air Terminal, Teterboro, N. J.
Schweitzer Paper Co., 182 Cornelison Ave., Jersey City, N. J.
Trefz Mfg. Co., 511 East 164th St., New York 56, N. Y.
United States Television Mfg. Corp., 3 West 61st St., New York 23, N. Y.
Weltronic Co., 19500 West 8 Mile Rd., Detroit 19, Mich.
Westinghouse Electric Corp., Electronic Tube Sales Dept., Bloomfield, N. J.
White Dental Mfg. Co., S. S., Industrial Div., 10 E. 40th St., New York 16, N. Y.

ADDITIONAL CORRECTIONS WILL APPEAR IN THE DECEMBER ISSUE

The Superior Tube Company, Electronics Division, has spared nothing in its effort to bring to the Radio Tube Industry, through its highly specialized facilities, metal tubing in the form of cathodes, anode and grid cylinders, and all types of fabricated tubular parts. These products, used in all types of electron tubes, are the metallurgical and physical counterparts of your electronic expectations. • Material control standards, otherwise unattainable, are now realities. Superior's Electronics Laboratory has made possible far-reaching research and development of electronic tubing, through the study of materials, processes and controls. • Whatever your requirements in metal tubing for electron tubes, bring your problems to us. The Engineering Staff of Superior Electronics Division will welcome your inquiries and the privilege of working with you.

THE BIGGER NAME IN SMALL TUBING **Superior**

SUPERIOR TUBE COMPANY
ELECTRONICS DIVISION

Post Office Drawer 191 • Norristown, Pa.
Telephone, Norristown 2070

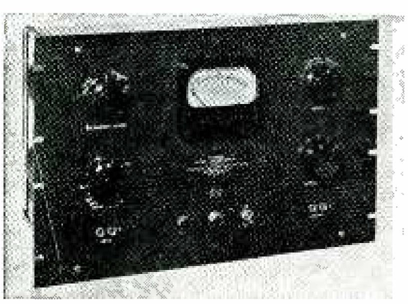
NEW PRODUCTS

Edited by A. A. McKENZIE

New apparatus, packaged units, and component parts are described. Services, catalogs, and manufacturers' publications are reviewed

Noise Suppressor (1)

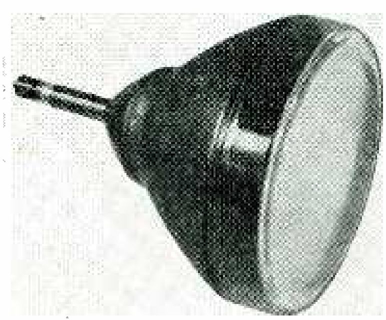
TECHNOLOGY INSTRUMENT CORP., 1058 Main St., Waltham 54, Mass. The new type 910-A Dynamic Noise Suppressor has been particularly designed for broadcast station use. It allows the playing of shellac and vinyl recordings, subject to the limits of their dynamic range, on the same program with high-quality transcriptions without the unfavorable comparison occasioned by the usual high background noise. An instantaneous gate circuit operates to let through musical passages with practically no impairment, but substantially eliminates noise. The equipment can also be used for such purposes as the presentation of shortwave rebroadcasts in which noise is often the limiting factor. Engineered for broadcast use, the equipment illustrated is arranged



for quick operation or removal and standard monitoring procedures. Maximum suppression of high-frequency noise is 20 db and for low-frequency noise, 15 db.

Television Tube (2)

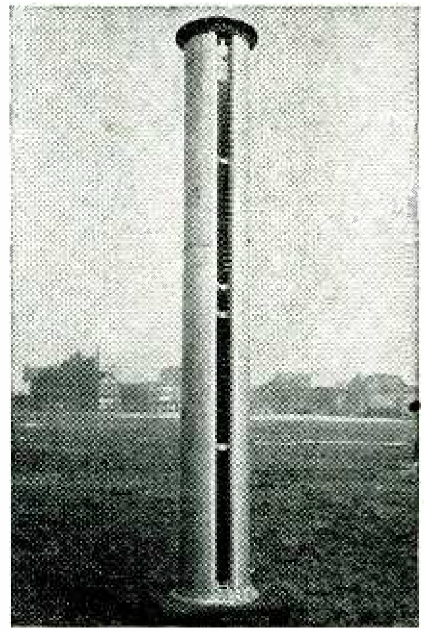
ZETKA LABORATORIES, INC., 131 Getty Ave., Clifton, N. J. The type Z-15DP4 television tube has a black and white screen 15 inches in diameter. Focus and deflection are magnetic. A feature of the new tube is its short overall length (about 20 inches). The face plate is substantially flat to provide a large useful screen surface. Typical operation



includes anode voltage of 8,000 to 10,000 volts; grid no. 2, 250 volts; grid no. 1, minus 45 volts; and focusing coil current between 88 and 116 milliamperes.

F-M Antenna (3)

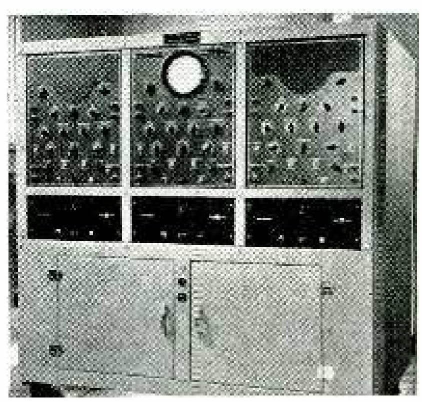
RADIO CORP. OF AMERICA, Camden, N. J. The Pylon antenna is a single-element f-m radiator that is self-supporting. When additional gain is desired, one unit can be stacked upon another and an additional feed run from element to element inside the tube that forms the antenna. A stack of four sections results in a power gain of six over a simple dipole. The same antenna structure operates over the whole f-m band (88-108 megacycles) and will handle maximum power granted to f-m stations. Each pylon



is 13 feet high, with a diameter of 19 inches, and weighs 350 pounds. Each end is provided with a flange for mounting on a base, display of a beacon at the top, or addition of another element. Radiation is horizontally polarized.

Tri-Channel Oscilloscope (4)

ELECTRONIC TUBE CORP., 1200 East Mermaid Ave., Chestnut Hill, Philadelphia 18, Pa. The E-3G47-S1 triple-channel oscilloscope comprises three separate channels operating into a type 5Z3P11 triple-gun cathode-ray tube. The equipment has been designed for encephalographic studies and is equipped with a General Radio 35-mm oscillograph recorder capable of film speeds between 5 and 35 feet a second. The tube has a low-persistence actinic blue screen. Vertical



You can get efficient, economical protection against moisture for higher temperature installations

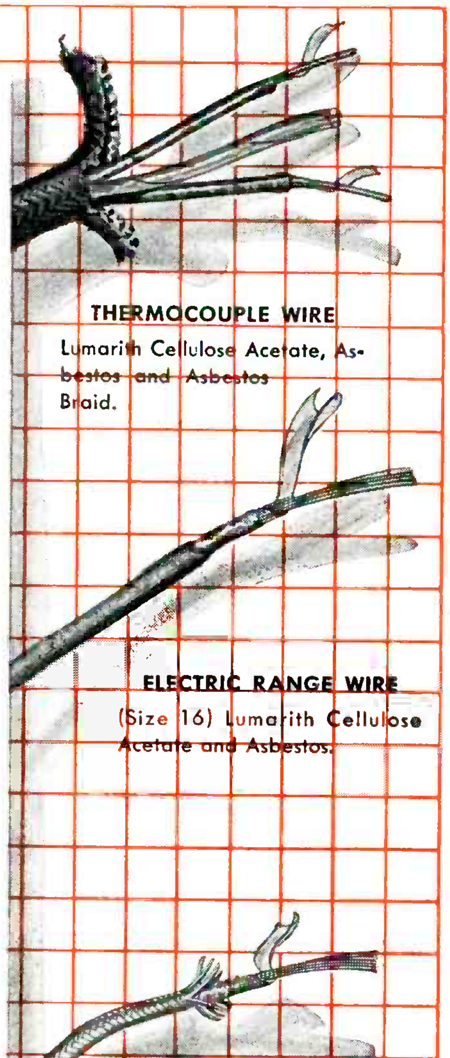
with **LUMARITH** CELLULOSE ACETATE

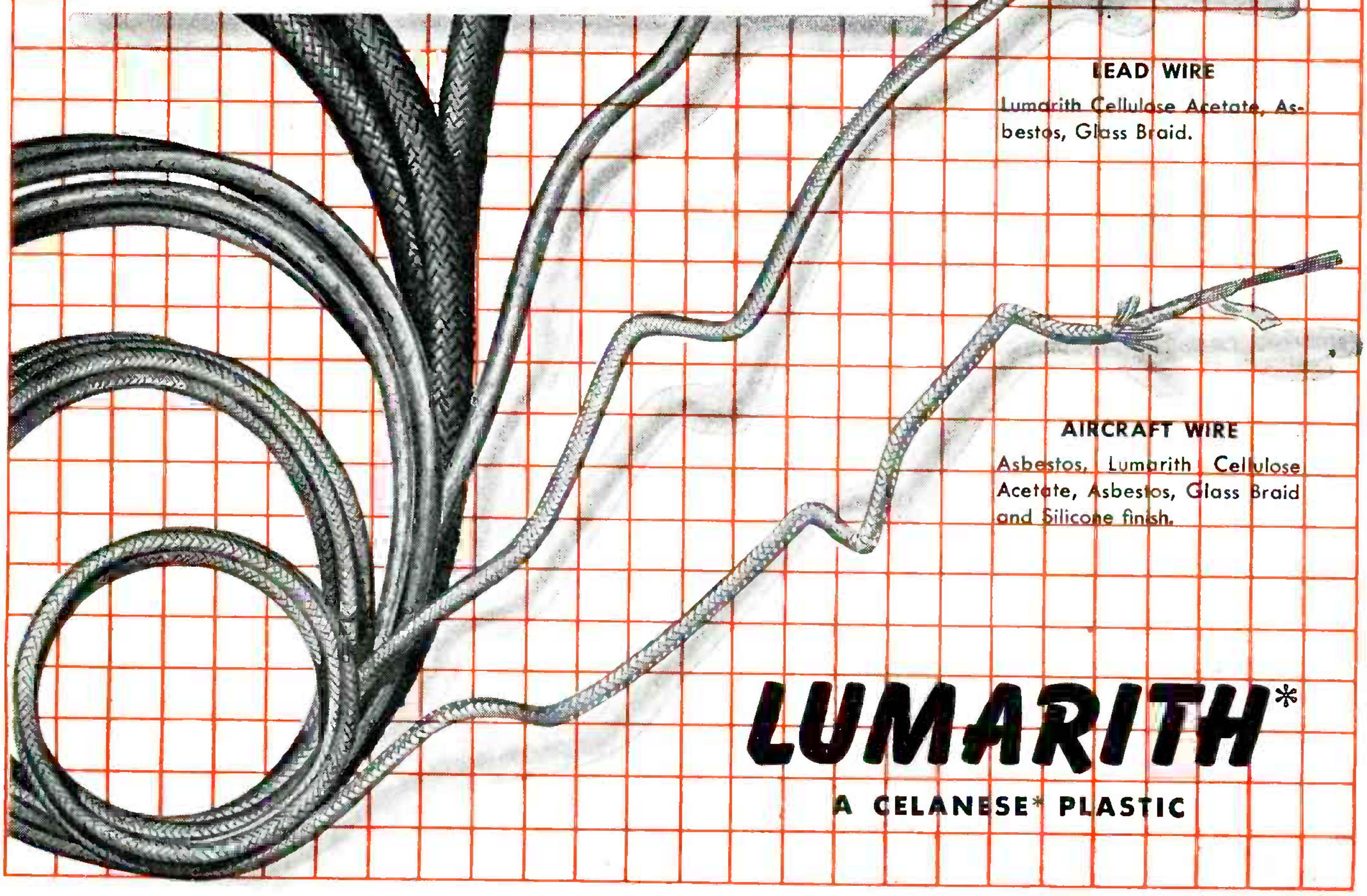
FILM INSULATION

Lumarith film is a moisture resistant thermoplastic with comparatively high heat resistance. In combination with heat insulating layers, it will give an insulation resistant both to heat and moisture.

Investigate the electrical possibilities of all Lumarith plastic materials: films, sheets, rods, tubes and molding materials. They may help cut down production time and cost. Write for booklet entitled, "Celanese Synthetics for the Electrical Industry". Celanese Plastics Corporation, a division of Celanese Corporation of America, 180 Madison Avenue, New York 16, N. Y.

*Reg. U. S. Pat. Off.





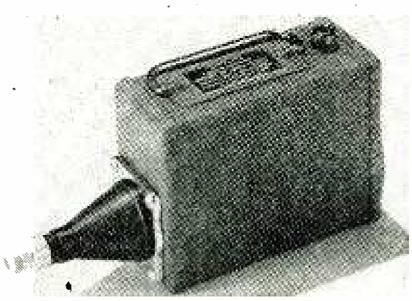
LUMARITH*

A CELANESE* PLASTIC

amplifiers have a uniform frequency response from 2 cycles to 100 kilocycles and the horizontal amplifiers have a uniform response from 1 cycle to 30 kilocycles. Each of the three channels is equipped with a marker generator, and various switching and interconnection means are provided to make the use of the equipment as flexible as possible.

Coaxial Termination (5)

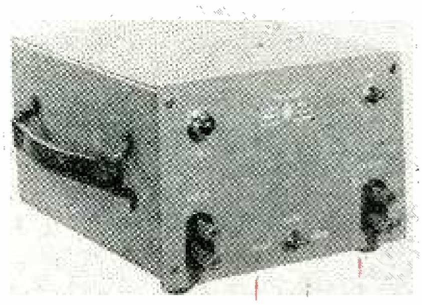
BIRD ELECTRONIC CORP., 1800 East 38th St., Cleveland 14, Ohio. The Termaline Model 81 coaxial resistor is designed to dissipate up to 50 watts of r-f power with a low voltage standing wave ratio. It consists essentially of a coaxial resistor immersed in a liquid coolant. It can be used as an impedance stand-



ard, non-reactive termination, dummy antenna and for the measurement of standing wave ratios.

Wide-Band Amplifier (6)

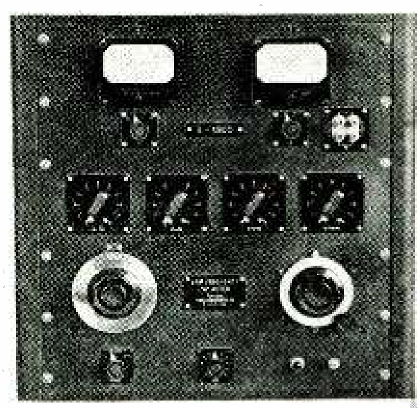
HEWLETT-PACKARD CO., Palo Alto, Calif. The type 450A amplifier has been designed for general purpose or laboratory use with frequency response flat within 0.5 db between



10 and 1,000,000 cycles. Input impedance is 1 megohm shunted by 15 micromicrofarads. The equipment is stable at a gain of 20 or 40 db.

Low-Frequency Q-Meter (7)

FREED TRANSFORMER CO., INC., 72 Spring St., New York, N. Y. The No. 1030 Q-meter contains an audio-frequency oscillator, precision tuning capacitor, power amplifier and two vacuum-tube voltmeters. Oscillator frequency range is continu-



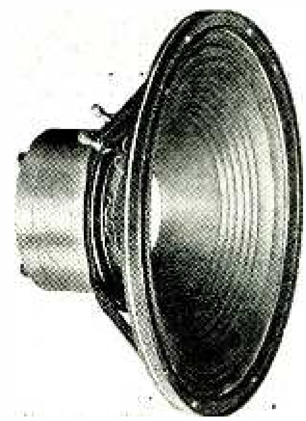
ously variable from 50 cycles to 50,000 cycles in four ranges. Accuracy of the Q measurement is approximately 6 percent.

Permeability Tuners (8)

ELECTRONIC LABORATORIES, INC., Indianapolis, Ind. The E-L Vario-Tuner is a new permeability-type broadcast tuner consisting of r-f and oscillator sections covering the frequency range 540 to 1,620 kilocycles. The unit is manufactured particularly for experimenters and schools desiring to build a 6-tube receiver.

Medium-Power Speaker (9)

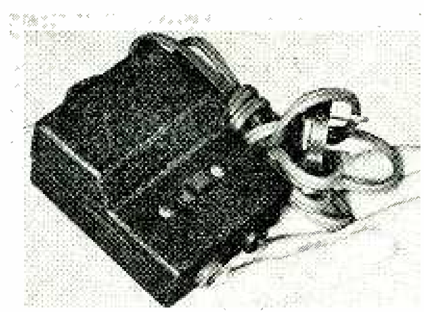
ALTEC LANSING CORP., 250 West 57th St., New York 19, N. Y. The model 600 Dia-Cone speaker is an-



other in the line of dual speakers designed for good fidelity in home reception and reproduction. This model has a power rating of 18 watts and a 3-inch voice coil with an impedance of 10 ohms. Weight of the unit is 12 pounds.

Circuit Tester (10)

ROBSON-BURGESS CO., Omaha, Neb. The Meg-Lite is essentially a continuity tester consisting of a 115-

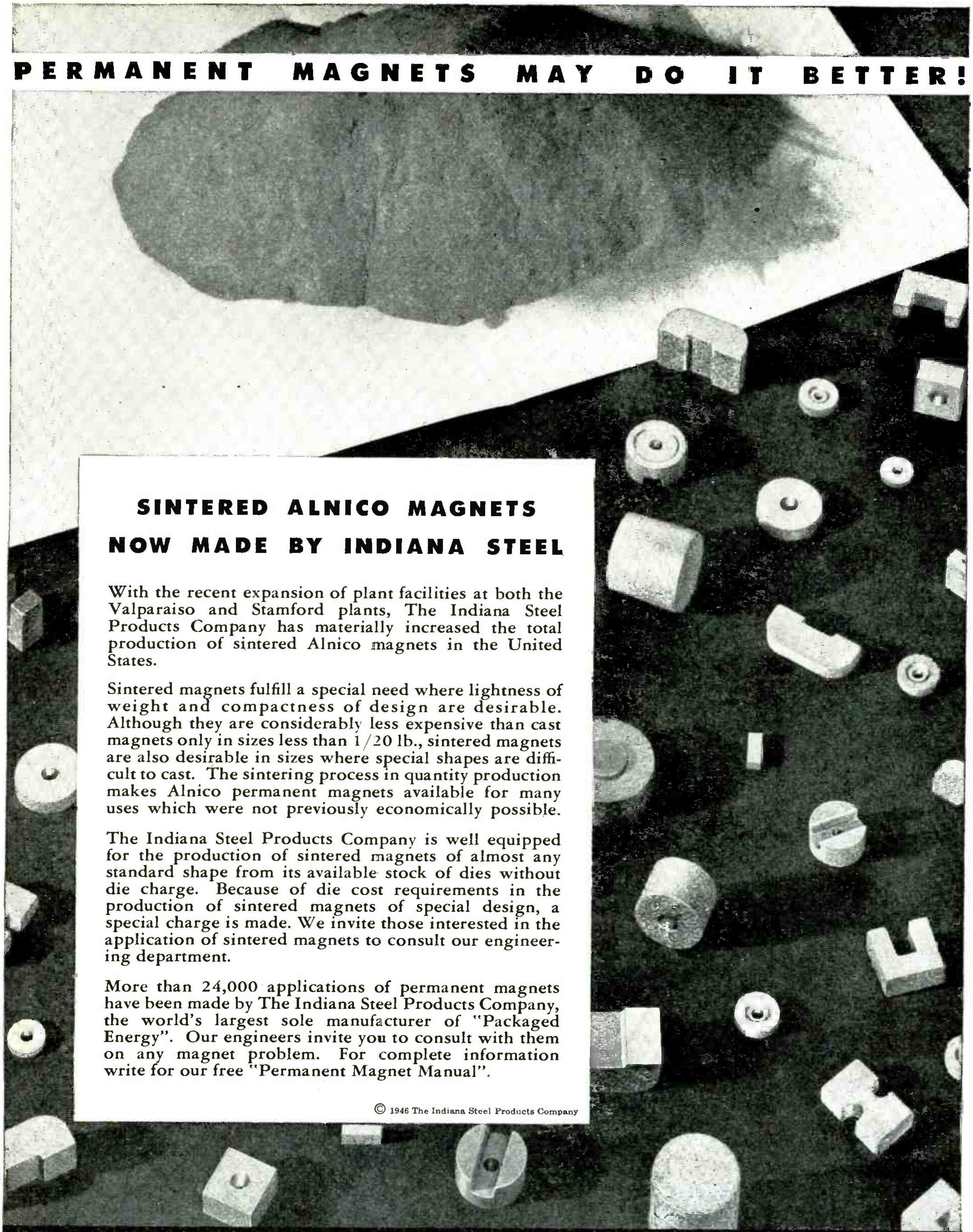


volt a-c or d-c line, a neon lamp, series resistor and switch, and a pair of leads. It is conveniently packaged for continuity testing and sells for about $5.

Air-Cooled Amplifier (11)

GENERAL ELECTRIC CO., Syracuse, N. Y. The type GL-5518 air-cooled transmitting tube has been designed for use in grounded-grid circuits. A pair of the tubes in an experimental transmitter operating at 108 megacycles showed a useful

PERMANENT MAGNETS MAY DO IT BETTER!



SINTERED ALNICO MAGNETS NOW MADE BY INDIANA STEEL

With the recent expansion of plant facilities at both the Valparaiso and Stamford plants, The Indiana Steel Products Company has materially increased the total production of sintered Alnico magnets in the United States.

Sintered magnets fulfill a special need where lightness of weight and compactness of design are desirable. Although they are considerably less expensive than cast magnets only in sizes less than 1/20 lb., sintered magnets are also desirable in sizes where special shapes are difficult to cast. The sintering process in quantity production makes Alnico permanent magnets available for many uses which were not previously economically possible.

The Indiana Steel Products Company is well equipped for the production of sintered magnets of almost any standard shape from its available stock of dies without die charge. Because of die cost requirements in the production of sintered magnets of special design, a special charge is made. We invite those interested in the application of sintered magnets to consult our engineering department.

More than 24,000 applications of permanent magnets have been made by The Indiana Steel Products Company, the world's largest sole manufacturer of "Packaged Energy". Our engineers invite you to consult with them on any magnet problem. For complete information write for our free "Permanent Magnet Manual".

★ THE INDIANA STEEL PRODUCTS COMPANY ★

PRODUCERS OF "PACKAGED ENERGY"
6 NORTH MICHIGAN AVENUE • CHICAGO 2, ILL.

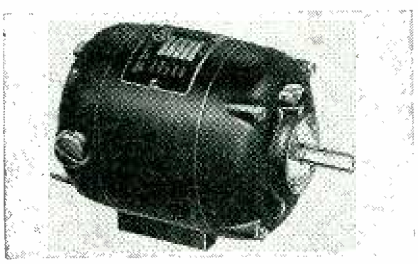
SPECIALISTS IN PERMANENT MAGNETS SINCE 1910

PLANTS: VALPARAISO, INDIANA
STAMFORD, CONN. (CINAUDAGRAPH DIV.)

output of 12.9 kilowatts with a d-c plate voltage of 6,000 volts. Full ratings apply up to 110 megacycles. In typical operation, driving power per tube is 1,400 watts.

High-Speed Motor (12)

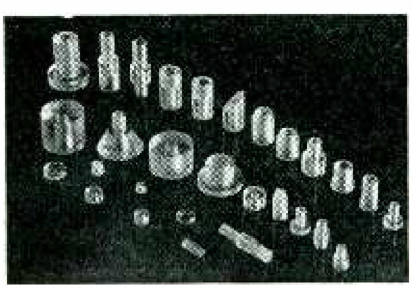
JOHN OSTER MFG. CO., Racine, Wis. The type EU-450 series-wound motor operates with a speed of 4,000 to 8,000 rpm at a power of



1/15 hp. Utilizing either a-c or d-c, the motor can be used for a tube-cooling blower or in similar applications.

New Plastic (13)

GENERAL ELECTRIC CO., Pittsfield, Mass. A new plastic material known as Textolite 1422 possesses a



low power factor and machines readily, making it suitable for coil forms and insulators used at ultra-high frequencies.

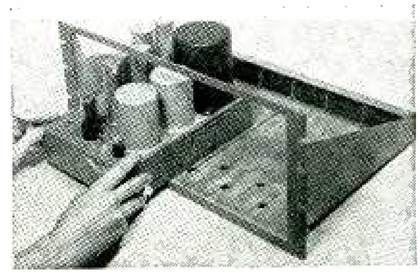
Electronic Timer (14)

GENERAL CONTROL CO., 1200 Soldiers Field Road, Boston 34, Mass. Promatic timers provide full automatic or semiautomatic control of industrial or radio equipment. Used

in pairs or combinations they can control a number of operations in a predetermined sequence with either self or manual recycling. Five timing periods, depending upon the value of fixed capacitor plugged into the circuit, are available from ½ to 60 seconds. The unit can also be modified for use as a sensitive control relay.

Plug-In Amplifier (15)

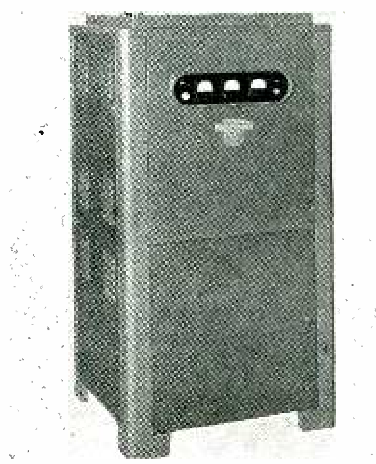
RADIO CORP. OF AMERICA, Camden, N. J. A new line of plug-in amplifiers is now in production for broadcast station use. With this system, a whole amplifier assembly can be demounted and replaced by another as is done with a tube. The BR-2A shelf assembly mounts in a standard rack. At the rear of the shelf are rectangular socket assemblies into which contactor prongs fit



when the amplifier unit is locked into place by one or two levers. A family of amplifiers used in various broadcast station functions is available in the proper dimensions for the new mounting. Six preamplifier chassis units, for instance, fit on a single shelf.

Dual Electronic Heater (16)

INDUCTION HEATING CORP., 389 Lafayette St., New York 3, N. Y. The Ther-Monic M-285C electronic heating generator is a single dual-



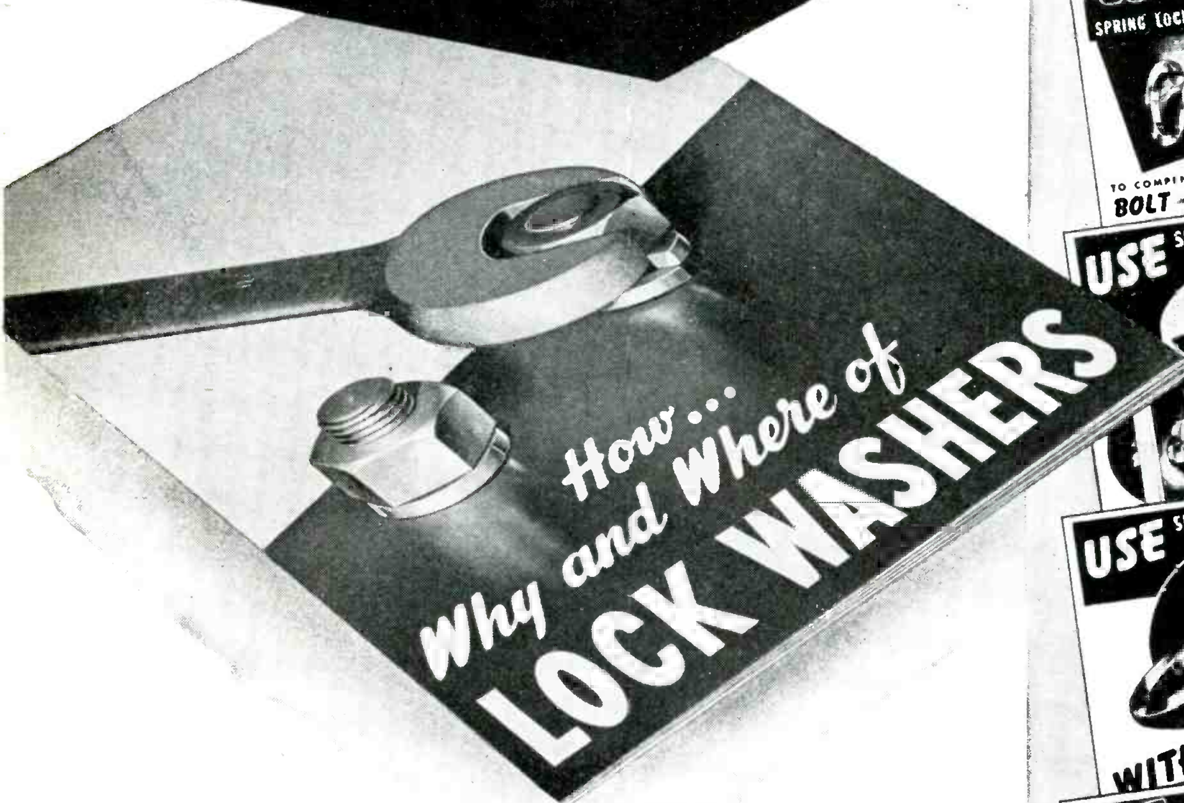
purpose unit suitable for both induction and dielectric heating operations. Full load output is about 285 Btu per minute or 5 kilowatts. The induction generator operates on 375 kilocycles and the dielectric on 20 megacycles. Changeover from one method to another merely involves replacing one radio-frequency unit with the other.

Transmitting Triode (17)

GENERAL ELECTRIC CO., Syracuse, N. Y. The type GL-5C24 triode has

IF YOU BUY OR SPECIFY LOCK WASHERS

GET THIS BOOK!



NEW FACTS . . . SPECIFICATIONS . . . RECOMMENDATIONS

You should know about Lock Washers

From the latest American Standards Specifications right on through to what to use and where. That's how complete this new Diamond G Lock Washer booklet is. On the right are shown some of the pages from this new book. In addition there are many other facts that every design engineer, production manager, purchasing agent and other executive should have at his finger tips when buying or specifying lock washers or other fastening devices.

This book is just part of the complete service the Diamond G man has to offer you. He is ready to help you with data and engineering advice . . . plus supplying you with a complete line of flat and lock washers—from No. 0 to 2″ in all materials and finishes. For quick deliveries, high quality and product satisfaction write, wire or phone . . .

GEORGE K. GARRETT CO., INC.
1421 CHESTNUT STREET, PHILADELPHIA 2, PA.

DIAMOND G PRODUCTS

LOCK WASHERS • • FLAT WASHERS • • STAMPINGS • • SPRINGS • • HOSE CLAMPS • • SNAP AND RETAINER RINGS

SEND THIS COUPON NOW!

GEORGE K. GARRETT CO., INC.
1421 Chestnut Street, Philadelphia 2, Pa.

Please send me a copy of the NEW DIAMOND G LOCK WASHER book . . .

NAME ____________________

TITLE ____________________

COMPANY ____________________

ADDRESS ____________________

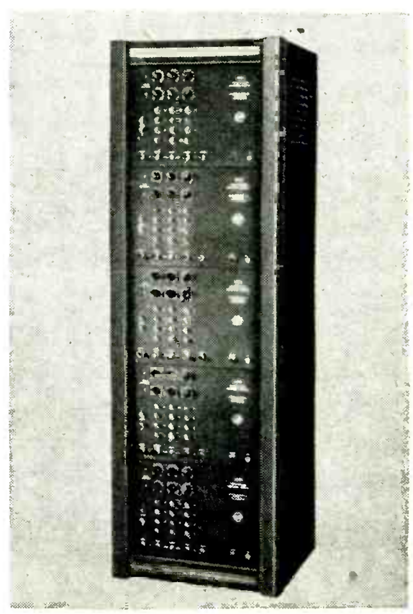
CITY ____________________

been designed primarily as a class A and class AB_1 audio-frequency amplifier and modulator. Typical potentials encountered in using the

tube as a class A amplifier are: d-c plate, 1,500 volts; peak a-f grid, 150 volts; power output, 55 watts.

Multiple Counter (18)

POTTER INSTRUMENT CO., 136-56 Roosevelt Ave., Flushing, N. Y. The Model 69-3 multiple counter consists of five dual counters in combi-



nation so that rates as high as 12,000 a minute may be determined. Such a device can be used for counting radiation particles, small

articles like pills and buttons or the totalizing of variable quantities from several independent channels.

Tube Voltmeter (19)

TELEVISO PRODUCTS CO., 7466 Irving Park Road, Chicago 34, Ill. The Series 200A vacuum-tube voltmeter uses a 0.5-volt full scale meter that allows accurate readings as low as 100,000 microvolts. The input tube is a plate circuit rectifier type that

indicates rms values, rather than the usual diode type whose input admittance varies with frequency. Careful voltage regulation makes the circuit feasible. In addition, a source of 5 volts rms plus or minus 2 percent is furnished for calibration.

Ferromagnetic Analyzer (20)

ALLEN B. DU MONT LABORATORIES, Inc., Passaic, N. J. The Ferrograph provides a simple means for relatively unskilled personnel to identify or compare ferrous materials at a rapid rate. The basic principle of operation is the harmonic analysis of the induced voltage in the secondary of a test transformer in which the sample

Impromptu Discussions about Miniature Tubes

"It's a fact, John, those little TUNG-SOL Miniatures are actually doing a better job than the big tubes. Take radio frequency amplifiers for example. There's the TUNG-SOL 6BA6 for transformer and storage battery operated sets and the 12BA6 for series filament operation. It's only natural that you get greater rigidity with the shorter structure and the same grid cathode spacing . . . and to give you some idea of space saving, one of these little fellows occupies less than half the chassis area that a big tube requires. Think what this means in compact equipment like an auto set.

"With these miniature amplifiers it's possible to obtain the correct bias by means of a cathode resistor of 68 ohms for normal operating current. If unbypassed this gives partial compensation for variations in input capacitance due to changes in automatic volume control voltage. Almost complete compensation can be obtained with a 100 ohm unbypassed cathode resistor. Under this condition the effective transconductance is 2700 microhms. Excellent performance is obtained in the frequency modulation and television intermediate frequency bands. The stable gain figure of merit is about the same as for the large type tube while the broad band figure of merit is about 30% greater.

"I tell you, John, you should lay your tube problems before these TUNG-SOL Engineers. They'll help you select the miniature that'll be most efficient and they won't disclose your plans to others. You see they're tube manufacturers, not set builders."

TUNG-SOL

vibration-tested

ELECTRON TUBES

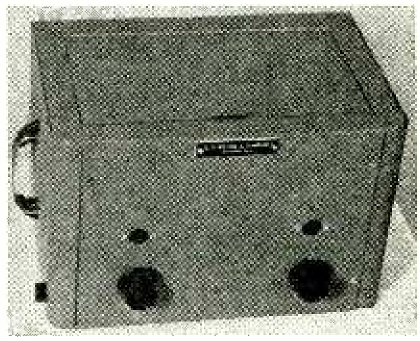
TUNG-SOL LAMP WORKS INC., NEWARK 4, NEW JERSEY

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 is made the core. Amplitude and phase angles of the fundamental and third harmonic components are usually sufficient indication for identification. A cathode-ray tube is used for direct display of the phenomena. The complete testing equipment weighs 115 pounds.

Strain Gage Amplifier (21)

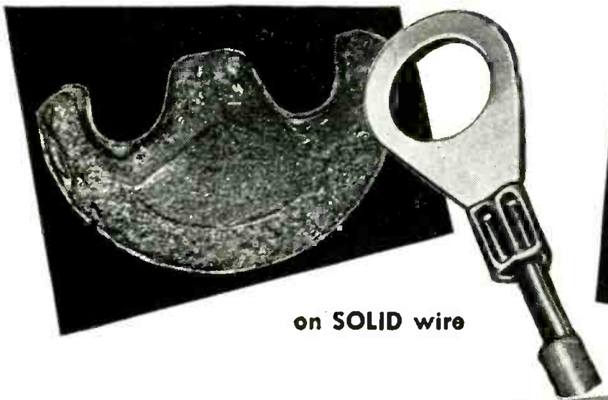
G. C. WILSON & CO., 2 N. Passaic Ave., Chatham, N. J. A new amplifier designed for vibration studies



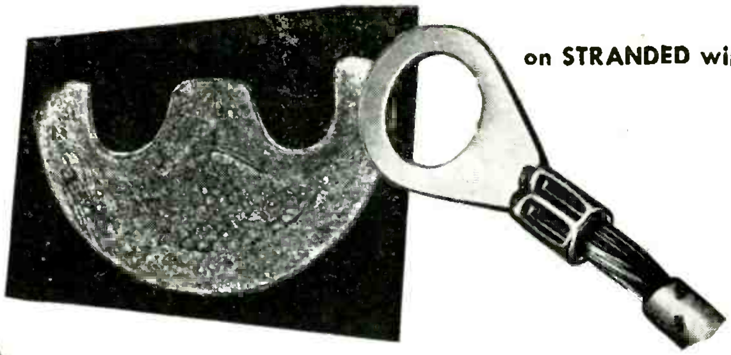
provides amplification of 25,000 between 1 and 30 cycles. Designed to couple directly to the plates of a cathode-ray oscilloscope, the unit includes its own regulated power supply.

Audible Signal Tracer (22)

ELECTRONIC INSTRUMENT CO., INC., 926 Clarkson Ave., Brooklyn 3, N. Y. The Model 113 Electron Tracer



on SOLID wire



on STRANDED wire

AMP MULTI-PURPOSE SOLDERLESS TERMINAL

THE SOLISTRAND

for connecting—

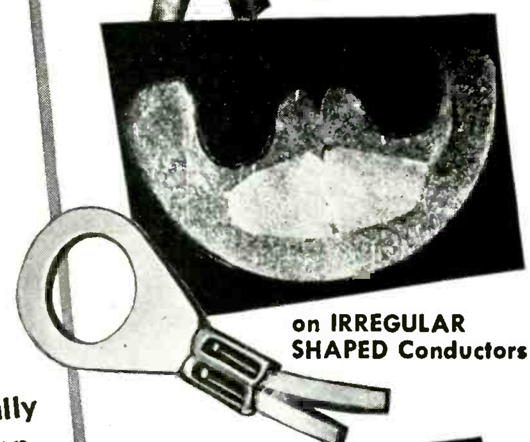
SOLID WIRE

STRANDED WIRE

SOLID AND STRANDED WIRE COMBINATIONS

IRREGULAR SHAPED CONDUCTORS

on combined SOLID and STRANDED wire

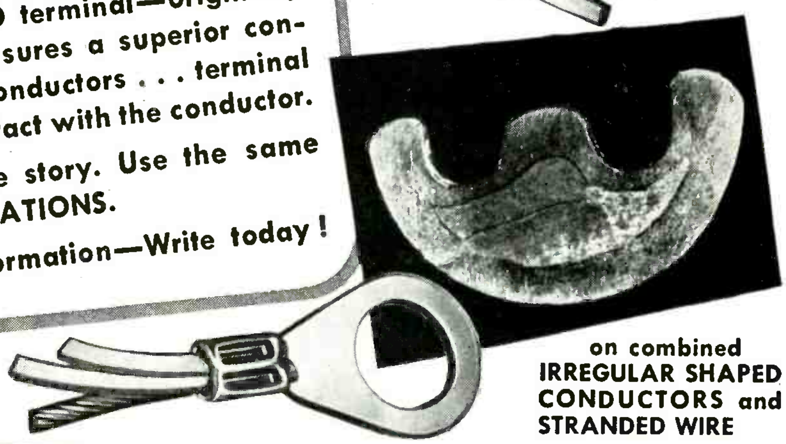


on IRREGULAR SHAPED Conductors

The new AMP SOLISTRAND terminal—originally designed for solid wire—assures a superior connection for ALL types of conductors . . . terminal makes full surface area contact with the conductor.

The cross sections tell the story. Use the same Solistrand for ALL INSTALLATIONS.

For samples and full information—Write today!



on combined IRREGULAR SHAPED CONDUCTORS and STRANDED WIRE

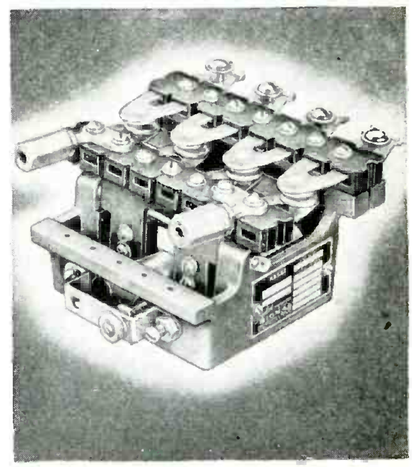
AMP

AIRCRAFT-MARINE PRODUCTS Inc.
1521-53 NORTH FOURTH STREET. HARRISBURG, PA.
In Canada: F. MANLEY CO., 82 Adelaide Street E., Toronto, Ont.

is a complete electronic volt-ohm-meter operating from socket power. It is also equipped with an audio amplifier and loudspeaker for audible signal tracing through the various stages of a receiver.

Heavy-Duty Relay (23)

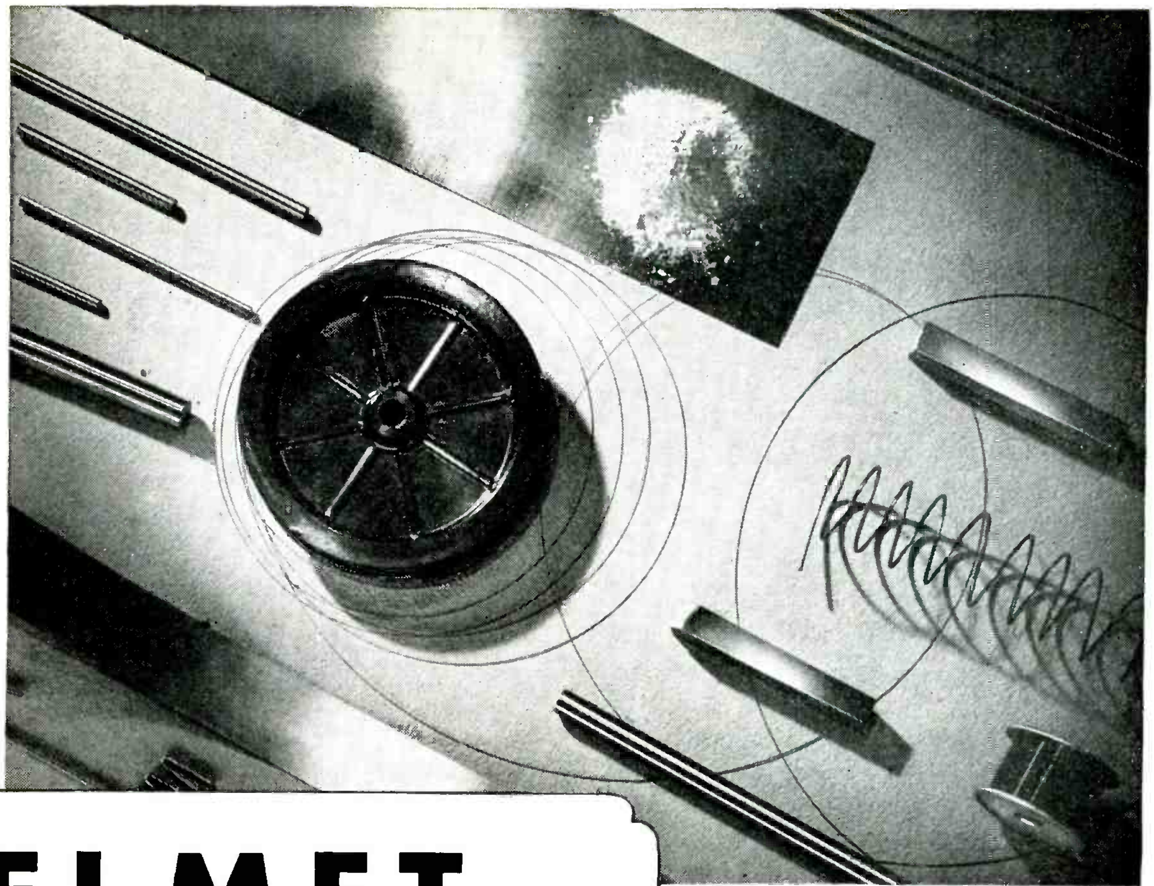
SIGNAL ENGINEERING & MFG. CO., 154 West 14th St., New York 11, N. Y. A new heavy-duty relay with double-pole, single-throw contacts will break 50 amperes at 115 volts a-c or 24 volts d-c. A double-break



feature of the contact mechanism eliminates pigtail connections. Coils can be supplied to operate at voltages up to 230 volts, a-c or d-c. Typical power consumption of the coils is less than 3.5 watts on d-c, 8 watts on a-c.

Helical Potentiometer (24)

VAN DYKE INSTRUMENTS, P. O. Box 696, Tarzana, Calif. The small size and weight of a new helical potentiometer make it useful for aircraft instrumentation and electronic cal-



ELMET

TUNGSTEN AND MOLYBDENUM MADE TO RIGID SPECIFICATIONS

RODS · BARS · WIRE · SHEET · POWDER

Every one of the tungsten and molybdenum products supplied by North American Philips is backed by the knowledge of processes and techniques developed by an organization with a background of over half a century in the electrical field. Every piece of material is controlled to your most rigid specifications.

We can supply you with most of the tungsten and molybdenum products you need—in rod, bar, wire, sheet or powder form.

When you want tungsten or molybdenum—write, wire or telephone North American Philips. And remember, the services of our application engineers are always at your disposal, their years of specialized experience are yours on call.

Products of North American Philips include: other fine wires, diamond dies, quartz oscillator plates, radio and television components, cathode ray tubes, industrial and medical x-ray equipment, tubes and accessories.

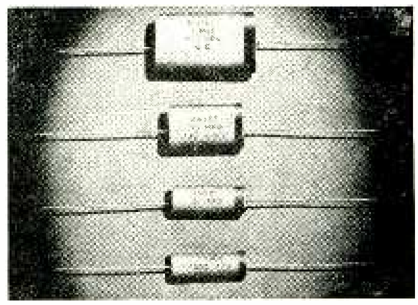
NORTH AMERICAN PHILIPS COMPANY, INC.

Dept. S-11, 100 East 42nd Street, New York 17, N. Y.

culators where space is at a premium. Five- and ten-turn units are available from stock, but other special types are available on order. The diameter of the potentiometer is 1 inch, the length varying with number of turns but usually not exceeding about 3¾ inches.

Flat Midget Capacitors (25)

CORNELL-DUBILIER ELECTRIC Corp., South Plainfield, N. J. A new line of flat midget capacitors, type ZN, is now available for pocket radio, hearing aid or similar use. The units are noninductively wound



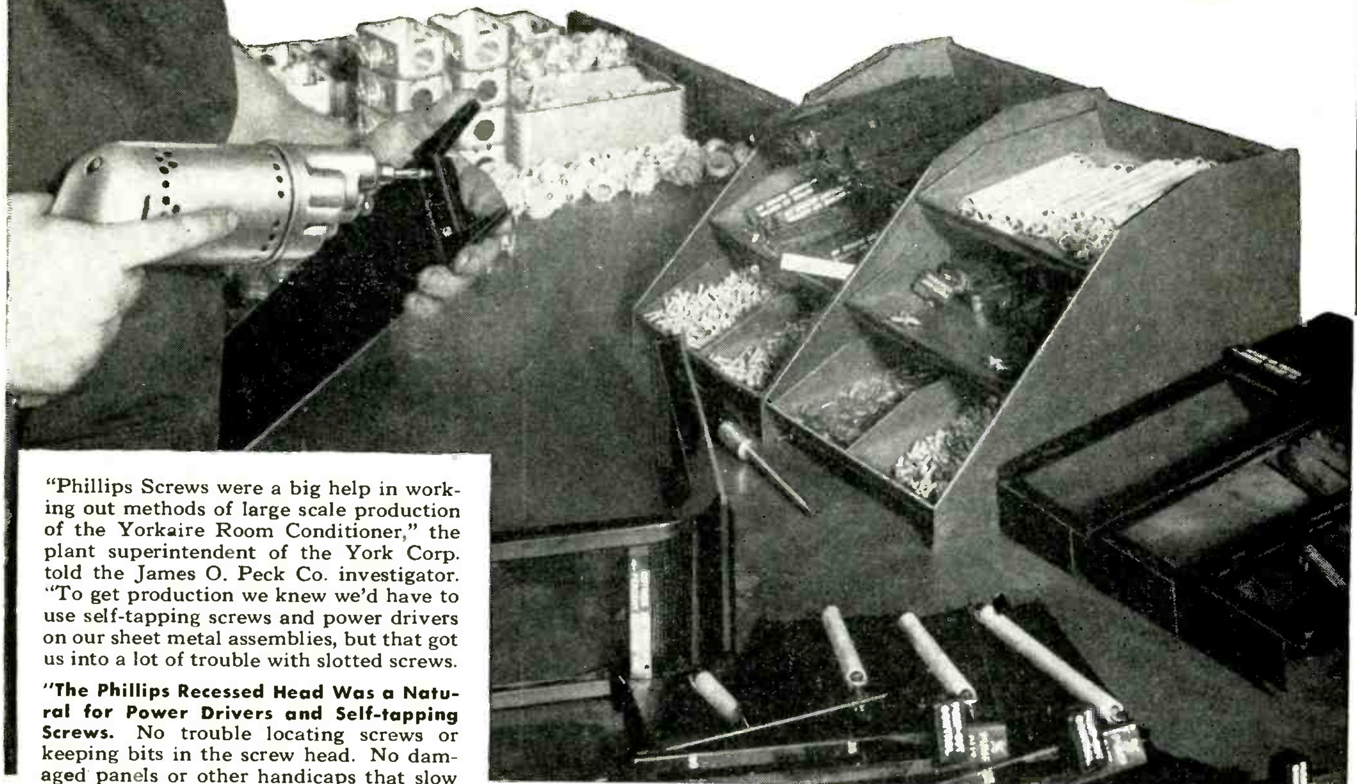
with Kraft paper and impregnated. Leads are securely anchored and the end-fill compound is not melted by a hot soldering iron. Capacitance values range from 0.001 to 0.1 microfarad in d-c rated voltages from 150 to 600 volts.

Gas-Free Metals (26)

NATIONAL RESEARCH CORP., 100 Brookline Ave., Boston 15, Mass. Quantities of gas-free metals in melts up to several hundred pounds are now available for high-vacuum work and allied techniques. A partial list of metals already used in the field of vacuum metallurgy includes copper, nickel, iron, chromium, manganese and lithium.

Flash Tube (27)

HYTRON RADIO AND ELECTRONICS CORP., Salem, Mass. The HD72 flash tube operates from the discharge



YORK credits Phillips Screws

"Faster driving cuts assembly time and costs in shift to mass production"

— REPORTS INVESTIGATOR from James O. Peck Co., industrial research authorities who are studying assembly methods in leading plants. At York Corp. he got information valuable to mass producers. Highlights follow:

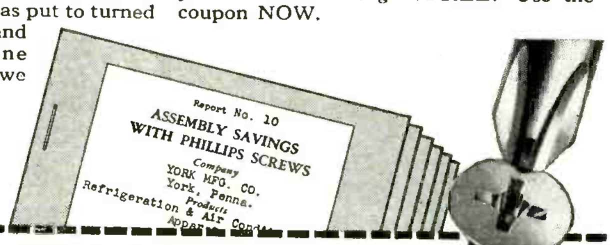
"Phillips Screws were a big help in working out methods of large scale production of the Yorkaire Room Conditioner," the plant superintendent of the York Corp. told the James O. Peck Co. investigator. "To get production we knew we'd have to use self-tapping screws and power drivers on our sheet metal assemblies, but that got us into a lot of trouble with slotted screws.

"The Phillips Recessed Head Was a Natural for Power Drivers and Self-tapping Screws. No trouble locating screws or keeping bits in the screw head. No damaged panels or other handicaps that slow down production. Since we adopted the Phillips Head in '37 it's been standard on all sheet metal assemblies.

"One-Hand Driving Is Easy With the Phillips 'Engineered Fit'. The precision recess snugs right onto the bit of the power driver and sticks there, making it so easy for the operator to center the screw in the hole that he can hold the work with one hand and drive with the other.

"Eliminated the Tremendous Amount of Screw Driver Slippage. Panels were no longer chewed up, a stop was put to turned or burred screw heads and the whole assembly line speeded up the moment we changed from slotted to Phillips Screws."

Important Information for You is available in the unabridged report by this independent investigator of the York Corporation's experience with Phillips Screws. *Other reports,* covering assembly practises in 9 prominent plants making products of metal, wood and plastics, are yours for the asking . . . FREE! Use the coupon NOW.



PHILLIPS *Recessed Head* SCREWS

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

26 SOURCES

American Screw Co.
Atlantic Screw Works
Atlas Bolt & 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.
Manufacturers Screw Products
Milford Rivet and Machine Co.
National Lock Co.
National Screw & Mfg. Co.
New England Screw Co.
Parker-Kalon Corporation
Pawtucket Screw Co.
Pheoll Manufacturing Co.
Reading Screw Co.
Russell Burdsall & Ward Bolt & Nut Co.
Scovill Manufacturing Co.
Shakeproof Inc.
The Southington Hardware Mfg. Co.
The Steel Company of Canada, Ltd.
Sterling Bolt Co.
Wolverine Bolt Company

Phillips Screw Mfrs., c/o Horton-Noyes 10
2300 Industrial Trust Bldg., Providence, R. I.

Send me reports on Assembly Savings with Phillips Screws.

Name..

Company..

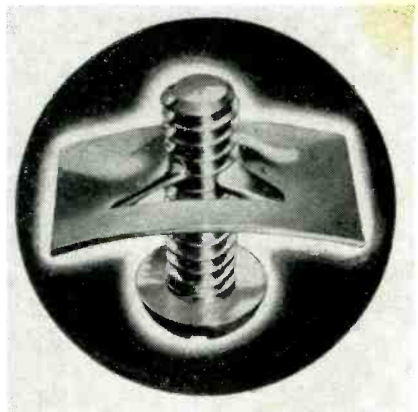
Address..

....

of a capacitor through a glass coil containing xenon gas. Anode potential can be varied between 5,000 and 3,000 volts. The flash exceeds 12 million peak lumens in intensity. The resultant light simulates that of the sun, making the device useful for color photography.

Speed Nut (28)

TINNERMAN PRODUCTS, INC., 2106 Fulton Road, Cleveland 13, Ohio. A new line of heat-treated spring steel



speed nuts is available in sizes to fit the ten most popular sheet metal and machine screws. The C7000 series take less room and cost less than the conventional threaded nut and lock washer.

Synchroscope (29)

SYLVANIA ELECTRIC PRODUCTS, INC., 500 Fifth Ave., New York 18, N. Y. A synchroscope designed for the visual examination of the fine structure of periodic waveforms encountered in television, pulse time

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

From 600 to over 30,000 Volts

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.

Applications

- For low and medium power coupling and bypass circuits where mica capacitors have previously been required
- Television and Oscilloscope Circuits
- Vibrator Buffer and Arc Elimination
- Geiger Counter and Instrument Capacitors

Write for illustrated literature featuring our complete line of Glassmike Capacitors.

***PLASTICONS:** *Plastic-Film Dielectric Capacitors*

Order from your jobber: If he cannot supply you, order direct

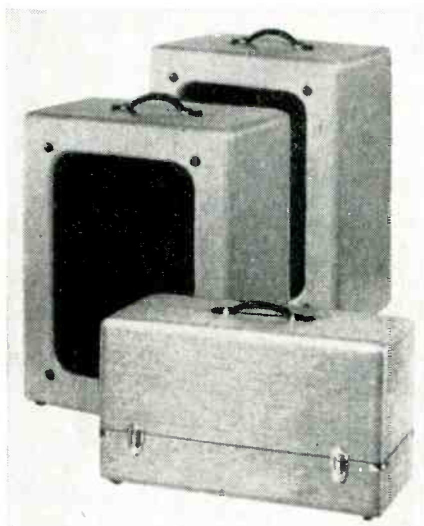
CP

Condenser Products Company

1375 NORTH BRANCH STREET • CHICAGO 22, ILLINOIS modulation, sonic depth finders, geophysical exploration and loran equipments has recently been announced. Included is a 5-inch cathode-ray oscilloscope, trigger generator and adjustable time delay circuits. Sweep speeds up to 5 inches a microsecond are possible with the sweep triggered by either positive or negative pulses. Internal trigger outputs of 500, 1,000, 2,000 and 5,000 pulses per second are available.

Portable Sound System (30)

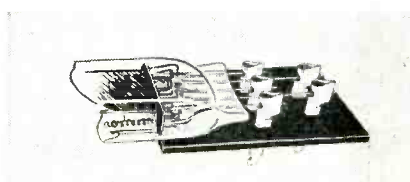
NEWCOMB AUDIO PRODUCTS CO., 2815 S. Hill St., Los Angeles 7, Calif. A new portable sound system contained in three carrying cases

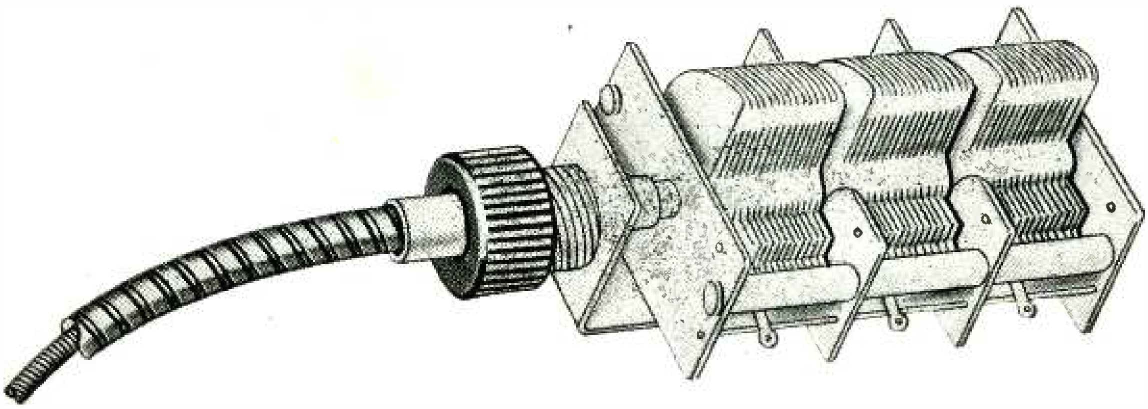


uses a 30-watt amplifier and two 12-inch speakers. Weight of the Model KX-30R12A equipment is 147 pounds.

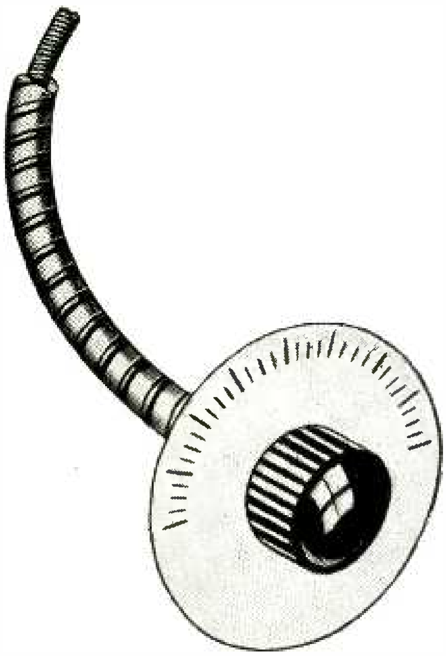
Subminiature Socket (31)

INSTRUMENT SPECIALTIES CO., Inc., Little Falls, N. J. A somewhat un-





Put FLEXIBILITY into ELECTRONIC DESIGN



When you make a circuit diagram, you put variable elements where you want them to simplify the design. You can gain the same "flexibility" when you design the actual equipment. Here's how—

DO IT WITH S.S.WHITE FLEXIBLE SHAFTS

When you couple variable elements to their controls with S.S.White Remote Control Flexible Shafts you have complete freedom in locating the elements where they best satisfy assembly, wiring and servicing requirements—and at the same time you have equal freedom in placing the control dials for convenient operation and harmonious appearance. For details—

WRITE FOR BULLETIN 4501

It gives essential facts and engineering data about flexible shafts and their application. Copy mailed on request.

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

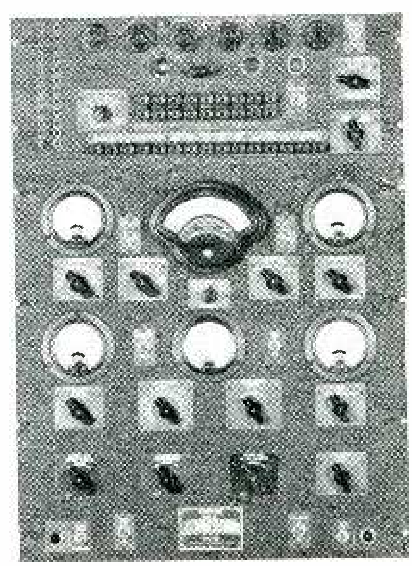
One of America's AAAA Industrial Enterprises usual socket is now available for subminiature tubes having coplanar leads spaced 0.050 inch or more. The contacts, illustrated, are formed in an open U section then wedged into a square hole in a supporting insulating sheet. Tube wires or miniature prongs pass through a hole and are seized on the other side by the spring metal. Connecting wires are soldered to the projections on the other side of the supporting insulator.

Regulated D-C Power Supplies (32)

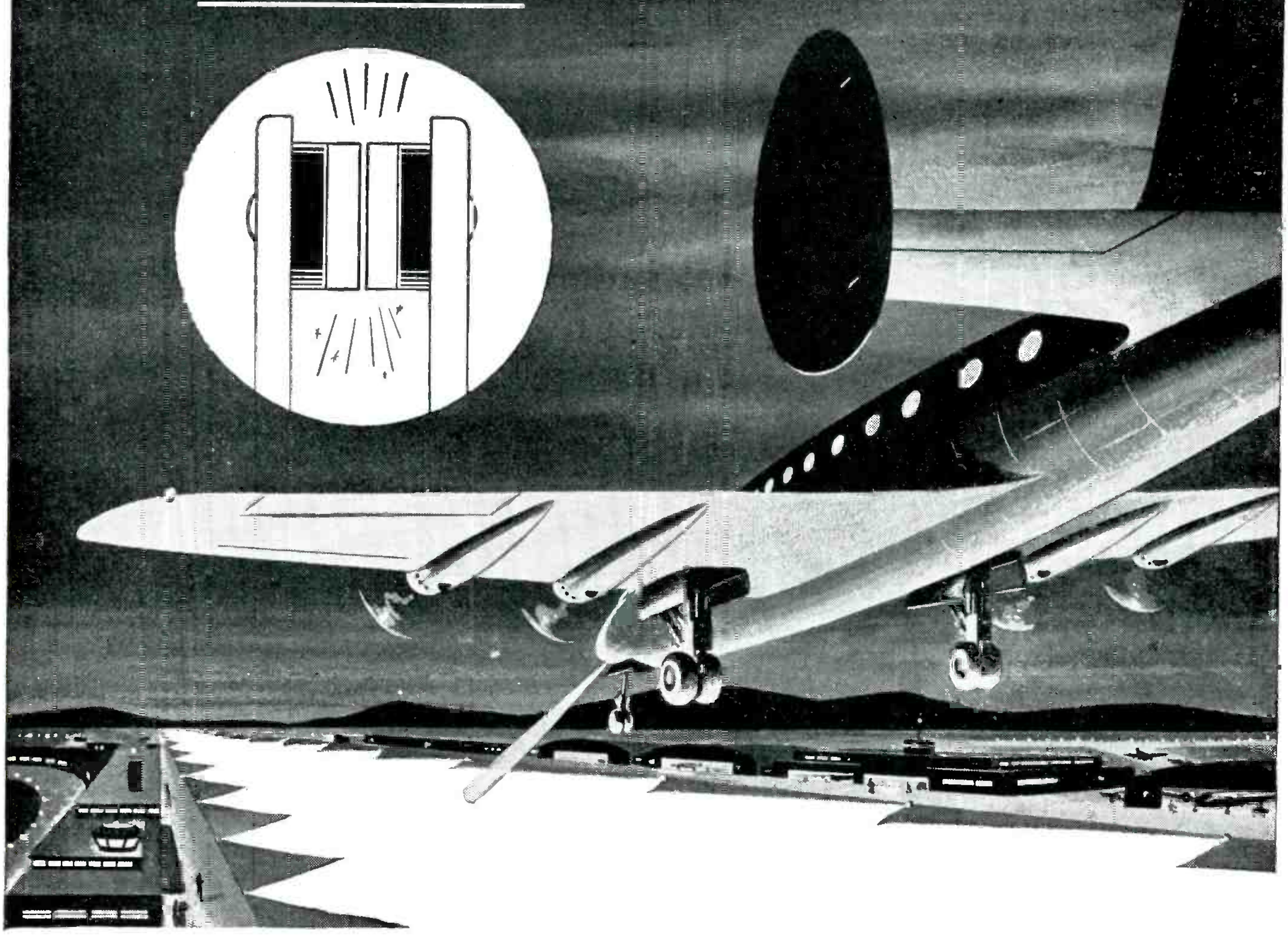
SORENSEN AND CO., INC., 375 Fairfield Ave., Stamford, Conn. Regulated d-c power is available at either 6 or 12 volts in current ratings between 5 and 15 amperes. Operating from conventional a-c power lines, these regulators maintain their d-c output with an accuracy of plus or minus 0.5 percent.

Dynamic Tube Analyzer (33)

WESTON ELECTRICAL INSTRUMENT CORP., 617 Frelinghuysen Ave., Newark 5, N. J. The Model 686 vacuum tube analyzer tests tubes under dynamic operating conditions. A large meter indicates mutual conductance in ranges of 3,000, 6,000, and 15,000 micromhos. A socket panel provides access to



THE VITAL LINK IN EVERY INDUSTRY...



WILCO CONTACTS

They keep the power flowing!

Today WILCO CONTACTS keep the power flowing in vital industrial applications through their *built-in* capacity for precision performance and longer service life. WILCO CONTACTS function dependably in frequency operations of every range by bringing to each operation requisite ductility, hardness, density, freedom from sticking, low metal transfer, high conductivity and arc-resistance.

You likewise can depend on WILCO CONTACTS to keep the power flowing in your products, because exclusive patented WILCO processes assure unequalled qualities. 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.

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

SPECIAL ALLOYS

NI-SPAN C*
New Constant Modulus Alloy

*Reg. Trade Mark, The International Nickel Co., Inc.

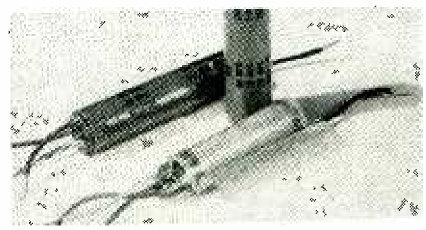
WILCO

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 each tube element and patch cords are used to set up circuits for the study of any tube. Plate, grid and other element potentials as well as signal voltages are provided in the analyzer.

Plastic Electrolytics (34)

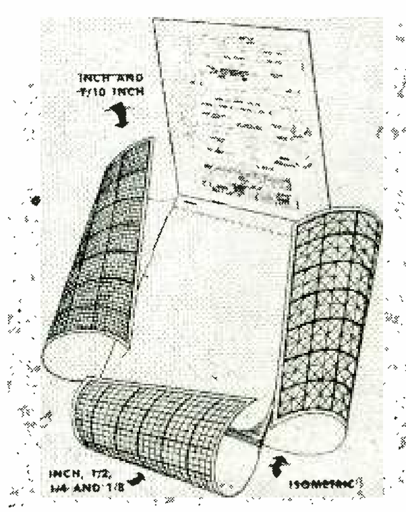
SOLAR MFG. CORP., 285 Madison Ave., New York 17, N. Y. Type DS, DT and DH dry electrolytic capacitors are now being wrapped in a



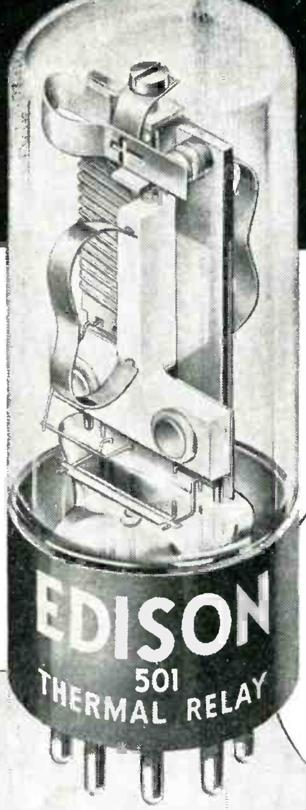
plastic film instead of Kraft paper liners before insertion in the cardboard housing. The film has been chosen to withstand the high potting temperatures and is said to increase the life of the capacitors materially.

Graphic Sketch Pad (35)

JIFFY SALES CO., 1879 East 37th St., Cleveland 14, Ohio. A pad of plain paper perforated for easy removal can be backed by one of three scales printed on cardboard flaps. Isometric, one-inch and tenths, or one-



What can this NEW Thermal Relay do for you?



Here are its characteristics. How can it fit your needs?

FEATURES:

Inexpensive, small, light . . .
Hermetic sealed, contacts totally enclosed and protected from dust, dirt and corrosion . . .
Long operating life . . .
Operates in any position, at any altitude . . .
AC/DC Operation, both heater and contacts operate interchangeably on AC or DC

In a thermal relay, an electrical heater, rather than magnetic coil, is used to operate the contacts. This results in certain useful characteristics—inbuilt delay timing, insensitivity to transients, a non-inductive device that operates from AC or DC or interchangeably, and simple construction.

The design of the EDISON Model 501 Thermal Relay adds certain important features to these general advantages. Hermetic sealing in glass protects all parts, guarantees consistent long life, and makes operation independent of altitude. Contacts operate noiselessly in an arc-quenching atmosphere with consequent equal current ratings on AC or DC. A compensating bi-metal assures uniform response time at all ambient temperatures. The relay will operate in any position. A convenient tube-base mounting is available. Sound thermodynamic design assures consistent operation and permits a wide range of characteristics.

Delay or timing is only one of the many uses of this versatile new relay. Engineers are constantly finding new applications for a device with its unusual and useful characteristics—applications which simplify and improve control circuits of many types.

For instance, it protects vacuum tubes by delaying the application of plate current until cathodes are hot. It will indicate or control over and under-current, over and under-voltage. It carries heavy AC and DC loads and prevents chatter when actuated by delicate controls. It does dozens of other jobs better and more cheaply than any other type of relay.

OPERATING CHARACTERISTICS:

- **CONTACT RATING**—6 amps. at 450 volts AC or DC (maximum).
- **HEATER INPUT**—5 watts nominal continuous excitation at up to 150 volts AC/DC.
- **DELAY PERIOD**—5 seconds to 8 minutes, preset at factory.
- **CONTACTS**—s.p.s.t.; normally open or normally closed.
- **DIMENSIONS**—1¼" dia. x 3¼" height (seated).
- **AMBIENT RANGE**—compensated for operation from −65°C to +100°C.
- **WEIGHT**—0.08 lb.
- **MOUNTING**—Standard octal or 4-pronged tube base.

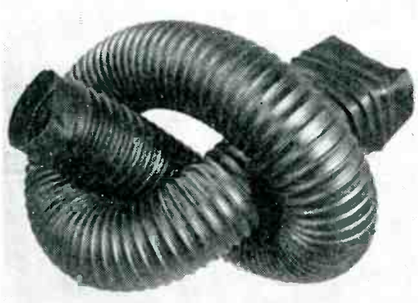
The services of Edison Engineers are available to assist you in working out any problem in connection with Edison instruments and controls. A letter giving as much data as possible on the proposed use will receive prompt attention. Instrument Division, Thomas A. Edison, Incorporated, 21 Lakeside Avenue, West Orange, N. J.

AN
EDISON
CONTROL

inch, half, quarter and eighth-inch scales are available. Electronic, power and welding symbols are printed on the back of the cover. Price is $1.65 each, or less in lots.

Ventilating Hose (36)

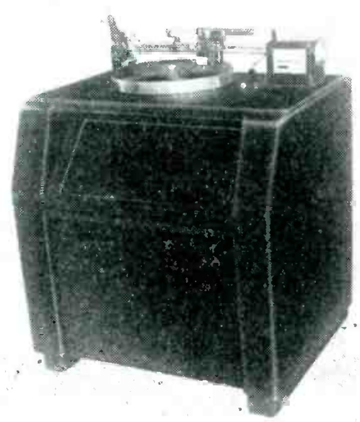
American Ventilating Hose Co., 15 Park Row, New York 7, N. Y. A new neoprene-coated fabric hose

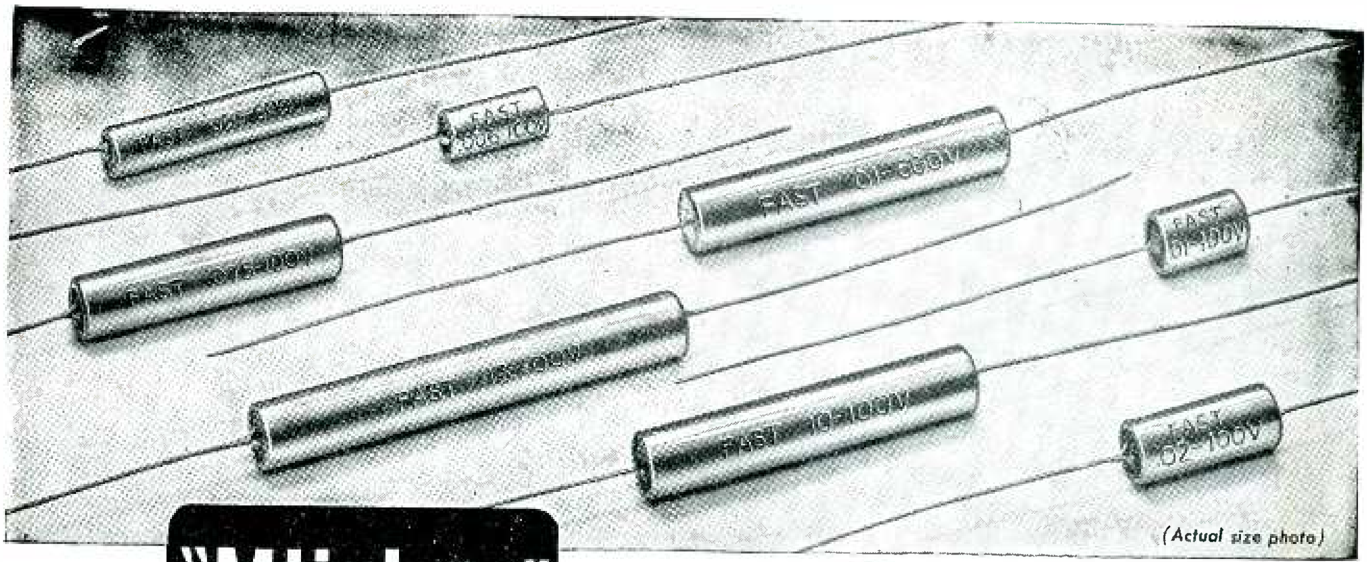


is available in diameters from 1 to 24 inches. Reinforced by a spiral wire, it can be used for a variety of cooling or ventilating purposes.

Studio Recorder (37)

Fairchild Camera and Instrument Corp., Jamaica, N. Y. The No. 523 studio recorder for instantaneous or wax recordings accommodates 18-inch masters. A positive drive at 33.3 rpm from a synchonous motor makes the a-c line the only standard of frequency necessary for dubbing in sound. Uniform





(Actual size photo)

FAST "Mijakon" HERMETICALLY SEALED TUBULAR *Capacitors*

Here is a line of **midget size** Capacitors that will fit into those many inaccessible places encountered in ELECTRONIC DEVICES, RADIOS AND TELEVISION SETS.

These are hermetically sealed *"Paper Dielectric"* units – impregnated and filled with oil* or wax – in tubular containers of brass with a heavy tin dip.

They are particularly suitable where a high quality capacitor is required to function under conditions of excess humidity; where stability and long life also are vital factors. They are fungus resistant – excellent units to use in radionic and electronic equipment for operation in tropical or similar areas. In certain regions servicing may be a problem, consequently continuous and reliable performance is essential.

This line includes the following ranges: In WAX – .002 to .1 MFD, 100 VDC; .002 to .075 MFD, 200 VDC; .002 to .05 MFD, 400 VDC; .001 to .03 MFD, 600 VDC. In OIL – .002 to .05 MFD, 100 and 200 VDC; .001 to .04 MFD, 400 VDC; .001 to .02 MFD, 600 VDC. Somewhat higher capacities can be supplied without increasing the size abnormally. Below is a Representative list of "MIJAKONS" showing detailed dimensions.

Please note these units are not carried in stock. Due to the difficulty in obtaining brass shells and tubing deliveries cannot be made until the end of the 1st quarter of 1947. Plan to use "MIJAKONS" in your 1947 models. Samples may be supplied in four to six weeks. WHEN MAKING INQUIRIES or REQUESTING samples PLEASE SPECIFY whether "Wax" or "Oil" are required.

Class 20—Both Terminals Insulated					Class 22—One Terminal Grounded				
Cap. Mfds.	Volts D.C.	Impregnant	Diameter (inches)	Length (inches)	Cap. Mfds.	Volts D.C.	Impregnant	Diameter (inches)	Length (inches)
.05	100	Oil	5/16	1-7/16	.008	100	Oil	9/32	9/16
.10	100	Wax	5/16	1-13/16	.075	100	Wax	19/64	1-3/8
.04	200	Oil	5/16	1-11/16	.004	200	Oil	1/4	3/4
.003	200	Wax	1/4	5/8	.002	200	Wax	1/4	1/2
.02	400	Oil	19/64	1-7/16	.001	400	Oil	1/4	5/8
.01	400	Wax	19/64	13/16	.05	400	Wax	5/16	1-3/4
.005	600	Oil	19/64	1	.01	600	Oil	19/64	1-3/8
.03	600	Wax	5/16	1-15/16	.02	600	Wax	5/16	1-3/8
.001	600	Oil	1/4	13/16	.005	600	Oil	19/64	15/16

WAX impregnated and filled units may be used for operation in temperatures up to 150°F (65°C) — the OIL Group up to 194°F (90°C).*

Standard Capacity Tolerance on "Mijakons" is ±20%. Closer tolerances may be obtained if required but at added cost.

***MINERAL OIL**

Standard or Special Units to Meet Every Need

FAST can supply practically any Capacitor of the "Paper Dielectric" type in OIL or WAX — impregnated and filled — or POLYSTYRENE FILM. Containers may be cardboard or metal, rectangular or tubular, in sizes from the smallest to the largest. CHOKE COILS of heavy wire (No. 12 to No. 18), Air or Iron Core, can also be made to your specifications.

"When You Think of Capacitors . . . Think FAST"

JOHN E. FAST & CO.

Capacitor Specialists for Over a Quarter-Century

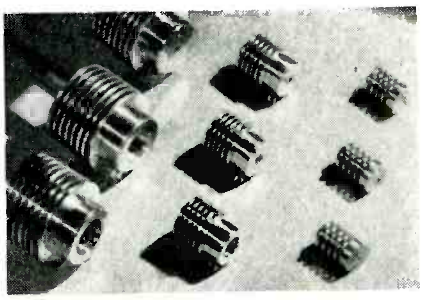
3101 N. Pulaski Road, Chicago 41

Canadian Representatives: Beaupre Engineering Works, Reg'd. 2101 Bennett Avenue, Montreal, for Power Factor Correction
J. R. Longstaffe, Ltd., 11 King Street, W., Toronto 1, for Special Applications

cutting is assured with a screw mechanism adjustable at any pitch from 80 to 160 lines, starting either from center or edge.

Radiating Connectors (38)

EITEL-MCCULLOUGH, INC., San Bruno, Calif. Type HR heat dissipating connectors are used to make electrical connections to the plate and grid terminals of power tubes,



at the same time providing efficient heat transfer from the tube element and the glass seal to the air. The connectors are machined from solid dural rod and are supplied with necessary machine screws to insure a tight joint.

Multiwire Connectors (39)

ALDEN PRODUCTS CO., 117 North Main St., Brockton 64, Mass. A new series of multiwire connectors features a knurled locking ring that engages slots in the chassis member. In the locked position a rubber gasket protects the junction from vibration and moisture. A means is provided for fastening cable shielding to obtain positive ground and prevent strain on the cable.

WHF Receiver (40)

RADIO RECEPTOR CO., INC., 251 West 19th St., New York 11, N. Y. The RV-1-B vhf crystal-controlled receiver is designed for fixed frequency service over the frequency

Company Community Country

★ YOU HELP ALL 3 WITH THE P. S. P.

● Participants in the Payroll Savings Plan benefit directly in terms of cash—because U. S. Savings Bonds at maturity pay $4 for every $3 invested.

Your company, your community, and your country benefit indirectly in terms of security—because: (1) Employees with a solid stake in the future are likely to be stable, productive workers. (2) The Bond-buying habit of local citizen-employees means a reserve of future purchasing power—a safeguard for the stability of your community. (3) Every Bond bought temporarily absorbs surplus funds and helps check inflationary tendencies.

You're doing everybody a favor—including yourself—by supporting the Payroll Savings Plan.

ARE YOU USING THESE BOOKLETS?

If not, or if you wish additional copies, just ask your State Director of the Treasury Department Savings Bonds Division.

The Peacetime Payroll Savings Plan—A booklet, published for key executives by the Treasury Department, containing helpful suggestions on the conduct of your payroll savings plan for U. S. Savings Bonds.

This Time It's For You—A booklet for employees . . . explaining graphically how the payroll savings plan works . . . goals to save for, and how to reach them with Savings Bonds.

The Treasury Department acknowledges with appreciation the publication of this message by

Electronics

This is an official U. S. Treasury advertisement prepared under the auspices of the Treasury Department and The Advertising Council

magnetic iron powders

Uniformly high magnetic performance, exceptional Q and high permeability of the wide variety of Mepham magnetic iron powders (hydrogen reduced) suggest their use for high-frequency cores, core material, tele-communication and magnetic applications. Production is strictly controlled—prices are attractively low . . . Consult the Mepham Technical Staff—send for literature.

G. S. MEPHAM CORPORATION
Established 1902 • • East St. Louis, Illinois

INDUCTIVE COMPONENTS
FOR INDUSTRIAL & SPECIAL APPLICATIONS

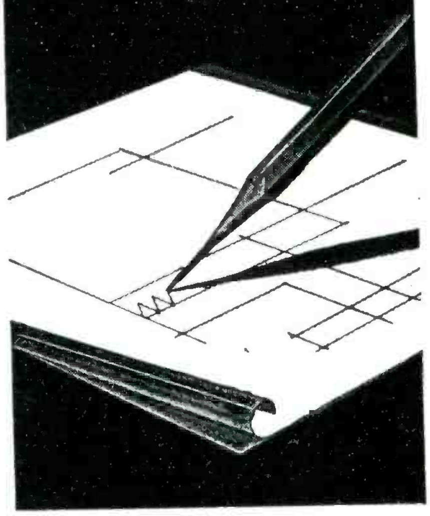
- Transformers
- Saturable Reactors
- Balanced Windings
- Solenoids & Relays
- Universal Windings
- Self Supporting Coils
- Hemispherical & Tapered Shapes

Special Units to Withstand Extreme Temperatures

RECTIFIERS — INDUSTRIAL
FOR PLATING & CONTROL PURPOSES
Your inquiry invited

NORTHERN COMMUNICATIONS MFG. CO.
210 East 40th Street • New York 16, N. Y.

TRACING CLOTH for HARD PENCILS



● Imperial Pencil Tracing Cloth has the same superbly uniform cloth foundation and transparency as the world famous Imperial Tracing Cloth. But it is distinguished by its special dull drawing surface, on which hard pencils can be used, giving clean, sharp, opaque, non-smudging lines.

Erasures are made easily, without damage. It gives sharp, contrasting prints of the finest lines. It resists the effects of time and wear, and does not become brittle or opaque.

Imperial Pencil Tracing Cloth is right for ink drawings as well.

IMPERIAL PENCIL TRACING CLOTH

SOLD BY LEADING STATIONERY AND DRAWING MATERIAL DEALERS EVERYWHERE.

range 100 to 162 megacycles. The unit is rack-mounted for airline or other fixed station use but can be

slid out of its dust cover and inverted while in operation. Further details are given in Bulletin 5007A.

Resonant Relays (41)

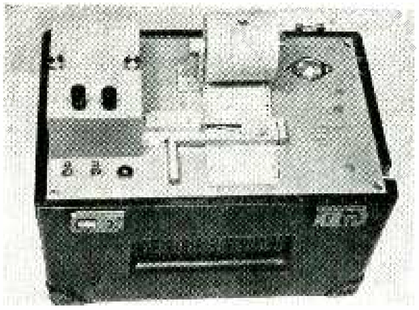
STEVENS-ARNOLD CO., 22 Elkins St., South Boston 27, Mass. The type 172 resonant relay uses a vibrating

reed mechanism adjusted to respond to a narrow band of frequencies. The units are totally enclosed and based with octal-tube type connections. The ON time of the contacts is 5 percent for all frequencies from 153 to 442 cps. An auxiliary relay or vacuum tube is used to control large currents that can not be handled by the vibrating contacts. The standard coil has an impedance of 500 ohms. Further details are given in Catalog 116.

Level Recorder (42)

SOUND APPARATUS CO., 233 Broadway, New York 7, N. Y. The type PS portable graphic recorder measures only 8 x 10 x 12 inches and

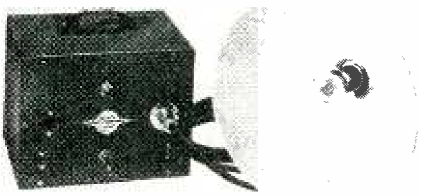
includes an input potentiometer, paper gate and scriber, amplifier, motor, and power supply. The unit



has a sensitivity of 10 millivolts for 0 db. Normal paper speed is 6 inches a minute. Recording speed is full scale in 0.6 second.

Stroboscopic Light (43)

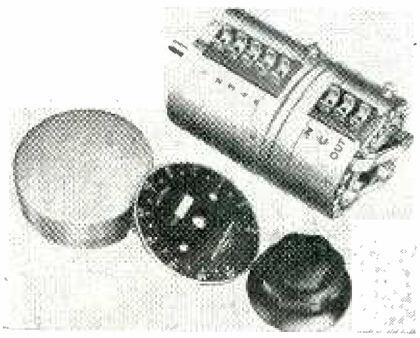
KLUGE ELECTRONICS CO., 1031 North Alvarado St., Los Angeles 26, Calif. A new portable strobo-

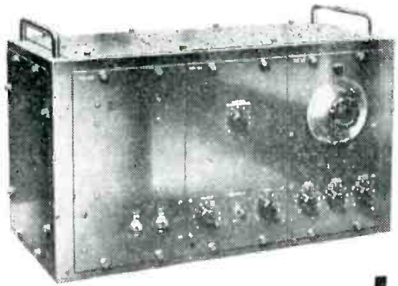


scopic lamp with a bulb giving sunlight values for color work operates from any a-c outlet and retails for $79.50 without tax.

Compensating Attenuator (44)

DAVEN CO., 191 CENTRAL AVE., Newark, N. J. The type LAC-720





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.

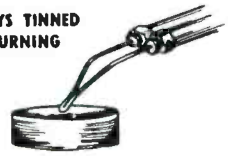
ACOUSTICAL MANUFACTURING CO., LTD.
HUNTINGDON · ENGLAND
TELEPHONE: HUNTINGDON 361

NEW SOLDERING GUN

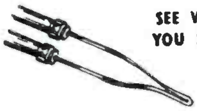
Heats in 5 Seconds

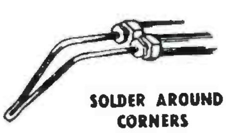
SPECIAL SOLDERING GUN ADVANTAGES

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

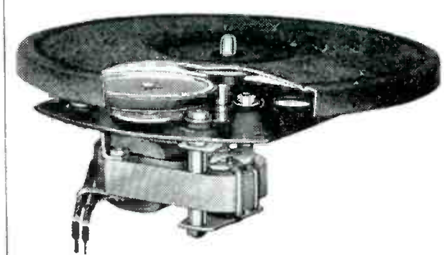
510 NORTHAMPTON ST.

WELLER MFG. CO. Easton, Pa.

Smooth Running Smooth Selling

with

Smooth Power



You'll build smoother performance into your phonographs, recorders and record-changers when you equip them with **GI** *Smooth Power* Motors.

Every unit in our wide line provides that combination of quick pick-up, unvarying speed and velvety operation which pleases customers and makes your selling job easier.

For smooth running and smooth selling, *standardize on Smooth Power Motors.*

THE GENERAL INDUSTRIES CO.

Dept. ME • Elyria, Ohio

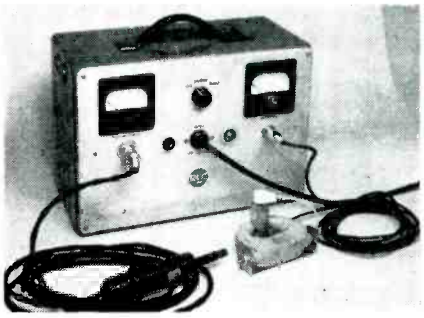
tone-compensating attenuator has been developed to facilitate authentic reproduction of the musical spectrum at any reasonable level. The device is essentially a ladder network designed so that the lower frequencies have a smaller loss than the middle register to compensate for the nonlinear response of the human ear. Six different characteristics, including a flat frequency response, can be chosen by proper connection to lugs on the unit.

Timing Motor (45)

A. W. HAYDON ENGINEERING CO., Waterbury, Conn. The Circle B timing motor can be supplied in 1 and 5 rpm speeds, operating from 110, 220, and 24 volts, 60 cycles. It will fit in a 2-inch circle, has through holes for mounting, solder terminals, and no projecting ears or leads.

Vacuum Gage (46)

RADIO CORP. OF AMERICA, Camden, N. J. The type EMG vacuum gage used in the electron microscope is now available as a separate assembly consisting of thermocouple, ionization tube and control unit. Rough pumping pressures are



indicated by the thermocouple, whereas the tube is connected after the diffusion pump has been started. A feature of this tube is its cold cathode. There is no filament to burn out with accidental increase of air pressure. The tube is also enclosed in an oval metal shell surrounded by a strong magnetic field. The anode consists of a rectangular loop of wire embracing the maximum position of the

"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 MAGNETIC CORPORATION

MANUFACTURERS OF HIGH COERCIVE MAGNETIC ALLOYS

G·M ALNICO

10001 ERWIN AVENUE
DETROIT 5, MICHIGAN

The FINEST MICROPHONES *for* P. A. *and* RECORDING!

AMPERITE VELOCITY MICROPHONE WITH **PATENTED ACOUSTIC COMPENSATOR**

***New* P. G. DYNAMIC** WITH NEW SUPERIOR ELIPSOID PICK UP PATTERN!

AMPERITE KONTAK MIKES
IDEAL FOR AMPLIFYING STRINGED INSTRUMENTS
USED WITH ANY AMPLIFIER AND WITH RADIO SETS.

ASK YOUR JOBBER . . . WRITE FOR FOLDER

AMPERITE

AMPERITE

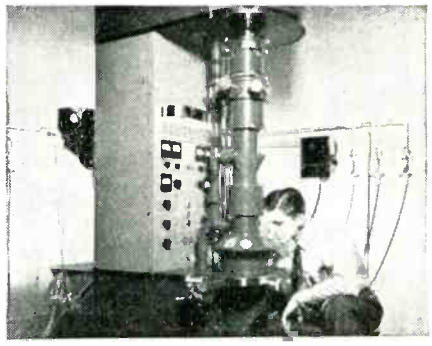
561 BROADWAY NEW YORK

Silicone News

DC SILICONES

DC 702 and DC 703
Silicone Diffusion Pump Fluids

STABLE TO AIR AND MOISTURE AT OPERATING TEMPERATURES



- In electron microscopes
- In metal evaporator systems
- In producing vacuum tubes
- In dehydrating foods or pharmaceuticals

Never before have there been diffusion pump oils producing vacua up to 5 x 10^{-8} yet able to withstand atmospheric pressure at operating temperatures without appreciable decomposition.

DC 702 and DC 703 have those properties. Their vapor pressures are as low or lower than the best organic diffusion pump oils: recovery times after exposure to atmosphere at operating temperatures are much faster. Ultimate vacuum obtainable with DC 703 in a three-stage glass pump without cold traps is less than 5 x 10^{-8} mm.

DC 702 has a lower boiling point, operates against a higher forepressure and produces vacua in the range of organic diffusion pump oils.

Additional information about DC 702 and DC 703 is contained in pamphlet No. N 9-1.

SILICONE FLUIDS AS LIQUID DIELECTRICS—DC 200 Fluids are used in liquid filled condensers because of inherent stability, inertness to moisture, and a dielectric constant and power factor which change very little over a wide frequency spectrum. For additional data on DC Silicone Fluids write for catalog No. N 1-1.

DOW CORNING CORPORATION
MIDLAND, MICHIGAN

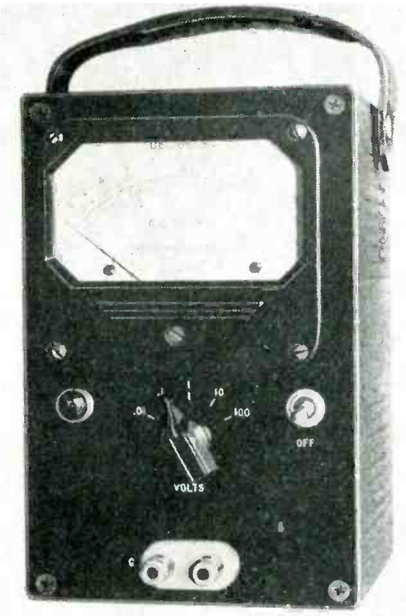
Chicago Office: Builders' Building
Cleveland Office: Terminal Tower Building
New York Office: Empire State Building
In Canada: Dow Corning Products Distributed by Fiberglas Canada, Ltd., Toronto

Dow Corning
FIRST IN SILICONES

magnetic field. The gage units are provided with standard threaded fittings, and leads with plugs to attach to the appropriate jacks in the control unit. Pressures as low as 0.1 micron can be accurately measured.

V-T Voltmeter (47)

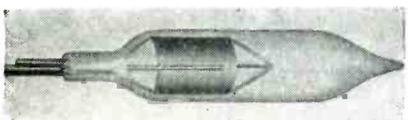
FREED TRANSFORMER CO., INC., 72 Spring St., New York, N. Y. The



No. 1040 vacuum-tube voltmeter has a range from 0.001 to 100 volts with an accuracy of 2 percent for sinusoidal voltages. Frequency range is 10 to 200,000 cycles with 0.1 db variation. The power supply is contained in the metal cabinet.

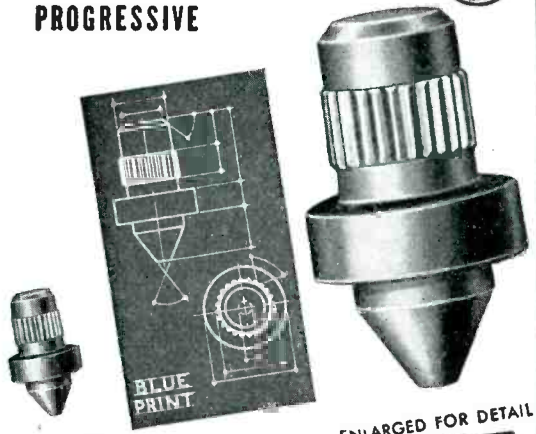
Miniature Phototubes (48)

CONTINENTAL ELECTRIC CO., Geneva, Ill. Cetron tubes CE-58 and CE-60 measure 1⅝ inches in length and have a diameter of 25/64 inch. The former tube is gas filled, has a red-sensitive surface and is available in two sensitivities, 80 or 150



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.

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 **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-2**

★ 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.

NEW YORK 242-50 W. 55th St. New York 19, N. Y. — **NEWARK ELECTRIC COMPANY, INC** — CHICAGO 323 W. Madison St. Chicago 6, Ill.

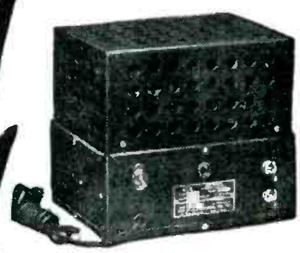
N.Y.C. Stores: 115 W. 45th St. & 212 Fulton St. Offices & Warehouse: 242 W. 55th St. N.Y. 19

NEWARK ELECTRIC COMPANY, INC. Dept R-2
Please send informative literature on the following:

NAME: ____________________
ADDRESS: ____________________
CITY: ____________ STATE: ____________

P.A. Depts. in all stores. Set & Appl. Depts. in N. Y. C.

NEW MODELS
Available Now!
of **ATR**
QUALITY PRODUCTS

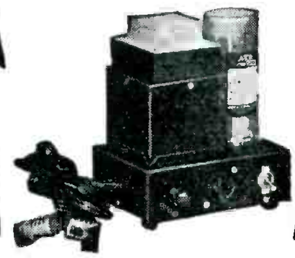


ATR "A"

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.



ATR

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.

ATR

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.

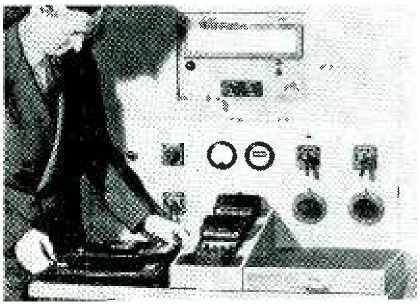
WRITE FOR NEW CATALOG— JUST OFF THE PRESS!

AMERICAN TELEVISION & RADIO CO.
Quality Products Since 1931
ST. PAUL 1, MINN. U. S. A.

microamperes per lumen. The CE-60 is blue-sensitive with either standard commercial sensitivity of 14 microamperes per lumen, or 25 for experimental use. Detailed specifications are available.

Core-Loss Tester (49)

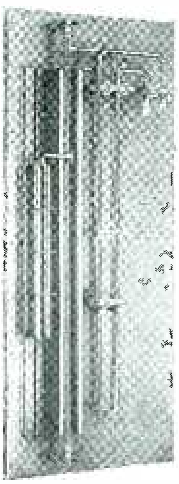
General Electric Co., Schenectady, N. Y. A new instrument to measure a-c permeability and core loss in steel samples is a self-con-



tained, desk-type unit. The apparatus meets ASTM specifications for measurements at commercial power frequencies and inductions up to 18 kilogausses.

F-M Antenna Coupler (50)

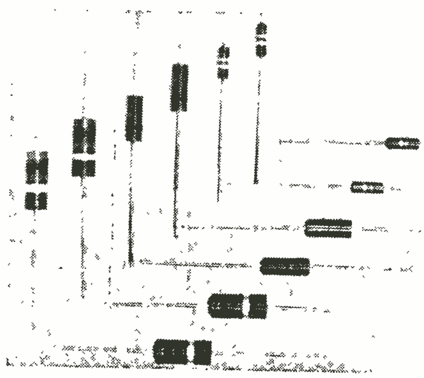
E. F. Johnson Co., Waseca, Minn. Broadcasters desirous of using existing a-m transmitting towers for



initial f-m antenna installations are often faced with the problem of feeding the new antenna without short-circuiting the a-m radiator or introducing crosstalk on the f-m frequency. The iso-coupler allows operation of 10-kilowatt f-m transmitters on 50-kilowatt a-m towers, matching 50-ohm lines from the f-m transmitter. The unit is furnished in a 94 x 37 x 24 inch outdoor cabinet.

Composition Resistors (51)

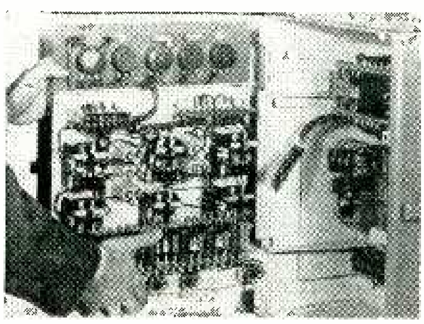
GENERAL ELECTRIC CO., Wolf St. Plant, Syracuse, N. Y. Composition resistors in standard RMA values capable of operation at full rating



up to 168 F have been announced. They are humidity-resistant and have strong pigtail leads that are heavily tinned. Up to 350 volts rms can be continuously applied across the half-watt unit and 1,000 volts across the two-watt resistor.

Welding Sequence Timer (52)

GENERAL ELECTRIC CO., SCHENECTADY, N. Y. A new line of sequence timers using electronic timing circuits has been developed. Quick change of welding sequence, easy

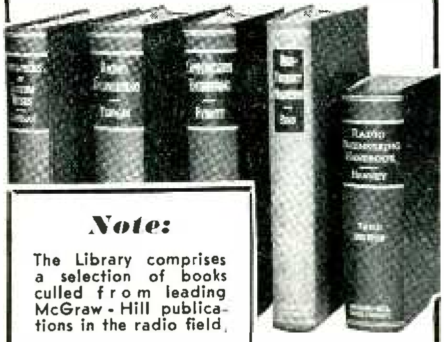


inspection and remote operation are features of the units that utilize

NOW

a really high-powered

RADIO ENGINEERING LIBRARY



Note:

The Library comprises a selection of books culled from leading McGraw-Hill publications in the radio field,

- especially selected by radio specialists of McGraw-Hill publications
- to give most complete, dependable coverage of facts needed by all whose fields are grounded on radio fundamentals
- available at a special price and terms

These books cover circuit phenomena, tube theory, networks, measurements, and other subjects—give specialized treatments of all fields of practical design and application. They are books of recognized position in the literature—books you will refer to and be referred to often. If you are a practical designer, researcher or engineer in any field based on radio, you want these books for the help they give in hundreds of problems throughout the whole field of radio engineering.

5 volumes, 2559 pages, 2558 illustrations

Eastman's FUNDAMENTALS OF VACUUM TUBES, 2nd Edition

Terman's RADIO ENGINEERING, 2nd edition

Everitt's COMMUNICATION ENGINEERING, 2nd edition

Hund's HIGH FREQUENCY MEASUREMENTS

Henney's RADIO ENGINEERING HANDBOOK, 3rd edition

SPECIAL LOW PRICE ● EASY TERMS

Special price under this offer less than cost of books bought separately. In addition, you have the privilege of paying in easy installments beginning with $2.50 in 10 days after receipt of books and $4.00 monthly thereafter. Already these books are recognized as standard works that you are bound to require sooner or later. Take advantage of these convenient terms to add them to your library now.

FOR 10 DAYS' EXAMINATION SEND THIS ON-APPROVAL COUPON

McGraw-Hill Book Co., 330 W. 42nd St., N.Y.C. 18

Send me Radio Engineering Library for 10 days' examination on approval. In 10 days I will send $2.50 plus few cents postage, and $4.00 monthly till $26.50 is paid, or return books postpaid. (We pay postage on orders accompanied by remittance of first installment.)

Name ....

Address ....

City and State ....

Company ....

Position L-11-46

For Canadian price write Embassy Book Co., 12 Richmond St. E., Toronto 1

A MOST COMPACT RHEOSTAT

Type 2462F is designed for relatively low wattage, and it fits into an exceptionally small space. From the back of the panel it measures only ¾ of an inch.

Its terminals are ideal for easy, rapid crimping and soldering.

The shaft and bushing are fully insulated from the contact mechanisms, so the rheostat can be mounted on a metal panel. And this little 10 watt rheostat is tested for 1500 volt breakdown.

Other types of Hardwick-Hindle rheostats, and our many resistors offer you valuable exclusive advantages also.

Write us today. Our engineers are always at your service.

ACTUAL SIZE OF RHEOSTAT

HARDWICK, HINDLE, INC.

RHEOSTATS and RESISTORS

Subsidiary of THE NATIONAL LOCK WASHER COMPANY

NEWARK 5, N. J. ESTABLISHED 1886 **U. S. A.**

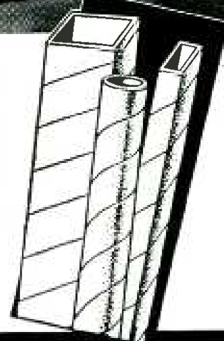
Telechron *uses* PARAMOUNT PAPER TUBES

PARAMOUNT Paper Tubes are used for coils in the field assembly of the motor in this Telechron electric clock, the "Telalarm, Jr.", as in all electric clocks made by Telechron, Inc., Ashland, Mass.

This is typical of the wide use of PARAMOUNT paper tubes by leading manufacturers of electrical, radio and electronic products. With over 15 years of specialized experience, PARAMOUNT can produce exactly the shape and size tubes you need for coil forms or other uses. Square, rectangular, or round. *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*. Samples and prices on request.

Write for Arbor List of over 1000 sizes

INSIDE PERIMETERS FROM .592" TO 19.0"



PARAMOUNT PAPER TUBE CORP.

616 LAFAYETTE ST., FORT WAYNE 2, INDIANA

Manufacturers of Paper Tubing for the Electrical Industry plug connections for quick replacement. Bulletin GEA-3318B describes the equipment in detail.

Rotary Stylus Record (53)

CONNECTICUT TELEPHONE AND ELECTRIC DIVISION, Meriden, Conn. A new inkless recorder has been designed particularly for plotting 48 complete stress-strain diagrams at one time. The size of each diagram is 5 x 2½ inches. The number of scanning cycles for 48 gages is 8 per minute with a maximum sensitivity for full diagram height of 1,000 microinches per inch.

Literature

(54)

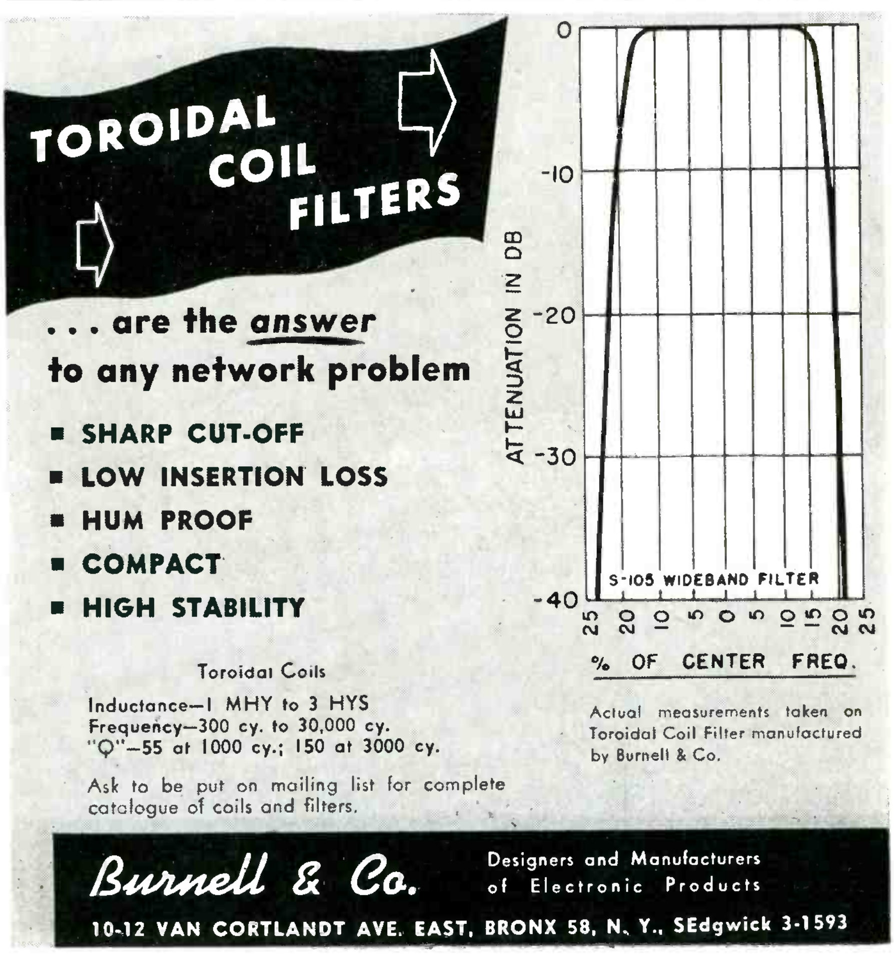
Receiver Information. Howard W. Sams & Co., 2924 East Washington St., Indianapolis, Ind. Photo Fact Folder Set No. 3 has recently been received by subscribers to the service. Each 4-page leaflet contains complete servicing information, photographs and a wiring diagram of a single broadcast receiver. When bound together, the leaflets form a complete service encyclopedia.

(55)

Fidelity Recorder. Electronic Chemical Engineering Co., 443 So. La Cienega, Los Angeles 36, Calif. The Electrone-Tone uses motion picture film for recording up to five tracks on a 16-mm strip. Other widths give a corresponding increase or decrease in the number of tracks. Film is developed in the conventional manner. A four-page booklet illustrates the equipment that is said to record up to 10,000 cycles.

(56)

Colloidal Graphite. Acheson Colloids Corp., Port Huron, Mich. Electronic applications of colloidal graphite for shielding, cathode-ray tube anode manufacture and building resistance layers



are well known. A new technical bulletin presents the uses and characteristics of "dag" solutions.

(57)

Technical Publication Resumed. Collins Radio Co., Cedar Rapids, Iowa. "The Collins Signal" will shortly resume publication after a lapse of several years. Engineers desiring the free publication should write the editor.

(58)

Diffusion Pump Fluids. Dow Corning Corp., Midland, Mich. A pamphlet describes a method of obtaining high vacuums up to 5×10^{-8} by use of silicone fluids DC702 and DC703 to eliminate breakdown of pumps formerly using low-vapor-pressure fluids.

(59)

Fiber Insulation. Continental-Diamond Fibre Co., Newark, Delaware. Bulletin GF16 describes a half dozen types of insulating materials, their electrical and mechanical properties and possible uses in a 14-page booklet.

(60)

Rectifier Ratings. General Electric Co., Schenectady, N. Y. The industrial phanotron FG-32 is a low-frequency, low-voltage, high-current rectifier tube. Increased temperature ratings have just been announced and are listed in a publication of the Tube Division.

(61)

Rectifiers. W. Green Electric Co., Inc., 130 Cedar St., New York 16, N. Y. Three new rectifier publications and a file folder summarize the company's bench and telegraph type products.

(62)

Ship-to-Shore Radiophone. Radiomarine Corp. of America, 75 Varick St., New York 13, N. Y. Model ET-8027 radiotelephone equipment has six crystal-controlled channels and a power output of 25 watts. It operates in the frequency range

TERMINALS
for ELECTRIC WIRES

Condenser Plates

Small Metal Stampings

- *in accordance with Customer's Prints*

- **ACCURACY**
- **PRECISION**
- **REASONABLE DIE CHARGES**

Modern Equipment and Factory

No Screw Machine Parts

PATTON-MacGUYER COMPANY
17 VIRGINIA AVENUE
PROVIDENCE, R. I.

(Patent Pending)

"DIALCO" PLN-849 *Pilot Lights*

Designed for the New Neon-51 Lamp

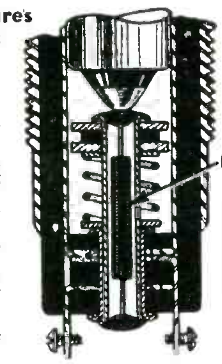
Feature BUILT-IN RESISTORS

For 110 Volts (and higher)

A RUGGED UNIT. Consumes a small amount of current (under one milliampere) and has dependable long life.

Note these important features of the PLN-849 Pilot Light:

(1) RESISTOR INTEGRAL with socket assembly. Value to suit supply voltage.
(2) Moulded Bakelite Socket.
(3) Full-view Jewel Plastic Cap for visibility at all angles.
(4) Rugged terminals, binding screw or permanent soldering type.
(5) High resistance to vibration or shock.
(6) Supplied complete with General Electric Neon NE-51 Bulbs. May also be adapted to accommodate General Electric Radio Panel Bulbs such as 47, 44, etc., for low voltage circuits. Bulbs removable from front of panel.



DIALCO

Dialco Pilot Lights, in thousands of variations, are **UNDERWRITERS' LABORATORIES** *listed.*

WRITE FOR NEW ILLUSTRATED BROCHURE

DIAL LIGHT CO. *of America, Inc.*
900 BROADWAY • NEW YORK 3, N. Y.
Telephone: ALgonquin 4-5180-1-2-3

BOOKS
FOR THE
ENGINEER

UNDERSTANDING MICROWAVES
(Chapter Heads)

The Ultra High Frequency Concept Stationery Charge and its Field • Magnetostatics • Alternating Current and Lumped Constants • Transmission Lines Poynting's Vector and Maxwell's Equations • Waveguides • Resonant Cavities • Antennas • Microwave Oscillators • Radar and Communication • Section Two is devoted to descriptions of Microwave Terms, Ideas and Theorems. Index.

400 PAGES — PRICE $6.00

A-C CALCULATION CHARTS

Student engineers will find this book invaluable. Simplifies and speeds work. Covers all AC calculations from 10 cycles to 1000 megacycles.

160 PAGES — PRICE $7.50

JOHN F. RIDER, Publisher, Inc.
404 FOURTH AVENUE, NEW YORK 16, N. Y.
EXPORT DIV.: ROCKE-INTERNATIONAL ELEC. CORP.
13 E. 40TH STREET, NEW YORK CITY   CABLE ARLAB

Laboratory Standards

PULSE GENERATOR

MODEL 79-B

SPECIFICATIONS:

FREQUENCY: continuously variable 60 to 100,000 cycles.
PULSE WIDTH: continuously variable 0.5 to 40 microseconds.
OUTPUT VOLTAGE: Approximately 150 volts positive.
OUTPUT IMPEDANCE: 6Y6G cathode follower with 1000 ohm load.
R. F. MODULATOR: Built-in carrier modulator applies pulse modulation to any r.f. carrier below 100 mc.
MISCELLANEOUS: Displaced sync output, individually calibrated frequency and pulse width dials, 117 volt, 40-60 cycles operation, size 14"x10"x10", wt. 31 lbs.

Immediate Delivery

MEASUREMENTS CORPORATION
BOONTON • NEW JERSEY

2,000 to 3,500 kilocycles and is fully described in a 4-page bulletin PC101.

(63)

Thermal Relay. Thomas A. Edison, Inc., West Orange, N. J. The model 501 thermal relay is in effect a thermal time-delay device, preset and sealed. Publication No. 3007X tells all about it.

(64)

Contract Manufacturer. Lewyt Corp., 60 Broadway, Brooklyn 11, N. Y. Some of the manufacturing facilities and contracting arrangements of the company are described in newspaper clipping pasteup form bound into a 16-page brochure.

(65)

Connectors. Cannon Electric Development Co., 3209 Humboldt St., Los Angeles 31, Calif. Descriptive of applications is a 78-page looseleaf book picturing Cannon plugs. There is no specific engineering or ordering information in this interesting publication.

TELEVISION OVER BIKINI

Practicing for the atom bomb tests at Bikini, Captains Davis and Seldomridge direct the takeoff of a pilotless B-17. The television receiver in the foreground shows the instrument panel of the bomber while the small control box is used to direct the takeoff and landing. The mother plane controls the B-17 in the air

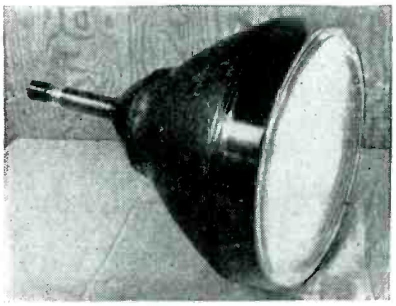
DIALS PLATES PANELS

For thirty-five years we have been leaders, specializing in the creation and production of distinctive etched and lithographed products.

We serve the leaders of many industries, meeting their high standards of quality and precision workmanship.

Send for new pamphlet

Premier
METAL ETCHING COMPANY
21-03 FORTY FOURTH AVENUE
LONG ISLAND CITY NEW YORK



NEW 15" TUBE *for Television*

High Vacuum, High Brilliance, Magnetic Focus & Deflection, Black & White Screen. Length 20¼", Face Plate approximately Flat. Operates anywhere from 8,000-15,000 Volts, best at 12,500 Volts. Write for full data. Also in production 12-inch magnetic tubes.

NO ION SPOTS — NO ION TRAP

ZETKA LABORATORIES, INC.

131 GETTY AVE., CLIFTON, NEW JERSEY

Affiliated with

UNITED STATES TELEVISION MFG. CORP.

ARGON	HELIUM	KRYPTON
NEON	XENON	MIXTURES

Linde

RARE GASES AND MIXTURES

... Spectroscopically Pure

... Easily removed from bulb without contamination

Scientific uses for LINDE rare gases include—

1. The study of electrical discharges.
2. Work with rectifying and stroboscopic devices.
3. Metallurgical research.
4. Work with inert atmospheres, where heat conduction must be increased or decreased.

Many standard mixtures are available. Special mixtures for experimental purposes can be supplied upon request.

The word "Linde" is a trade-mark of

THE LINDE AIR PRODUCTS COMPANY
Unit of Union Carbide and Carbon Corporation
30 E. 42nd St., New York 17 [UCC] Offices in Principal Cities
In Canada: Dominion Oxygen Company, Ltd., Toronto

The STOUT HEART of *World Famous Hathaway* OSCILLOGRAPHS is the Type OA-2 Galvanometer

Bifilar moving element, low mass, ultra-simple, takes less driving energy.
Complete in one unit, with magnet and universal mounting.
Natural frequency, 10,000 cycles per sec. Sensitivity to 50 millimeters per milliamperes at one meter.

There's a HATHAWAY Oscillograph to meet every requirement — Hathaway specialized service to help apply it to your problems. Write for information on Hathaway Oscillographs and Oscillograph Galvanometers. Hathaway Instrument Company, 1315 S. Clarkson St., Denver 10, Colorado.

Hathaway INSTRUMENTS

NEWS OF THE INDUSTRY

Edited by JOHN MARKUS

Rochester Fall Meeting announcement; radio production for August; color television demonstration; meetings to come

New RMA Tube Designations and Wiring Standards

TWO NEW RMA standards, a chassis wiring color code and a new type designation system for tubes other than receiving and cathode-ray types, have been approved by the Engineering Department of Radio Manufacturers Association and are now in effect among its members.

Where color coding is used, it shall be standard to employ the following schedule of solid colors for chassis hookup and component-lead wire insulation:

Black—Grounds, grounded elements, & returns
Brown—Heaters or filaments, off ground
Red—Power supply B plus
Orange—Screen grids
Yellow—Cathodes
Green—Control grids
Blue—Plates
Violet—Not used
Gray—A-C power lines
White—Above or below ground returns, avc, etc

For tubes and devices exclusive of receiving and cathode-ray tubes, the type designation shall consist of a pure numeric starting with 5500 and shall be assigned consecutively and chronologically in the order of type number request. A new type designation shall be assigned to a new version of a prototype whenever the new version is not completely interchangeable with the prototype. Whenever a new designation is assigned to a type which is unilaterally interchangeable with a former type, such interchangeability may be indicated by marking the new type with its assigned designation followed, at the option of the manufacturer, by the designation of the former type. The new system is not retroactive. Typical type designations are 5501, 5712, 5923, 6234, and 6545, as contrasted to designations like 1C23, 1N35, and 6D25 under the system previously in effect.

Moscow Radio Meeting

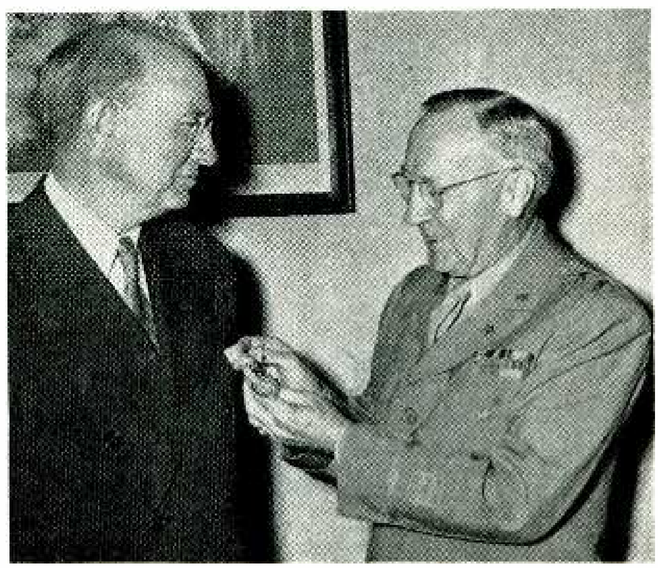
A FOURTEEN-MAN delegation from various government agencies represented the United States at a five-power preliminary telecommunications meeting held in Moscow recently for informal preliminary discussions aimed at convening of a world telecommunications conference sometime in 1947. This conference would revise the Madrid telecommunication convention of 1932, now in effect.

Navy Expands Training of Electronic Technicians

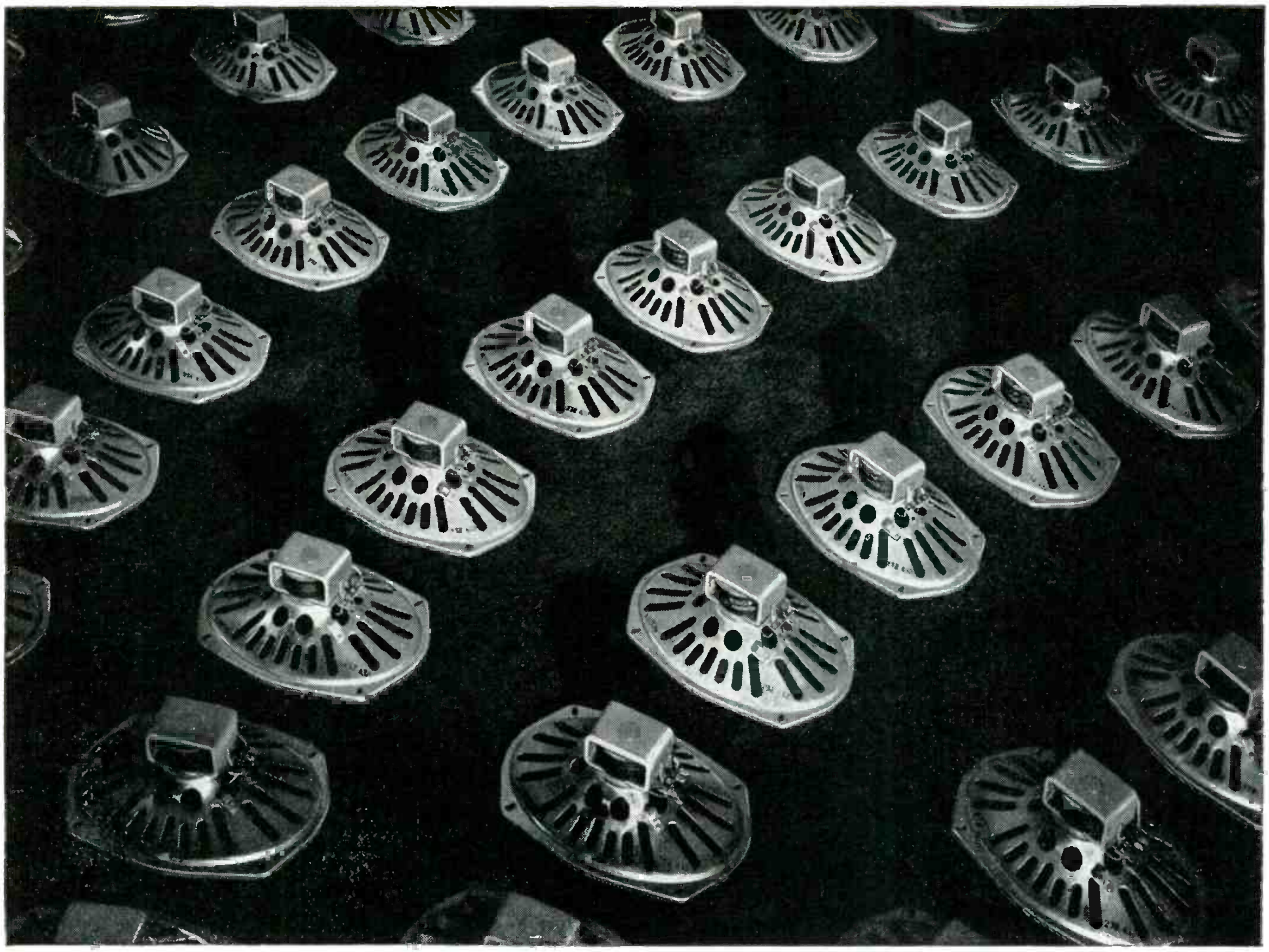
THE BASIC COURSE for electronic technician's mates in the Navy has been broadened from 20 weeks to 42 weeks, with classroom and

"....PRODUCED MORE THAN FIFTY PERCENT OF ALL RADAR...."

Clarence G. Stoll, president of Western Electric Co., receives the Medal for Merit, nation's highest civilian award, from Major General Harry C. Ingles, Chief Signal Officer. The accompanying citation reads in part, "Under his direction and outstanding leadership his Company produced more than 30 percent of all electronic and communications equipment and more than 50 percent of all radar manufactured in this country during the war."



Oliver E. Buckley, president of Bell Telephone Laboratories, also received from General Ingles on September 26, 1946 the Medal for Merit. The citation, signed by President Truman, reads in part, "He displayed great foresight by expediting development . . . even before its military value had become apparent, and his leadership was reflected in the highly effective collaboration of scientists and technicians. . . ."



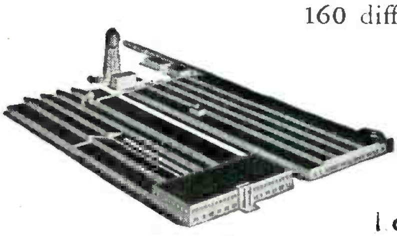
Almost every radio set made in recent years has a Magnavox speaker or other Magnavox components.

MAGNAVOX . . . first and foremost in the production of quality speakers

FOR 35 years Magnavox has specialized in speakers and speaker satisfaction. The oldest and largest manufacturer of loud speakers, Magnavox is established as *the standard of quality*.

Magnavox designers and engineers have achieved a breadth of experience and knowledge that enables them to meet your specifications exactly. Over 160 different speakers are produced expressly for the manufacturing trade.

Hard-to-satisfy research engineers constantly seek better speaker designs and production methods. They stand ready to apply their developments to your speaker problems. When you need speakers, specify Magnavox. There is no substitute for experience. The Magnavox Company, Components Division, Fort Wayne 4, Indiana.



Magnavox

has served the radio industry for over 30 years

SPEAKERS • CAPACITORS • ELECTRONIC EQUIPMENT laboratory instruction increased from 800 hours to 1,680 hours. Upon completion, the students receive practical experience at sea or shore stations before becoming eligible for the 28-week advanced course. These two courses cover radio, radar, sonar, loran, and other recently developed applications of a secret or confidential nature. In addition, advanced and specialized courses in specific equipments such as blind-landing and television are given.

Revisions in Program of Rochester Fall Meeting

THE TECHNICAL program of the Rochester Fall Meeting, scheduled for Nov. 11, 12, 13 at the Sheraton Hotel, Rochester, N. Y., has been modified from the setup given on page 262 of the Oct. 1946 issue as follows:

Monday Nov. 11, 2:00 p.m. session, add Measurement Methods for Ferromagnetic Materials, by H. W. Lamson of General Radio Co., and remove this paper from the last Wednesday session.

Tuesday Nov. 12, 9:30 a.m. session, Some New Tube Developments will be presented by F. E. Gehrke of Sylvania Laboratories instead of M. A. Acheson. An additional paper in this session is Wide Band I-F Amplifiers Above 150 MC, by M. T. Lebenbaum of Airborne Instruments Laboratory, Inc.

Wednesday Nov. 13, 9:30 a.m. session, add Application of Selenium Rectifiers to Receiver Designs, by H. Heins and T. M. Liimatainen of Sylvania Electric Products Inc. 2:00 p.m. session, add High Frequency A-M Broadcasting Designed for Small Community Use, by Sarkes Tarizan, A. Valdettaro, and M. Weijdel, consulting engineers. 8:00 p.m. photographic session—Recent Developments in Color Photography, by A. L. TerLouw of Eastman Kodak Co.

August Radio Output

A TOTAL OUTPUT of 1,442,757 radio sets was reported for August by RMA member-companies, and the corresponding Bureau of Census figure is 1,700,000 sets by the entire industry. RMA figures break down into 101,744 console and radio-phonograph combinations, 13,892 f-m sets, 1,030,183 table models of the electric type, and the rest battery and auto sets.

The latest OPA list of radio manufacturers includes names of 211 producers and 20 nonproducers of radio sets, along with 176 manufacturers and 10 nonmanufacturers

MICROPHONE NEWS

The **NEW** *St. Louis* **OUTDOOR RUGGED**

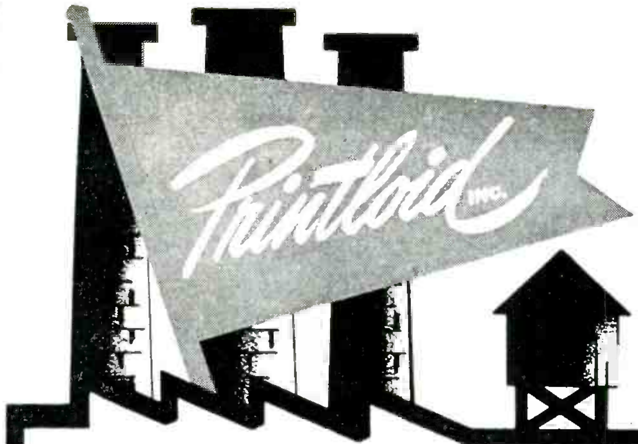
MICROPHONE

One of the "Finest Line of Modern Dynamic Microphones." Each engineered to fit your specific applications. Modern design—Rugged construction. Ranges: 40 to 9000 Cycles. Built to take the toughest treatment under the worst operating and climatic conditions. Alnico-V Magnet. Variable impedance output adjustable to low, 200, 500 or high. Gunmetal Gray, Black Lacquer or Olive Drab Finishes.

Write today for further information on the Complete St. Louis Line.

Licensed under patents of the American Tel. & Tel. Co. and Western Electric Company, Inc.

ST. LOUIS MICROPHONE CO.
2726-28 Brentwood Blvd.
St. Louis 17, Missouri



Complete plastic fabrication

"ALL UNDER ONE ROOF"

Measuring 1¾" x 2½" x 1⅞", this acrylic stand-off insulator holds vertical whip antennas erect in marine radio installations. A brass strip with wing nut swings open to permit easy removal for low-bridge underpassing. This is another typical example of Printloid's ingenuity with plastics.

Write for our new 1946 catalog of special plastic fabrications.

"The House That Plastic Built"

Printloid INC.
PLASTIC FABRICATION
DEPT. E
93 MERCER STREET, NEW YORK 12, N. Y.

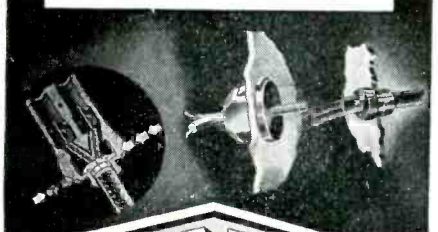
HEYCO SOLDERING LUGS

Available in various sizes and shapes. These copper lugs are easy to apply. Samples free.

HEYCO STRAIN RELIEFS

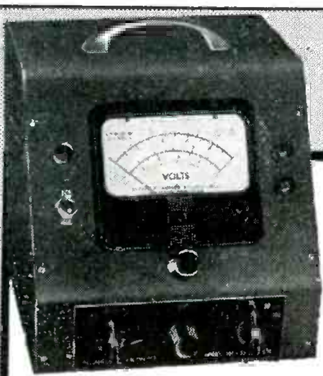
Three low-cost types. Prolong appliance life ... Improve product performance ... Act as grommet. Samples and literature.

HEYMAN MANUFACTURING CO.
510 Michigan Ave. Kenilworth, N. J.



HEYCO

VOLTMETERS FOR EVERY RF NEED...



Permanent accuracy, high stability and impedance input! You get all three with each of these three voltmeters. Suitable for laboratory, test bench or production line! Each has a frequency and voltage range adaptable to your particular needs . . . sturdy construction; easy-to-read meter scales!

STANDARD ELECTRONIC VOLTMETER MODEL VM-27A

RANGE: 0.1 to 100 volts in five ranges a-c and d-c. (1, 3, 10 and 100 volts full scale.)
ACCURACY: 2 percent of full scale on all ranges, on sinusoidal voltages.
CALIBRATION: Calibrated to read 0.707 of peak on a-c voltage, hence r.m.s. of a sinusoidal wave.
FREQUENCY RANGE: 2 cycles to over 100 megacycles with full accuracy from 50 cycles to 50 megacycles.
INPUT IMPEDANCE: d-c input 7 megohms, a-c input 4 megohms at audio frequencies and at radio frequencies equivalent to a capacity of 5 micro-microfarads having a power factor of 0.5 percent.
POWER SUPPLY: 105 to 125 volts 50-60 cycles at 30 watts.
TUBES: one 6H6 in probe, two matched 6J5GT and one 6X5GT rectifier.
DIMENSIONS: 8x8x8, probe 2 inches diameter, by 4 inches long.
WEIGHT: 11 lbs. less probe.
PRICE: $150.00 net, F.O.B. Flushing, N. Y.

MODEL VM-27-ZC

Same as Model VM-27A, but with means for setting meter to mid-scale on d-c.
PRICE: $155.00 net, F.O.B. Flushing, N. Y.

WRITE FOR DESCRIPTIVE BULLETINS

HIGH FREQUENCY ELECTRONIC VOLTMETER MODEL 32

RANGE: 0.3 to 300 volts r-f in five ranges (3, 10, 30, 100 and 300 volts full scale).
ACCURACY: 5 per cent of full scale on all ranges, on sinusoidal voltages.
FREQUENCY RANGE: 500 kilocycles to 500 megacycles.
INPUT IMPEDANCE: 0.5 to 1 micro-microfarad at a Q of about 200.
POWER SUPPLY: 115 volts 60 cycles at 30 watts.
TUBES: One 6AL5 in probe, two matched 6J5GT and one 6X5GT rectifier.
DIMENSIONS: 5½x9½x9½.
WEIGHT: 8 lbs.
PRICE: $99.50 F.O.B. Flushing, N. Y. (net)

HIGH VOLTAGE ELECTRONIC VOLTMETER MODEL 31

RANGE: 10 to 10,000 volts r-f in five ranges (100, 300, 1000, 3000 and 10,000 volts full scale).
ACCURACY: 5 percent of full scale on all ranges, on sinusoidal voltages.
FREQUENCY RANGE: 100 kilocycles to 100 megacycles.
INPUT IMPEDANCE: Approximately 1 micro-microfarad at a Q of over 500.
POWER SUPPLY: 115 volts 60 cycles at 30 watts.
TUBES: One 6AL5 in probe, two matched 6J5GT and one 6X5GT rectifier.
DIMENSIONS: 5½x9½x9½.
WEIGHT: 8 lbs.
PRICE: $99.50 net, F.O.B. Flushing, N. Y.

ALFRED W. BARBER LABORATORIES ★ 34-06 FRANCIS LEWIS BLVD. FLUSHING • NEW YORK

of phonographs. OPA officials believe that many newcomers dropped out upon receiving unsatisfactory price ceilings or have stopped producing as well-known brands became plentiful.

Live Pickup Demonstrated with UHF Color Television

SUCCESSFUL DEMONSTRATION of color television for live pickups has been announced, using a studio-type orthicon. Images were viewed in a fully lighted room. Color breakup in fast sports scenes such as boxing was not discernible, according to the CBS press release. Remote live pickup color equipment for both outdoor and indoor events is scheduled for operation by the end of the year. A new aluminum-backed cathode-ray receiving tube that concentrates the light on the viewing screen was used in the receivers.

Radio for Private Fliers

TWO NEW FREQUENCIES to be used by private aircraft will be guarded by the Civil Aeronautics Administration beginning Jan. 1, 1947. These are 121.1 mc for air to ground communication, and 122.5 mc for air to ground communication at airport control towers. The present frequencies 131.7 and 131.9 mc for these purposes will continue to be guarded. It is expected that some time may elapse before all municipal and private airports acquire the necessary vhf equipment to match this CAA service for private fliers.

MEETINGS TO COME

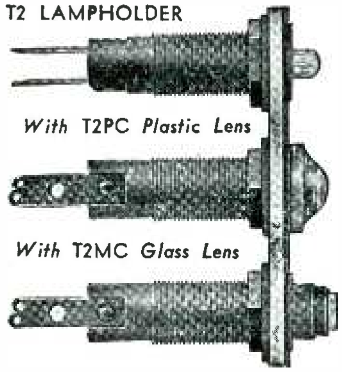
NOV. 11-13; ROCHESTER FALL MEETING; Sheraton Hotel, Rochester, N. Y.; technical papers and exhibits.

NOV. 11-14; INTERNATIONAL MUNICIPAL SIGNAL ASSOCIATION; Annual Meeting; Miami, Florida; technical program and exhibits

KIRKLAND Pioneer
INDICATING LAMPS

TYPE T2 UNITS

T2 LAMPHOLDER



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.

• The meeting of extraordinary applications—the designing and developing of new and specialized transformers—these are the day-by-day jobs Electronic Engineering is known for doing well.

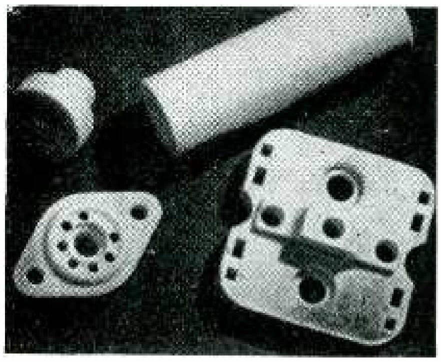
ELECTRONIC *Engineering* COMPANY INC.

Transformers

will meet your most exacting requirements, ordinary or unique—and the finest engineering talent and most complete electronic laboratories available are ready today to consult with and help you.

"SPECIALIZED *Transformer* ENGINEERS"

Electronic Engineering Company, Inc., 3223-9 W. Armitage Ave., Chicago 47, Ill.



Lavite STEATITE CERAMIC

Properties and Characteristics of Our LAVITE S1-5 Steatite Ceramic Body

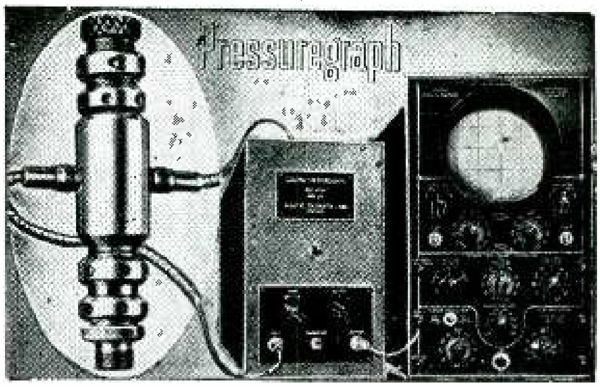
Compressive Strength	96,000 lbs. per square inch
Tensile Strength	7,200 lbs. per square inch
Flexural Strength	10,500 lbs. per square inch
Modulus of Rupture	20,000 lbs. per square inch
Dielectric Strength	235 volts per mil
Dielectric Constant	6.42 (Frequency of 1 megacycle)
Loss Factor	2.90 (Frequency of 1 megacycle)
Power Factor	.446 (Frequency of 1 megacycle)
Bulk Specific Gravity	2.664%
Density (from above gravity)	0.096 lbs. per cubic inch
Hardness (Mohr scale)	7.0
Softening Temperature	2.350°F.
Linear Coefficient of Expansion	8.13×10^{-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

New! PRESSUREGRAPH
LINEAR PRESSURE — TIME — CURVE INDICATOR



Indicates in linear response, on screen of cathode ray oscillograph, the pressure - time - curve of any internal combustion engine, pump, airline, or other pressure system where pressure measurements are desired. Covers wide range of engine speeds and pressures up to 10,000 p.s.i. Screws into cylinder and can be calibrated using static pressures. Vibration-proof. Accurate, dependable for frequent engine tuning. Simple operation — only one control.

Also Pioneer Manufacturers of

THE FAMOUS *Electro* BATTERY ELIMINATORS

A complete line — Models for use anywhere beyond high line connections (operate from 6 volt battery) — Others for operation from 110 volt AC. Improve radio reception. Greatly reduce battery drain.

For complete information write

ELECTRO PRODUCTS LABORATORIES
549 W. Randolph St., Chicago 6, Ill. Phone STate 7444

cover fire and police radio, signaling, etc.

Nov. 19-21; COMMUNICATIONS SECTION, ASSOCIATION OF AMERICAN RAILROADS; Annual Session; Hotel Statler, Detroit, Mich.; four papers on communications subjects.

Nov. 18-22; THE NATIONAL METAL EXPOSITION; Municipal Auditorium, Atlantic City, N. J.; held in conjunction with annual meetings of The American Industrial Radium and X-ray Society, The American Welding Society, The American Society for Metals, and two sections of the American Institute of Mining and Metallurgical Engineers. Of more than 70 technical papers to be delivered at ASM meetings, one each day in the afternoon will be devoted to Electronic Methods of Inspection of Metals.

DEC. 2-7; NATIONAL POWER SHOW Grand Central Palace, New York City.

DEC. 5-7; JOINT EMSA AND ASXRED WINTER MEETING; Mellon Institute of Industrial Research and Univ. of Pittsburgh, Pittsburgh, Pa.; sponsored by Electron Microscope Society of America and American Society for X-ray and Electron Diffraction; make dinner reservations with Dr. Max Lauffer, Univ. of Pittsburgh.

JAN. 23-26; SOCIETY OF THE PLASTICS INDUSTRY; technical papers and exhibit; Edgewater Beach Hotel, Chicago.

JAN. 27-31; ELECTRICAL ENGINEERING EXPOSITION; held concurrently with AIEE winter convention; 71st Regiment Armory, New York City.

JAN. 27-31; INTERNATIONAL HEATING AND VENTILATING EXPOSITION; Lakeside Hall, Cleveland, Ohio.

BUSINESS NEWS

BENDIX AVIATION CORP. has been for many months engaged in research on controls and engine accessories for guided missiles and pilotless aircraft, with Dr. Harner Selvidge, formerly of Johns Hopkins University, as director. Two laboratories are devoted exclusively

Optical Glass Specialties

Television Reflectors

Precision-polished optical face plates for cathode ray tubes

Optical lenses, prisms and flats

FS Precision-Bore Glass Tubes with bore exact within .0002"

Contact us for such requirements

FISH-SCHURMAN CORPORATION
230 East 45th St., New York 17, N. Y.

Fish-Schurman

S.S.White MOLDED RESISTORS

The "All-Weather" Resistors

TYPE 65X

Actual Size
Other types available in the lower values

RESISTOR BULLETIN 4505 GIVES FULL DETAILS . . .

It shows illustrations of the different types of S. S. White Molded Resistors and gives details about construction, dimensions, etc. A copy, with Price List will be mailed on request. Write for it—today.

- 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 DIVISION
THE S. S. WHITE DENTAL MFG. CO.
DEPT. K, 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

Free Radionic Catalog

RADIONIC EQUIPMENT CO.
170 Nassau St., Dept. 4011, New York 7, N. Y.

Please send me a FREE copy of your 1947 Catalog. I understand it has thousands of items illustrated, described and priced and will be a great help to me in my search for "hard-to-find" radio equipment.

Name ....
Address ....
City .... State........

GRACOIL

"One Good Turn – or a Million"

★ Here, in expanded plant facilities, GRACOIL Coils and Transformers are expertly designed and built to exact specifications. Plan your next product with GRACOILS.

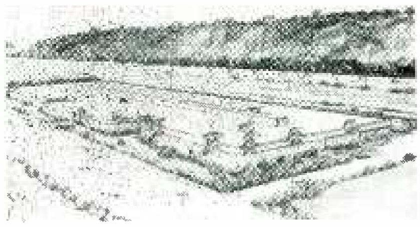
THE GRAMER COMPANY
Established in 1935
Electrical Coils and Transformers
2736 N. PULASKI RD., CHICAGO 39, ILL. U. S. A.

to this work, one at the Eclipse-Pioneer division in Teterboro, N. J. with R. Beardsley Graham as chief engineer, and the other at the Pacific division in North Hollywood, California with Rollin M. Russell as executive engineer.

NORTH AMERICAN PHILIPS CO., INC. has moved its Wire Division from Dobbs Ferry, N. Y. to Lewiston, Maine. A new addition has been erected to house the added production operations there.

A. W. FRANKLIN MFG. CORP. has relocated in a modern new building at 43-20 34th St., Long Island City, N. Y.

THE INDIANA STEEL PRODUCTS CO. has acquired approximately 14 acres of land along the Saw Mill River Parkway in Greenburgh, New York



Artist's sketch of new magnet plant

as a site for their proposed new and ultramodern plant to be used largely for production of special products in the permanent magnet field.

SENTINEL LABORATORIES, Philadelphia, Pa., has opened an electronics engineering service for research, design, and development.

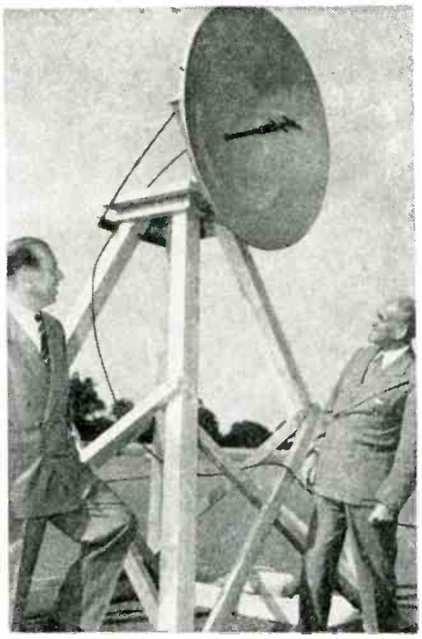
STERLING ELECTRONIC CO., Pasadena, Calif., has been formed recently with J. S. Jackson, Jr., as president, and production of electronic volt-ohmmeters is under way.

FARNSWORTH TELEVISION & RADIO CORP., Fort Wayne, Ind., demonstrated a complete vhf railroad radio communications system at Potomac Yard, Washington, D. C. Sept. 11 for railroad, government, military, civic, press, and radio representatives.

MCGRAW-HILL BOOK CO., INC., New York, N. Y. announces a change of policy whereby catalog descriptions of their books will contain the year of publication or last revision. Prices on approximately 90 percent

of their books were raised as of July 1, 1946 to meet increased costs.

FEDERAL TELECOMMUNICATION LABORATORIES, Nutley, N. J., demonstrated to the press Sept. 9 an adaption of I.T.&T.'s pulse time modulation system whereby eight



Parabolic antenna used in eight-channel ptm demonstration, with Henri [illegible]signies (left) and H. H. Buttner, director and president respectively of Federal Telecommunication Laboratories

separate radio broadcast programs can be placed on one carrier frequency and radiated over one antenna.

BARKER & WILLIAMSON, Upper Darby, Pa., have leased a new factory building in Bristol, Pa. for special and developmental work.

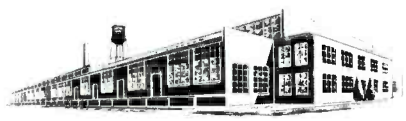
BENDIX RADIO DIVISION, Baltimore, Md. has been granted an experimental license by the FCC for a full-color television broadcasting station, to be located in their Towson, Md. plant.

WORNER ELECTRONIC DEVICES, Chicago, is moving into its own new plant in Rankin, Illinois.

PHILCO CORPORATION, Philadelphia, has started production of radio-phonograph combinations in its new $2,250,000 plant in Philadelphia, adjoining the main Philco plants. When in full operation, the

new plant will have continuous radio production lines claimed to be the longest in the world.

ELECTRO-VOICE has combined all facilities of its three South Bend



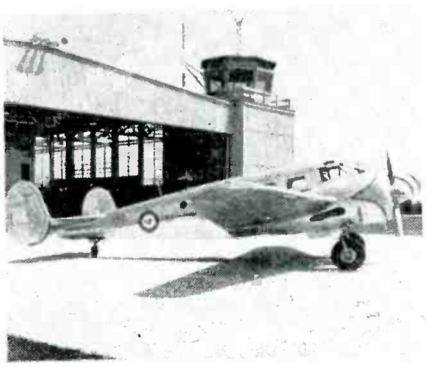
New Electro-Voice plant for manufacturing complete line of microphones

plants in one big modern plant 14 miles north in Buchanan, Michigan.

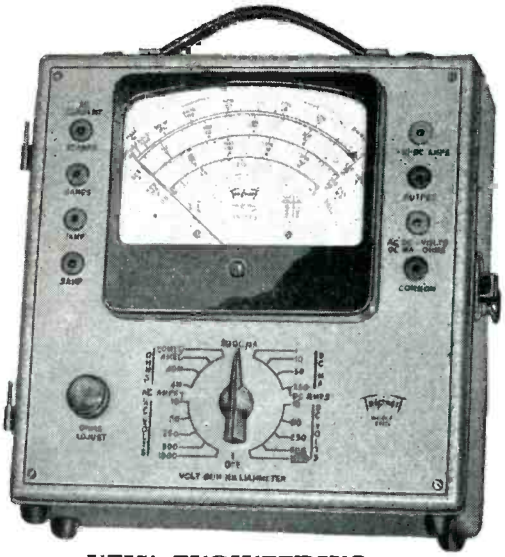
RADIO ENGINEERING LABORATORIES, INC., Long Island City, N. Y. has tentatively scheduled for Dec. 2, 3, and 4 an f-m engineering clinic to be headed by Frank A. Gunther, devoted to review of f-m theory and solution of problems facing f-m broadcast station engineers. REL engineers and outstanding engineers in the f-m field will participate.

RCA VICTOR DIVISION, Camden, N. J. has made initial deliveries of land and mobile f-m transmitters and receivers to the three Bell System companies that will provide two-way highway radiotelephone service on or in the vicinity of the Boston Post Road running between New York and Boston. Six 250-watt land transmitters will be used, operating in the 30-44 mc band.

COLLINS RADIO CO., Cedar Rapids, Iowa, maintains a technical staff at its private hangar on Cedar Rapids Municipal airport, for the purpose



Beechcraft on apron of Collins hangar after installation of Collins type 17H-2 multi-channel transmitter



MODEL 2405
Volt • Ohm Milliammeter
25,000 OHMS PER VOLT D.C.

STANDARDS ARE SET BY TRIPLETT

NEW ENGINEERING
NEW DESIGN • NEW RANGES
30 RANGES

Voltage: 5 D.C. 0-10-50-250-500-1000 at 25000 ohms per volt.
5 A.C. 0-10-50-250-500-1000 at 1000 ohms per volt.
Current: 4 A.C. 0-.5-1-5-10 amp.
6 D.C. 0-50 microamperes—0-1-10-50-250 milliamperes—0-10 amperes.
4 Resistance 0-4000-40,000 ohms—4-40 megohms
6 Decibel -10 to +15, +29, +43, +49, +55
Output Condenser in series with A.C. volt ranges

SPECIFICATIONS

NEW "SQUARE LINE" metal case, attractive tan "hammered" baked-on enamel, brown trim.

■ PLUG-IN RECTIFIER—replacement in case of overloading is as simple as changing radio tube.

■ READABILITY—the most readable of all Volt-Ohm-Milliammeter scales—5.6 inches long at top arc.

Model 2400 is similar but has D. C. volts Ranges at 5000 ohms per volt.

Write for complete description

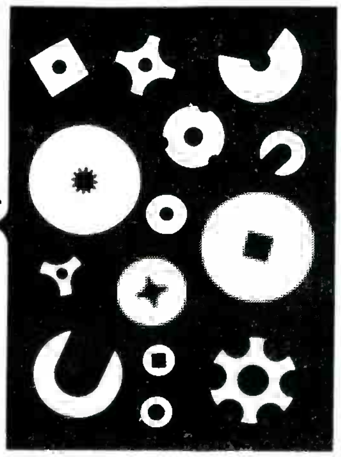
Triplett
ELECTRICAL INSTRUMENT CO.
BLUFFTON ■ OHIO

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.

DESIGNED FOR PRECISION JOBS.

THE QUADRIGA MFG. CO.
221-A W. Grand Ave., Chicago 10, Ill.



- 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

MICRO-DIMENSIONAL
WIRE & RIBBON for VACUUM TUBE FILAMENTS & GRIDS

- Many sizes and alloys for a range of applications such as miniature tubes, hearing aid tubes, low-current-drain battery tubes, receiving tubes . . .
- Melted and worked to assure maximum uniformity and strength. WIRES drawn to .0004" diameter; RIBBON rolled to .0001" thickness . . .
- Wollaston Process Wire drawn as small as .000010"; made to your specifications for diameter and resistance.

SPECIAL ALLOYS made to meet individual requirements. Write for list of stock alloys.

SIGMUND COHN & CO.
44 GOLD ST. NEW YORK
SINCE 1901

of installing Collins radio equipment in aircraft.

DORMITZER ELECTRIC & MFG. CORP., Boston, Mass. has been formed by combining facilities and personnel of Wholesale Radio Laboratories and American Coil Co., and will manufacture industrial x-ray units, transformers, amplifying systems, and electromechanical devices as well as custom equipment.

PERSONNEL

ARTHUR H. JONES, now with Gray Mfg. Co., Hartford, Conn., was awarded the Legion of Merit for his wartime services as Lieutenant Colonel in the Coast Artillery Corps, where he devised new and improved methods for radar spotting of mortars.

HENRY LAVIN, recently discharged from the Navy as chief radio technician, received an appointment as field engineer for Kahn and Co., Hartford, Conn.

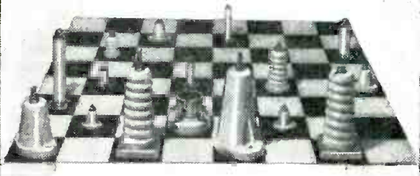
L. MORGAN CRAFT has been elected vice-president in charge of engineering and manufacturing for The Collins Radio Co., Cedar Rapids, Iowa. Within a few years after joining the Collins organization in 1935 he was made chief engineer, and since then has assumed increasingly greater administrative responsibilities.

L. M. Craft

W. N. Tuttle

W. N. TUTTLE of General Radio Co. received the Medal of Freedom for distinguished work in adapting blind bombing equipment and technique for introduction into the Eighth Air Force.

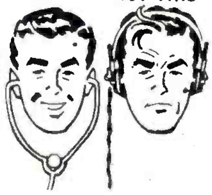
EDWARD E. SCHULTZ, chief engineer of Press Wireless during the war, *Your best move* IS **BIRNBACH'S**



CERAMIC PORCELAIN & INSULATORS for every purpose

Since 1923

BIRNBACH RADIO CO., Inc.
145 HUDSON ST. N.Y. 13, N.Y.



Man, Here's *Comfort* for EARS!

Complete with light plastic cord and standard phone plug.

That's right, mister. The Telex MONOSET replaces hot, headache-y, old-style headphones wherever comfortable hearing is needed. Worn under the chin, the MONOSET eliminates head and ear fatigue. So for *comfort* for ears (your own or your customers) specify Telex MONOSET. *Immediate delivery.*

Weighs only 1.3 oz. Fully adjustable to all head sizes. Rugged Tenite construction. Removable plastic ear tips. Frequency response: 50 to 3,000 c.p.s. Maximum sound pressure output: 300 to 400 dyns per sq. cent. Available in two impedances: 128 and 2,000 ohms.

USERS: Electrical transcribing machines. Program distribution systems. Commercial aircraft operations. RR inter-communication systems. Laboratory testing equipment. Wired music systems. Radio station operations. Radio "hams" and engineers.

Write to Department H for information and quotations.

"Hearing At Its Best"

TELEX INC.
ELECTRO-ACOUSTIC DIVISION
Minneapolis, Minn.

Canadian Distributors: Addison Industries, Ltd., Toronto

TEST YOUR MAGNETIC CIRCUITS

RAWSON FLUXMETER TYPE 504

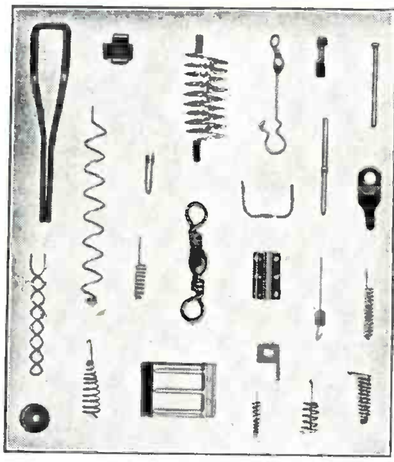
The only portable fluxmeter available which returns rapidly to zero when a single button is depressed. Simple and fast in operation. Convenient and light in weight.

Not limited to a single type of measurement. Has universal application for laboratory or production. Measures strength of magnets and electromagnets, permeability and hysteresis loops for iron and steel, total flux lines in circuit, flux lines developed in air gap, etc.

Has a mechanical clamp to protect the pivots and jewels when in transit.

Low price $125 net FOB Cambridge, Mass.

RAWSON ELECTRICAL INSTRUMENT COMPANY
111 Potter Street, Cambridge 42, Mass.
Representatives
Chicago   Los Angeles   New York City



SMALL PARTS

Filaments, anodes, supports, springs, etc. for electronic tubes. Small wire and flat metal formed parts to your prints for your assemblies. Double pointed pins. Wire straightened and cut diameter up to 1/8-inch. Any length up to 12 feet.

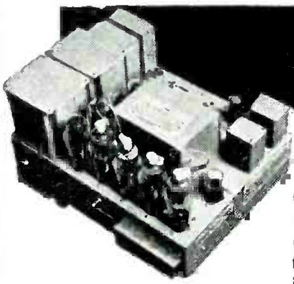
LUXON fishing tackle accessories.

Inquiries will receive prompt attention.

ART WIRE AND STAMPING CO.

227 High St.   Newark 2, N. J.

LATERAL FEEDBACK CUTTER
—Driver Amplifier Combination



Recording Systems
Licensed under U S.Pats. of
Western Electric Co., Inc.

NEW CIRCUIT
THOROUGHLY LIFE-TESTED
FIRST ON THE MARKET
STABLE — DEPENDABLE

16 db OVERALL FEEDBACK
20 db STABILIZING FEEDBACK
35-40 db TOTAL FEEDBACK
thru the useful range

CHARACTERISTICS: ● 10-12 db reserve power UNDISTORTED ● ± 2 vu 30-12,000 with 30 cm/sec capability at 12 kc. ● Sharp cut-off at 12 kc to avoid widening groove ● Overall flux feedback for stylus control and damping ● Internal current feedback for stability ● Input equalizer – instant selection of recording characteristic ● Intermodulation unbelievably low ● Interchangeable cutters ● Regular size cutter standard mounting holes ● 50 watt amplifier push-pull throughout

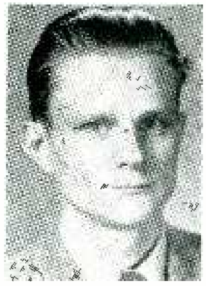
NEGLIGIBLE MAINTENANCE – INSTALL IT AND FORGET IT
"No comparison with previous systems for technical performance or listening satisfaction."
Engineering staff available for special requirements

COOK LABORATORIES • 139 Gordon Blvd. • Floral Park • New York

has joined Cook Electric Co., Chicago, and will assist in directing research on transient motion measuring instruments and electronic controls for aircraft.

ROY DALLY is now chief engineer in charge of phonograph needle and pickup design for Electrovox Co., Inc., Newark, N. J.

R. Dally



W. F. Frankart

WILLIAM F. FRANKART has been appointed senior radio project engineer at Lear, Inc., Grand Rapids, Michigan. He was formerly chief radio engineer for Precision Specialties, Inc. of Los Angeles. Before that he was employed by Air Associates, Inc. of California as a design engineer, and previous to that was in turn assistant chief engineer at Aireon Mfg. Corp. of Kansas City and project engineer for Farnsworth Radio & Television Corp. of Fort Wayne, Indiana.

L. E. BESSEMER, formerly chief production engineer for Collins Radio Co., Cedar Rapids, Iowa, has been promoted to become general manager of the Manufacturing Division.

SAMUEL HEYMAN, formerly production manager of Aerovox Corp., becomes factory manager for the Tobe Deutschmann Corp., Canton, Mass.

ROBERT W. MCKIRDY, who served during the war as Electronics Liaison Officer between the Bureau of Ships and the British Admiralty Delegation, has joined Centro Research Laboratories, Inc., Briarcliff Manor, N. Y., as technical service director.

FIRST COMMERCIAL radio program was sponsored in 1922 by a Jackson Heights, N. Y. real estate company, Queensborough Corp. It paid $100 for ten minutes.

name
PLEASE:

Are you on the mailing list for our bulletins and catalogs? If not, you ought to be. We've probably got just what you want in parts, or complete rigs, and our prices are shaved paper-thin. So send us a note or post card. Keep smart company.

LAFAYETTE
Radio
Radio Wire Television
DEPT. EK-6 100 SIXTH AVE., NEW YORK 13, N. Y.
110 FEDERAL STREET, BOSTON 10, MASS.
24 CENTRAL AVENUE, NEWARK 2, N. J.

THE NEWEST CONTRIBUTION TO FASTER, LOWER COST METAL JOINING

EASY-FLO 45 and EASY-FLO 35

These new silver brazing alloys offer new low brazing temperatures and new low silver contents, features that make possible the faster production of strong, ductile, leak-tight joints and lower costs on a wide variety of metal joining operations . . . They have been created by Handy & Harman, originators of the well known silver brazing alloys, SIL-FOS and EASY-FLO. They are offered to industry now as a timely contribution to help lick two big problems — to increase production . . . and to decrease costs.

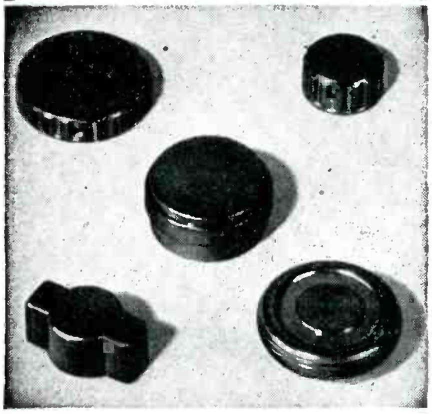
What will these New Alloys do for you?

THAT'S THE QUESTION — You want to know if the lower flow point, lower silver content, faster spreading action and small amount of alloy required will save time and cut your costs — and how much. For a quick answer — ask your regular supplier for a free demonstration — or better still, place a trial order with him and put these alloys to your own tests on your own work.

HANDY & HARMAN
82 FULTON ST., NEW YORK 7, N. Y.
Bridgeport, Conn • Chicago, Ill. • Los Angeles, Cal. • Providence, R. I • Toronto, Canada
Agents in Principal Cities

HANDY & HARMAN FOUNDED 1867 QUALITY SERVICE

CUSTOM MOLDED
PLASTICS PARTS
FOR THE ELECTRONICS INDUSTRY

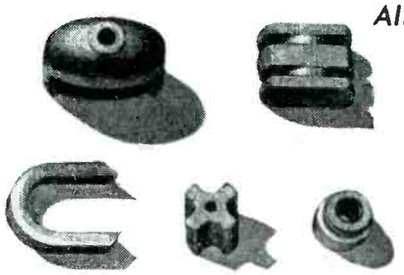


Compression Molded . . to meet specific requirements . . . by an experienced organization . . . tooled for the production of plastics parts for electrical or general applications. Inquiries acknowledged promptly.

Midwest Molding and Manufacturing Co.
338 NORTH WHIPPLE ST. • CHICAGO 12, ILL.

PERMANENT MAGNETS

Alloys: COBALT • CHROME • ALNICO



The making of permanent magnets is an alloy, too . . . of experience, engineering, facilities. We'll be glad to tell you more. Write for bulletin.

THOMAS & SKINNER STEEL PRODUCTS CO.
1116 E. 23rd St., Indianapolis 5, Ind.

Thomas & Skinner

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

NEW BOOKS

Scientific Instruments

Edited by Herbert J. Cooper, Head of Engineering Dept., South-West Essex Technical College, England. Chemical Publishing Co., Brooklyn 2, N. Y., 1946, 304 *pages*, $6.00.

ANY SINGLE volume that attempts to describe scientific instruments ranging from water meters and calculating machines through cathode-ray tubes and optical devices, must be arbitrary of choice. The editor has doubtless planned his volume for a given purpose, packing it with useful information, but the final result gives the feeling of perusing a mail-order catalog. Furthermore, though not labeled as such by the publisher, this is apparently a reprint of a British book, and illustrates British instruments.—A. A. MCK.

Radioman's Handbook

Compiled by technical staff of Coyne Electrical School. Published by Coyne Electrical School, Chicago, Ill., 355 *pages*, $3.25.

A CONGLOMERATION of elementary radio theory, examples of arithmetical calculations used in radio, and some of the simpler tables, charts, and nomographs used by technicians rather than engineers. The level of writing is for home radio students and radio shop technicians.—J. M.

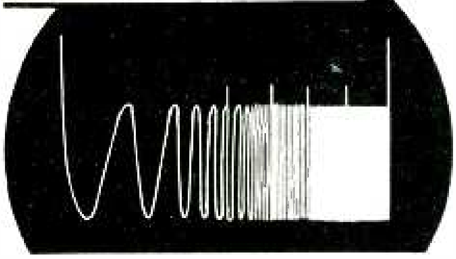
Electron and Nuclear Counters

By SERGE A. KORFF, *Associate Professor of Physics, New York University. D. Van Nostrand Co., Inc., New York, N. Y.,* 212 *pages*, $3.00.

A HIGHLY COMMENDABLE survey and summary of the present state of the art of using Geiger counters and related special-purpose counters, written at an intermediate level for graduate students, workers in industrial laboratories and medical research institutions, and the many others who are finding counters to be useful tools for measurements and research. Some knowledge of atomic physics and some familiarity with vacuum-tube circuits is presupposed.

Chapter I analyzes progressive

CHECK AUDIO SYSTEMS THIS NEW QUICK WAY



MAKE FREQUENCY RESPONSE CHECKS INSTANTANEOUSLY

Invaluable for Broadcast and F. M. Stations, Laboratories production testing, and Motion Picture Sound Equipment.

SEE A COMPLETE PICTURE of the response characteristics for all types of transcription pickups, amplifiers, and audio systems with the new Sweep Frequency Transcription on 12" and 16" Vinylite. Make adjustments in system or components quickly. Reveals all types of distortion and transient phenomena—frequency range 60 to 10,000 CPS. Write for free technical data sheet #104-E.

CLARKSTAN CORP.

11927 W. Pico, Los Angeles 34, Calif.

ALLIED for everything in Electronics and Sound

Equipment for Research Development • Maintenance

1946 Catalog FREE

Largest Stocks • Complete Service From one Central Supply Service

Leading industrial and engineering firms depend on the ALLIED Catalog as their Buying Guide for everything in radio, electronics and sound. Lists more than 10,000 quality items . . . radio and electronic parts, vacuum tubes, tools, test instruments, audio amplifiers, accessories . . . complete lines stocked by a single reliable source. Try ALLIED'S expert, specialized industrial service. Send for FREE Catalog now!

Sound Equipment

See ALLIED'S wide selection of Intercom, Paging and Public Address systems. Models for every industrial purpose.

Everything in Radio and Electronics

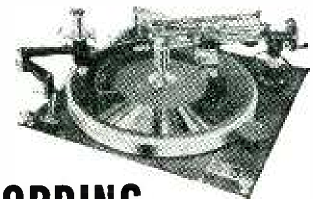
ALLIED RADIO CORP.

833 W. Jackson Blvd., Dept. 24-L-6 Chicago 7, Illinois

Send for Your ALLIED CATALOG

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 benefit of its seasoned skill.

Write for our New Descriptive Bulletin.

ALLIED RECORDING PRODUCTS CO.

21-09 43rd Ave, LONG ISLAND CITY, NEW YORK

PRINTING-FINISHING SERVICE

DIALS NAME PLATES CALIBRATIONS
INSTRUMENT PANELS AND HOUSINGS

ALUMINUM
ACETATES — ACRYLATES
PHENOLICS — NITRATES

Printing so durable that it replaces etching, so sharp on wrinkle that it appears engraved; also perfect writing and erasing finish on both metals and plastics.

PROMPT QUOTATIONS — PROMPT DELIVERIES — SAMPLES ON REQUEST

The ANSONIA CLOCK COMPANY Inc.

SPECIAL PARTS DIVISION, 105 LAFAYETTE ST., NEW YORK 13, N. Y.
TELEPHONE WORTH 4-6654

LAMINATED PLASTICS

Phenol Fibre . . . Water-, oil-, and chemical-resisting sheets of high dielectric strength. Supplied in black and natural color. Standard sheets approximately 49 x 49 inches. Thicknesses from .010 to 9 inches. Rods and tubes.

Vulcanized Fibre Remarkably uniform, high-grade, hard fibre in sheets 56 x 90 inches to save waste in cutting. Smaller sheets if desired. Also in standard-size rods.

FABRICATED PARTS • TAYLOR INSULATION • SILENT GEAR STOCK

We're ready whenever you are. Send blueprints.

TAYLOR FIBRE COMPANY Norristown, Pennsylvania

Pacific Coast Plant: La Verne, California • Offices in Principal Cities

changes in counter behavior as voltage is raised, and presents the terminology of counter circuits. Following chapters cover counting chambers, integrating types of ionization chambers, proportional counters, neutron counters, counters for heavy ionizing particles, nonselfquenching counters, and selfquenching counters. Chapter V gives highly practical suggestions for preparation and construction of counters, chapter VI covers errors and corrections in counting, and the final chapter covers auxiliary circuits such as quenching, coincidence, scaling, recording, voltage supply, regulating, integrating, and pulse amplifying circuits. Values of components for many of the circuits are given. A unique and valuable appendix contains a list of manufacturers of counters and associated equipment along with conventional reference and bibliography sections. All in all, this book constitutes a significant contribution to the literature of electronics.
—J. M.

Wave Propagation in Periodic Structures

By LEON BRILLOUIN, *Applied Mathematics Group at Columbia University. McGraw-Hill Book Co., Inc., New York*, 1946, 247 *pages*, $4.00.

MATHEMATICAL TREATMENTS of wave propagation in electric lines and filters, crystal lattices, and in an idealized elastic medium, being essentially identical, provide the theme of this short addition to the International Series in Pure and Applied Physics. For those who can make the mental jump from familiar electrical symbols to generalized notation and are not confused by the various particular physical phenomena to which the mathematics is applied, the work demonstrates how to use complex algebra and calculus in solving the problems under discussion. Wave propagation and boundary conditions of uniform systems are thoroughly analyzed. As the text was prepared from notes made by Mary H. Payne while attending the author's lectures, explanations that

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 - Electronic - Magnetic.
188 West 4th St. New York 14, N. Y.
Chelsea 2-4208

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

MIDLAND ASSOCIATES
Consulting Engineers
Engineering Design & Development
Television Receivers—Technical Manuals
FM. Receivers—Test Instruments
A.M. Receivers—Special Problems
in all phases of Electronics
1959 Lunt Ave. Chicago 26, Ill.

EDWARD J. CONTENT
Acoustical Consultant
and
Audio Systems Engineering, FM Standard Broadcast and Television Studio Design.
Roxbury Road Stamford 3-7459
Stamford, Conn.

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

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.

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

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.

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

STANLEY D. EILENBERGER
Consulting Engineer
INDUSTRIAL ELECTRONICS
Design—Development—Models
Complete Laboratory and Shop Facilities
6309-13—27th Av.
Kenosha, Wis. Telephone 2-4213

C. M. HATHAWAY
Consulting Engineer
Research and Development
Product Designs
Tool & Methods Engineering
Pilot Manufacturing
1315 S. Clarkson St., Denver 10, Colorado

ARTHUR J. SANIAL
Consulting Engineer
Loudspeakers and Allied Devices
168-14 32 Ave. Flushing, N. Y.

ELECTRO ENGINEERING WORKS
Specializing in High Voltage Filament and Plant Transformers for Electronic Projects
Quick Deliveries
6021 College Ave. Oakland 11, Calif.

INDUSTRIAL DEVELOPMENT ENGINEERING ASSOCIATES
Engineering Consultants
Electronic Control, Motion Picture & Sound Equipment
Development—Design—Models
5874 College Ave. Indianapolis 5, Ind.

TECHLIT CONSULTANTS, INC.
Technical literature and art. Specialists in electronics. Instruction manuals, sales brochures, catalogues, isometrics, perspective, photo-retouching, schematics, wiring diagrams. Expert work at low cost. We have never missed a deadline.
140 Nassau Street New York 7, N. Y.

ELECTRONIC RESEARCH ASSOCIATES
ERA will apply progressive, war-proven developments in electronic research . . . *counting . . . timing . . . measuring . . . industrial controls* . . . to your manufacturing advantage.
Box 333, 305 Linden Av., South San Francisco, Cal.

RICHARD C. KLEINBERGER
Licensed Professional Engineer
Electronic Heating Applications
20 Cushman Road, White Plains, N. Y.

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.
BIG-9240

THE CONSULTING ENGINEER

"By reason of special training, wide experience and tested ability, coupled with professional integrity the consulting engineer brings to his client detached engineer and economic advice that rises above local limitations and encompasses the availability of all modern developments in the fields where he practices as an expert. His services, which do not replace but supplement and broaden those of regularly employed personnel, are justified on the ground that he saves his client more than he costs him."

might have seemed trivial to a mathematician but guide learners have been retained.—F. R.

Tables of Fractional Powers

MATHEMATICAL TABLES PROJECT, *sponsored by National Bureau of Standards. Prepared by the Columbia University Press, New York,* 1946, 486 *pages,* $7.50.

THE BOOK contains two parts. Part I presents values of A^x for $A = 0.01$ to 0.99 in steps of 0.01, and $A = 2$ to 9 in steps of 1 for values of $x = 0.001$ to 0.01 in steps of 0.001, and 0.01 to 0.99 in steps of 0.01; also for $A = \pi$ and $A = 10$ for values of x from 0.001 to 1.000 in steps of 0.001. Part II presents values of x^a for $a = \pm 1/2$, $\pm 1/3$, $\pm 2/3$, and $\pm 1/4$ for values of x from 0 to 9.99 in steps of 0.01. A bibliography of seventy-six tabulations containing related tables is included.—F. R.

Circuit Analysis by Laboratory Methods

By CARL E. SKRODER AND M. STANLEY HELM, *Electrical Engineering Department, University of Illinois. Prentice-Hall, Inc., New York,* 288 *pages,* $5.35.

LABORATORY MANUALS, like all texts, are judged by teachers on their suitability to the particular objectives of courses for which they may be used. There are several laboratory manuals for introductory applied electrical engineering courses, flanked on one side by basic texts on electrical measurements per se, and on the other side by manuals on advanced electrical machine testing.

All such books include both reference material on theory and instructions for experiments. This book includes in addition standard laboratory practices and report writing. The level of the material makes it suitable for trade school and first year college electrical and nonelectrical courses in d-c and a-c circuits, depending on the nature of the class instruction which this work is intended to supplement.—F. R.

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.

Electron Tube Machinery

of every type, — standard, and special design

Specialists in Equipment for the manufacture of Radio Tubes, Cathode Ray Tubes, Fluorescent Lamps, Incandescent Lamps, Neon Tubes, Photo Cells, X-ray Tubes and other glass or electronic products, on production or laboratory basis.

Kahle

ENGINEERING COMPANY

1307-1309 Seventh St., North Bergen, N. J.

MINIATURE PRECISION BALL BEARINGS

(WORLD'S SMALLEST BALL BEARING)

For precision instruments, laboratory equipment, electronic devices, to minimize friction, space, weight; overcome starting torque.

ACTUAL SIZES

ENLARGED SIX DIAM.

Radial Series (5 Sizes) 1/8" to 5/16" O. D.

Pivot Series (6 Sizes) 2 mm to 10 mm O. D.

Write for data sheet EL

MINIATURE *Precision* BEARINGS

KEENE, NEW HAMPSHIRE, U·S·A·

PRECISE ELECTRONICS CO.

Manufacturer of

all types of COILS for radio and other electronic devices.

Wire cut and stripped to size.

614 West 49th Street   New York, N. Y.

Telephone: Circle 5-9063

We manufacture a complete line of equipment

SPOT WELDERS, electric from ¼ to 50 KVA
TRANSFORMERS, special and standard types
INCANDESCENT LAMP manufacturing equipment
FLUORESCENT TUBE MAKING EQUIPMENT
ELECTRONIC EQUIPMENT, vacuum pumps, etc.
WET GLASS SLICING and cutting machines for laboratory use
GENERAL GLASS working machines and burners
COLLEGE GLASS working units for students and laboratory

AC ARC WELDERS from 100 to 400 Amps

EISLER ENGINEERING CO.

731 So. 13th St. (near Avon Ave.)   Newark, New Jersey

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

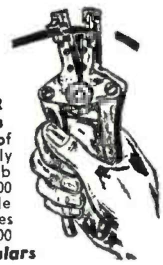
Strip Insulated Wires

QUICKER ... BETTER

with *"Speedex"*

AUTOMATIC WIRE STRIPPER

...Speeds Production



Strips Insulation from all types of wire—instantly, easily, perfectly. Just press the handles and the job is done. Cuts wire too. Strips 800 to 1000 wires per hour. Available for all size solid or stranded wires —No. 8 to No. 30. List Price $6.00

Write Dept. E for Full Particulars

GENERAL CEMENT MFG. CO.

Rockford, Illinois, U.S.A.

Miles FILMGRAPH

CONFERENCE, TELEPHONE, DICTATION

Permanent recorders & Instantaneous play-back machines for all industrial purposes. Safety film cost 5c per hour.

MILES REPRODUCER CO., INC.

812 B'way, Dept. E, New York, 3, N. Y.

High Speed Production Of Quality R. F. Coils and Sub-Assemblies, For Discriminating Manufacturers

CIL

Clippard INSTRUMENT LABORATORY, INC.

1125 Bank Street, Cincinnati 14, Ohio

18 YEARS IN RADIO

GET THIS *New* CATALOG By This Old Firm

Latest developments in radio and electronic parts and devices, newest ham gear, gadgets for experimenters, bargains in war surplus items.

FREE TO YOU

Mail the coupon below and get this new catalog FREE.

BURSTEIN-APPLEBEE CO.,
1012 McGee, Kansas City 6, Mo.

Send me FREE catalog advertised in Electronics.

I AM ______
STATE CONNECTION IN INDUSTRY

NAME ______

ADDRESS ______

TOWN ______ STATE ______

THIS

CONTACTS

SECTION

Supplements other advertising in this issue with these additional announcements of products essential to efficient and economical production and maintenance. Make it a habit of checking this page, each issue.

Classified Advertising Division

ELECTRONICS

MICROMETER FREQUENCY METER

for checking Transmitters from 100 Kc to 175 Mc. within 0.01 per cent

LAMPKIN LABORATORIES

Bradenton, Fla., U. S. A.

FREE SYMBOLS CHART!

Over 10,000 engineers, professors, and hams in labs, schools, and industrial plants have made valuable use of Sun Radio's Chart of Graphical Symbols For Electronic Diagrams. For your *free* copy, write Sun Radio today on your company letterhead.

SUN RADIO & ELECTRONICS CO., Inc.

ESTABLISHED 1922

122-124 DUANE ST.   NEW YORK 7, N. Y.   BArclay 7-1840

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.

Birth of Radar Idea?

Dear Editor:

IN SEPTEMBER ELECTRONICS, page 184, you intimate that the idea of radar was given by Baird in the year 1926. But this idea is much older.

In: Geschichtszahlen der drahtlosen Telegraphie und Telephonie by Dr. Ing. Franz Maria Feldhaus and Ing. Walther H. Fitze, Verlag Rothgiesser & Diesing, Berlin 1925, page 103 you may read:

(Translation) 1904: Eng. Christian Hülsmeye in Duesseldorf invented the Telemobiloscope, a device for automatically signaling on the sea. The electric waves of a transmitter of wireless telegraphy are only able to reach a receiver on the same ship if they are reflected by the metal of another ship which is looked for.

And in: Lexikon der Elektrizität und Elektrotechnik by Fritz Hoppe, A. Hartlebens Verlag, Wien and Leipzig, 1906, page 909:

(Translation) Telemobiloscope is a device invented by Huelsmeyer, Duesseldorf, which is based on the fundamentals of wireless telegraphy with the purpose to find ships and metallic things on the sea. The receiver and the transmitter are placed on the same ship. The electric waves sent out by the transmitter cannot reach the receiver directly but have to be reflected by a metallic body (for instance a ship) on the sea and in this reflected way to the receiver.

DR. KURT BORCHARDT
Toronto, Ontario Canada

Carbon Pickup

Dear Sir:

I READ WITH interest the article

(ELECTRONICS, September 1946, p 162) by my good friends, the Kaufman twins, in which they suggest the use of a carbon-type phonograph pickup.

I'll wager they'll be surprised to learn that Magnavox once produced such a pickup commercially. That was 23 years ago, when the Kaufmans were quite small. This pickup was a component of the granddaddy of all public address sets, which was the wonder of its day.

Incidentally, Magnavox went the Kaufmans one better. Where the article suggests amplifiers with only one tube, in the earlier application tubes were dispensed with entirely. The necessary power was obtained by paralleling four buttons.

W. W. CLEMENTS, JR.
Army and Navy General Hospital
Hot Springs National Park, Arkansas

THE 1,000TH standard a-m broadcast station license in this country was awarded by the FCC on Sept. 25, 1946 to a new station, WIRA, that will go on the air full time in Ft. Pierce, Florida with 250 watts on 1400 kc.

POSITIONS VACANT

RADIO INSTRUCTORS. Receiver servicing experience. College degree preferred. $3600 a year to start, $4200 after four months. Work in the heart of the Radio Industry. Write Raleigh G. Dougherty, 158 Market Street, Newark 2, New Jersey, c/o New York Technical Institute of New Jersey.

ASSOCIATE PROFESSOR Of Electrical Engineering. Education: M.S. degree in E.E. with specialization in Electronics. Teaching experience required. Industrial or military experience desirable. Salary $3200.00 to $3600.00 for nine months school year depending on age and experience. Write: Department of Electrical Engineering, North Dakota Agricultural College, Fargo, North Dakota.

ENGINEERS: JUNIOR and senior electrical engineers or physicists for general development engineering in television and allied radio and electronic fields. Established manufacturing concern located suburban New York City. P-249, Electronics, 330 W. 42nd St., New York 18, N. Y.

INSTRUMENT ENGINEER—Young graduate electrical engineer well grounded in electronic work, radio and audio frequency and interested in applications to physical measurements. Position involving analytical studies, circuit analysis and design in support of an active instrument section of Flight Research Department. Replies will be held in strict confidence. Write Employment Office, Cornell Aeronautical Laboratory, Buffalo 5, New York.

INSTALLATION ENGINEER—Wanted in Midwest by manufacturer of high quality AM and FM Transmitters Speech equipment and accessories. Man 25 to 40 with at least 3 to 5 years experience in Broadcast Station Operation and Construction duties: Accumulating data making quotations and consolidating requirements and shipments for purchasers of complete broadcast installations. A good opportunity with a substantial salary write fully. P-248, Electronics, 520 N. Michigan Ave., Chicago 11, Ill.

COIL DEPT. 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-250, Electronics, 330 W. 42nd St., New York 18, N. Y.

SEARCHLIGHT SECTION
(Classified Advertising)

EMPLOYMENT : BUSINESS : "OPPORTUNITIES" : EQUIPMENT : (Used or Resale)

UNDISPLAYED —RATES— DISPLAYED

15 CENTS A WORD. MINIMUM CHARGE $3.00.
Positions Wanted (full or part time salaried employment only) ½ the above rates payable in advance.
Box Numbers- Care of publication New York, Chicago or San Francisco offices count as 10 words.
Discount of 10% if full payment is made in advance for 4 consecutive insertions.

Individual Spaces with border rules for prominent display of advertisements.
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 ⅞" vertically on one column, 3 columns—30 inches—to a page.

NEW ADVERTISEMENTS received by November 11 will appear in the December issue, subject to limitations of space available.

WANTED

Prominent Aircraft Company, Eastern United States needs men with following qualifications:

Experienced engineers with Bachelor's, Master's, Doctor's degrees in Electrical Engineering, Physics, Mathematics. At least two years experience in design and development of radar and television systems, automatic computers, servomechanisms, target seekers, etc., required. Positions open for preliminary and detail design, research, and development of guided missiles under Army and Navy contracts.

Starting salary commensurate with experience. Address

P-243, Electronics
330 West 42nd St., New York 18, New York

EMPLOYMENT SERVICE

SALARIED POSITIONS $2,500-$25,000. This thoroughly organized confidential service of 36 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.

POSITIONS WANTED

TECHNICAL EDITOR-WRITER Graduate E.E. Wide experience electronic and allied fields. 10 years experience preparation of instruction handbooks, manuals, military and naval publications. Take charge of copy, layout, illustrations, production. Knowledge typography, printing problems. Presently in full charge publications large engineering organization. Desire position East, far West. PW-251, Electronics, 330 W. 42nd St., New York 18, N. Y.

(Continued on the following page)

Additional Employment ads on pages 292 and 293

POSITIONS WANTED
(Continued from preceding page)

COMMUNICATIONS ENGINEER, Stanford AB '37, EE '39, wants administrative or technical job. Interested air navigation, airport control, allied fields; broad growing responsibilities; liaison, systems planning. Harvard-MIT Radar school plus 3 years Signal Corps Officer in AAF radar and communications. Age 32. Good appearance, pleasing personality. PW-252, Electronics, 68 Post St., San Francisco 4, Cal.

EXECUTIVE ENGINEER (graduate EE) with 12 years utility and industrial experience, both management and technical, desires supervisory or technical position in industry. Also have extensive training and experience in electronics, and knowledge of mechanical and civil engineering. Milder climates preferred. PW-253, Electronics, 520 N. Michigan Ave., Chicago 11, Ill.

TELEVISION RESEARCH Engineer: seeks opportunity to do advanced research in industry or university with or without teaching responsibilities. Age 40, Ph. D. Over 200 patents. Industrial experience includes tube development and design of complete television systems. Present interest: Research on television pick-up and reproduction tubes. Midwest or far-west preferred but not restrictive. PW-254, Electronics, 330 W. 42nd St., New York 18, N. Y.

PRODUCTION EXECUTIVE, under 30, with background in economics and industrial engineering; eight years experience in production organization and management, methods, costs, quality control, time and motion study, etc., in metals, machinery and radio components, looks for connection with future. Languages for foreign position. PW-255, Electronics, 330 W. 42nd St., New York 18, N. Y.

ELECTRICAL ENGINEER: young, single. BEE 1943. Three years experience as Navy Radar and Communications Officer. Presently employed in electronics research work. Desires a position in sales engineering. Location not important. PW-257, Electronics, 330 W. 42nd St., New York 18, N. Y.

INDUSTRIAL RELATIONS

Former Personnel Director of large Electronic Manufacturing Company. Conducted first Job Evaluation in this field. Skilled in Placement—Testing—Wage Administration—Morale Techniques—Job Evaluation—Grievances—Labor Negotiations. 38 Years of age. Available November 1. Salary open.

PW-247, Electronics
330 West 42nd St., New York 18, N. Y.

FOR SALE

Here's an opportunity to purchase a complete

TRANSFORMER FACTORY

all operating—fully staffed—located in the east—requires aprox. $150,000. cash.

BO-256, Electronics
330 West 42nd St., New York 18, N. Y.

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.

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.

OPPORTUNITIES AT ZENITH LONG DISTANCE RADIO

Zenith has some interesting openings for experienced Senior and Junior radio engineers in all branches of home radio receiver design and development. Apply to J. E. Brown, Chief Engineer, Zenith Radio Corporation, 6001 West Dickens, Chicago. All applications treated in confidence.

WANTED
Mechanical Engineer

Preferably familiar with speaker design. Factory located in small midwest town. Salary open. Please send full particulars stating experience, starting salary desired, etc. All replies strictly confidential.

P-242, Electronics
330 West 42nd St., New York 18, N. Y.

WANTED
LOUDSPEAKER ENGINEER

Eastern Manufacturer has position open for man experienced in development, design and manufacture of radio loudspeakers. Please give details of education, experience and personal history. *Salary open.*

P-245, Electronics
330 West 42nd St., New York 18, N. Y.

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

SALES ENGINEERS Wanted

by large radio parts manufacturer

Will be trained for territorial office managementships. Good appearance, pleasant personality and desire to learn overall sales and business management are essential, but none need apply who lack the prime requisite of practical broadcast receiver design engineering experience. In reply give historical background, nationality and salary requirement.

SW-231, Electronics
330 West 42nd St., New York 18, N. Y.

Electronic Engineering Service

Research Design Development
in ELECTRONICS
and APPLIED PHYSICS
for industry and laboratory

SUBMIT YOUR PROBLEMS

SENTINEL LABORATORIES
1019-23 Appletree St. Philadelphia 7, Pa.

SURPLUS NEW METERS

D.C. METERS
MICROAMMETERS GALVONOMETERS

McClintock, 3½" square, 0-50 ua mvt., spec. scale $6.50

Gruen, 2½", 0-100 ua mvt., Black scale with markings −8 to +6 DBM and 0-100, 2000 ohms resist.........$3.50

Weston 301, 3½", 0-200 ua........$7.50

Marion, 2½", 200 microamp undamped mvt., spec. sc...................$3.50

Marion, 3½", 0-200 ua 68 ohms resistance, undamped mvt............$4.95

G. E., DO-41, 3½", 200 MICROAMP Mvt., SPEC. SC. KNIFE EDGE POINTER, COMP. WITH PAPER V-O-M.A. SCALE $6.00

W.E. 3½", concentric style, 0-200 microamp $4.00

G.E., DO-41, 3½", 0-500 microamp mvt. scale 20 K.V., comp with paper V-O-M.A. sc.......................$4.95

D. C. MILLIAMMETERS

G.E., DO-53, 3½" square, 0-1 M.A..$4.95

G.E., DO-53, 3½" square, 1 M.A. mvt, 5000 ohm resist, 0-50 sc..........$3.95

G.E., DW-41, 2½", 1 M.A.........$3.95

G.E., DO-53, 3½" square, 20 M.A...$4.95

Weston 506, 2½", 3 M.A..........$3.00

W.H., RX-53, 3½" square, 0-30 & 0-300 M.A. dual range...............$4.95

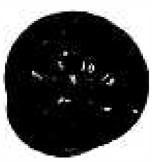
Simpson 25, 3½", 5 M.A. movement Zero Right Scale—6 to 100 caption "DB" above 1 Microvolt..............$3.00

Simpson 26, 3½", 0-15 M.A........$4.50

Simpson 3½", 0-200 M.A..........$4.50

Weston 3½", 0-1000 M.A..........$4.50

D.C. VOLTMETERS & KILOVOLT METERS



G.E., DW-41, 2½", 15 VOLT BLACK SCALE, 15 MARKINGS, NO CAPTION $2.50

W.H., SX-33, 2½", Surf. Mtd., 3-0-3 V, 200 r/v........................$1.25

W.H., NX-35, 3½", 15 K.V. comp. with 1000 r/v ext prec resist L.P..$160.00. Your cost $16.00

W.H., NX-35, 3½" 20 K.V. comp with 100 r/v ext prec resist L.P.....$210.00. Your cost $21.00

W.H., NX-35, 3½", 0-200 V, 1000 r/v $5.50

W.H., NX-35, 3½", 0-200 v, 1000 r/v mtd on 45 degree metal angle panel $6.00

Western Electric, 3½", Concentric Style, 0-75 volt D.C., 1000 r/v..........$3.00

W.E., 3½", 500 volt, 1000 r/v Concentric Style $5.00

Weston 301, 3½", 0-4 KV with ext prec resist $7.95

Guren, 2½", 150 volt.............$3.50

D.C. AMMETERS

Triplett, 3½", 0-15 amp..........$4.00

Weston 506, 2½", 200 amp. with ext shunt $9.50

G.E., DO-41, 3½", 200 amp. with ext shunt $12.50

RADIO FREQUENCY AMMETERS

G.E., DW-44, 2½", 0-1 A.R.F. Black scale $3.50

G.E., DO-44, 3½", 1.5 Amp........$6.50

Weston 425, 3½", 1 Amp Surf Mtd.$6.50

Weston 507, 2½", 0-1.5 A.R.F. Black scale, Metal case...............$2.95

Weston 507, 2½", 3 Amp bk sc....$3.50

Weston 640, 4½", Surf Mtd, 0-3 A.R.F. $9.50

Weston 425, 3½", 0-500 M.A. R.F..$7.50

Simpson, 2", 3 Amp, expanded at lower part of scale...................$3.50

A.C. VOLTMETERS

G.E., AW-42, 2½", 0-10 V.A.C....$3.95

G.E., AO-22, 3½", 1000 cycle, 50 volts, mtd on metal angle bracket with 6' Tyrex leads & clips............$2.50

G.E., AO-22, 3½", 150 volt........$5.50

G.E., AO-22, 3½", 0-150 V.A.C. Black scale $3.50

G.E., AO-22, 3½", 300 volt........$8.00

Weston 476, 3½", 130 volt........$4.50

W.H., NA-35, 3½", 150 volt.......$5.50

Triplett 332, JP, 3½", 0-150 V.A.C. metal case $4.50

Triplett 232, 2½", 250 volt........$4.95

A.C. AMMETERS

G.E., AO-22. 3½", 80 Amp S.C....$3.50

Simpson, 3½" square case 60 Amp S.C. $4.50

Simpson 3½" square, 0-60 sc.......$4.50

AIRCRAFT METERS

G.E., 2½", Aircraft type, 0-30 Amps. D.C. black scale, luminous mkgs with internal shunt...................$1.50

G.E., 2½", Aircraft type, 0-60 Amps. D.C. black scale, luminous mkgs with external shunt $2.25

G.E., 2½" Aircraft type, 0-60 Amps & 0-30 Volts D.C. black scale, luminous mkgs with external shunt........$3.00

G.E., 2½", Aircraft type, 0-120 Amps D.C. black scale, luminous mkgs with external shunt..................$2.75

W.H., 2½", Aircraft type, 0-30 volt D.C. bk sc. lum mkgs, 5 M.A. movement 6000 ohm resist.................$1.25

W.H., 2½", Aircraft type, 0-120 Amp & 30 Volts D.C. black scale, luminous mkgs with external shunt........$3.50

W.H., 2½", Aircraft type, 0-150 volt A.C. bk sc lum mkgs, suitable for use from 25 to 125 cycles................$1.50

PORTABLE A.C. AMMETER

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, plush-lined 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

SPECIAL METERS

Weston 301, Power Level Indicator, 625 Microamp 1.2 volt A.C. mvt, self cont rect, blank sc..................$6.00

Weston 301, 3½", 0-150 V.A.C. Rectifier Type, 1000 r/v A.C............$6.50

Weston 301, 3½", Type 61 Decibel—10+6, 6 M.W. 600 ohms high speed type .29-.35 sec. to final reading L.P. $24.50. Your cost $9.50

Weston 705, Sensitrol relay 100 microamp, Solennoid reset, S.P. norm closed $7.50

G.E., miniature, 1½" square, 1 M.A. 100 ohm mvt, 10 divis sc, bk sc......$2.75

G.E., DW-46, 2½" DB—10+5, 6 M.W. 600 ohms zero DB=1.90 volts....$4.50

G.E., DO-46, 3½", 400 Microamp 3 volt A.C. mvt, self cont. rect. Spec sc..$5.50

G.E., Totalizing hour meter, 3½" 5 Digits, 99,999 hrs. 115 volt 60 cycle...$4.95

J.B.T., 3½", Frequency Meter, 58-62 cycle 5 reed..........................$4.00

Marion, 2½", ring mtd "S" meter made for National Co. 1 M.A. mvt scale "1-9 S units 0-40 D.B. above S 9".$3.50

Roller Smith, mainiature, 1½" sq 1.37 M.A. mvt, spec bk sc...........$2.50

Roller Smith, miniature, 1½" sq 2 M.A. mvt, with 2' lead & plug jack 0-10 div sc $2.50

PRECISION RESISTORS

±½% Accuracy—Wire Wound—1 M.A., Weston, G.E., I R C on Sprague

1.0 Meg 1 KV..................$1.50
1.5 Meg 1.5 KV.................$2.00
2.5 Meg 2.5 KV.................$2.50
5.0 Meg 5.0 KV.................$5.00
20.0 Meg 20.0 KV............. $16.50

All meters are white scale in round, flush, bakelite cases, unless specified otherwise.
Add sufficient money on parcel post orders, excess will be refunded.

MARITIME SWITCHBOARD • **Worth. 4-8217. 336 Canal St., N. Y. 13, N. Y.**

WANTED RADIO & Electronic PARTS

Have you any surplus, discontinued or unnecessary RADIO, ELECTRONIC or ELECTRICAL EQUIPMENT or PARTS. We will buy them—any quantity—large or small.

Write or phone us, giving complete information. We will give you quick action.

CLARK-REISS DISTRIBUTORS
32 Broadway
Digby 4-6891 New York City 4

Volume Controls

FOR IMMEDIATE DELIVERY

We have in stock hundreds of thousands of volume controls available for immediate shipment. These controls were built to the very highest standards of precision by Allen-Bradley, Chicago Telephone Supply, Clarostat and I.R.C. All are new and fully guaranteed. All types and sizes from 100 ohms to 5 megohms are represented. Send us your requirements or write for special Volume Control Catalog.

Our huge inventory of Government Contract termination components also includes a million RELAYS of all types. Relays for every purpose, JAN inspected and packed in original cartons, have been priced at a fraction of their original cost. Special Relay Catalog will be mailed upon request.

A complete selection of MICRO-SWITCHES is also available immediately. These are listed in our special Micro-Switch Catalog.

In addition, Wells is a quick source for resistors, mica condensers, field wire, selenium rectifiers, time switches and transmitting tubes. Quotations upon request.

WELLS SALES, INC.
4717-R WEST MADISON ST., CHICAGO 44, ILL.

RADIO, ELECTRONIC PLANTS, INVENTORIES, & SURPLUS STOCKS

BOUGHT FOR CASH

W-246, Electronics
330 West 42nd St., New York 18, N. Y.

INSTRUMENTS

Complete repair, rebuilding services on panel, switchboard, portable indicating meters.

Take advantage of these services by a company equipped to turn out high quality work.

A competent staff and modern laboratory assure dependable and continuous performance.

Backed by 20 years' experience in the instrument field.

PRECISION ELECTRICAL INSTRUMENT CO.
146 Grand Street New York 13, N. Y.

HAZELTON INSTRUMENT CO.

Electric Meter Laboratory
Electrical instruments, Tube Checkers and Analyzers repaired
War surplus meters converted for civilian use.
140 Liberty St., New York, N. Y.
Tel. BArcloy 7-4239

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.

Four Federal F124 Transmitter Tubes and sockets, from 1753 to 4721 hours, in good condition.

MAKE US AN OFFER
RADIO STATION KSL
Salt Lake City, Utah

PAN-OSCILLO RECEIVER

Latest design, 3" Oscilloscope, Panoramic Adapter, Synchroscope, Receiver (when used with converter). Push-pull vertical and horizontal amplifiers. Ideal for laboratory, television, and general use, 110 V, 60 Cycle AC. New in orig. cartons. Originally $2,000—your cost with 21 tubes *$97.50 F.O.B.* Write for picture flyer or send 60c for eighty-page technical manual.

Meters—new original boxes
3" Milliammeters Weston 0-100 $3.95.
W.E. 0-80 $2.95 Westinghouse 0-800 $3.65.
2" Milliammeters Triplett 0-150 Two for $6.40
2" Milliammeters GE 0-50 $2.45
3" Voltmeters Weston 0-8 AC Type 476 $3.45.
2" Voltmeters Marion 0-1000 DC $3.45.
3" Frequency meter 48-62 cycles $2.95.
3" Output meter WE —4 to +6 DB. $3.95.
3" RF Milliammeters Triplett 0-500 $6.40.

Transmitting Tubes—new original boxes
G.E. 814 Pair $11.45.
RCA 8012 UHF triode full efficiency to 500 mc—pair $8.95.

Selsyns 5G bronze cases 110 v 60 cycle. 4" x 5"—pair $11.50. Like new.

Selsyn hookup cable Simplex 8 conductor, shielded and weatherproofed ½ diameter, very flexible $.11 per foot, new

High power modulators Aircraft Accessories Corp., Signal Corps. Model MD1/FRC modulators brand new original boxes; consists of 2-500 watt modulators complete with power supplies in one cabinet; size 1' x 2' x 5' 110 v. 60 cycle ac less 11 tubes. Secondary RF load 2300 ohms or 4600 ohms. Original cost $1500, your cost $325.00.

Westchester Electronic Products
29 Milburne St. Bronxville, N. Y.

METERS

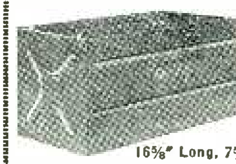
AND INSTRUMENTS

VOLTMETERS
AMMETERS
MICRO AMMETERS
OHMMETERS
FREQ. METERS
BRIDGES (Wheatstone)
MEGOHMMETERS
RHEOSTATS
VARIABLE TRANSFORMERS
RELAYS

ELECTRO-TECH Equipment Co.
119 Lafayette St., New York 13, N. Y.

METAL RADIO-ELECTRONIC CASES

Black Wrinkle Finish



40c EACH Lots of 100
F.O.B. Chicago
BRAND NEW!

16⅝" Long, 7⅝" Wide, 7⅜" Deep, I.D.

Approximately 23 GAUGE SHEET STEEL

A STRONG, sturdy case built to rigid Gov. "Specs"! Ideal for radio, or electronic apparatus. Packed 6 to carton. Immediate Delivery while 1600 last, $40.00 per hundred!

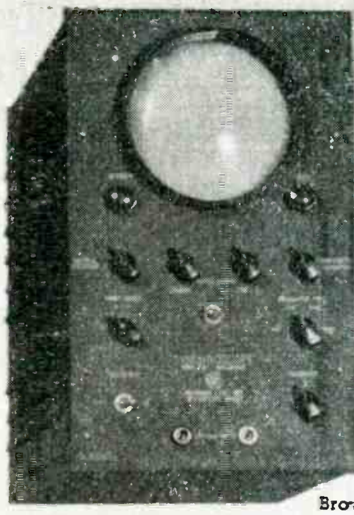
WARSHAWSKY & LAZAR
DEPT. E.
2126 S. Michigan Ave. Chicago 16 Ill.

Delivery vs. Delay . . .

When knowing where to find what you need is the deciding factor between DELIVERY and DELAY . . . consult the advertising pages. If you do not find what you need . . . write

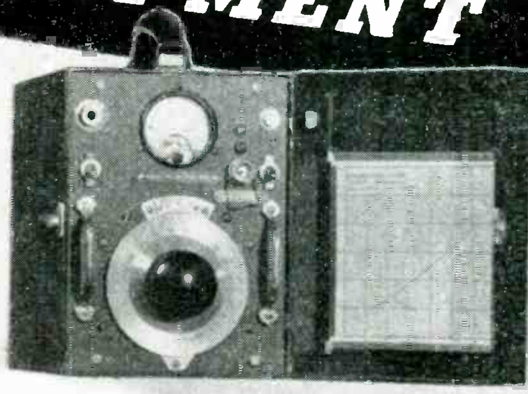
ELECTRONICS

Eldico
MICROWAVE EQUIPMENT



Just a Few New Units Left—

SYNCHROSCOPE
Browning Labs type P4E sweep ranges 1.7 — 12 microseconds wide band amplifiers, 5" scope a laboratory instrument suitable for radar, television, etc. **250.00**



ABSORPTION TYPE WAVE METER
Type BC906D ultra high frequencies (160 to 220 Megacycles) coaxial pot wave meter utilizing diode rectifier and amplification with visual or aural detection. Less tubes **37.50**

WAVE METER
WE I-140-A resonance indicator. Range 2.65 KMC to 3.00 KMC. Micrometer pot tuning. **55.50**

HALF WAVE DI-POLE
10 cm ½ wave with co-ax input. Plexiglass hemispherical shield and reflector.
Lots of 6— **1.85 ea.**

MAGNETRONS
Type 725A or 2J21A designed for 3 cm region. JAN-1 inspected.
Lots of 10—**18.50 ea.**
Lots of 100—**15.00 ea.**
Magnets for above Magnetrons (CFF 2000 Gauses).
Lots of 10—**13.50 ea.**
Lots of 100—**10.00 ea.**

TUBES AND CRYSTALS

UHF OSCILLATORS TUBE
Sheppard Pierce — 723A/B. 3CM region—JAN-1 boxed—manufactured by Western Electric and Raytheon. **5.28**

715 B MAGNETRON DRIVER
10.00 ea.

UHF CRYSTALS
JAN-1—1N21—1N21A—1N21B—1N23A or 1N23B. Each crystal individually boxed and stamped—JAN-1. Inspected—
100 lots—any type. **70c ea.**
1N26—Lots of 100— **1.00 ea.**

TEST EQUIPMENT

'X' BAND SIGNAL GENERATOR
consists of 'X' band oscillator, freq. meter, power level meter and attenuator. Output of 'X' band oscillator is constant or pulsed. Designed to operate on 115V 50 to 1200 cps. **139.50**

FREQ. STANDARD
covering frequencies from 100 to 45,000 kc. Check points at 1000-100-10 KC. Features multi-vibrator and tuned output amplifier. For 100-250 volt, 25-60 cycle operation. Furnished with dual crystals and spare tubes. **29.50**

FREQUENCY METER
Frequency range 375 to 725 mc. with guaranteed accuracy of better than 1 mc. under *all* conditions. Visual or aural indication, modulated or unmodulated complete with spares. **59.50**

Eldico INC. OF NEW YORK
44-31 DOUGLASTON PARKWAY
Douglaston, N. Y.

SEND FOR OUR COMPLETE CATALOG

INDEX TO ADVERTISERS

INDEX TO ADVERTISERS

Excellent electrical properties
Thin coating of insulation
More conductors in a given space
Ease of handling
Easy stripping
Light weight
Resistance to ozone, wear, sunlight, water, chemicals, and most other normally destructive factors
14 colors including NEMA standards

Wire insulation made with GEON has <u>ALL</u> these advantages

Geon
Polyvinyl Materials
A TRADE MARK OF B. F. GOODRICH CHEMICAL COMPANY

Be sure to specify wire or cable insulated with GEON in order to get *all* these advantages. Or, for information regarding special applications please write Department F-11, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio.

B. F. Goodrich Chemical Company A DIVISION OF THE B. F. GOODRICH COMPANY

DAVEN

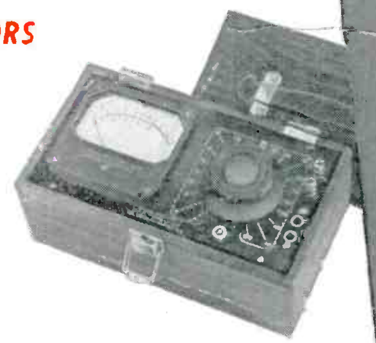
Precision Measuring, Testing and Control Equipment . . .

ATTENUATORS

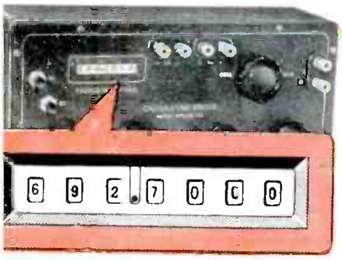
DAVEN offers the most extensive line of standard and special attenuators for radio broadcast, television, sound recording, sound cinema, public address systems, laboratory test equipment and industrial electronic uses. Among the many features of DAVEN attenuators are detent gear for accurate indexing, improved shielding, captive terminal board, special silver contacts, certain stop, separable coupling on dual and multiple unit models.

VOLUME LEVEL INDICATORS

Daven volume level indicators are designed to indicate audio levels in broadcasting, sound recording and allied fields. They are sturdily constructed and correctly damped for precise monitoring. Specialized experience, for almost a quarter century, in the design and development of test equipment has established Daven-Engineered products as "preferred" by leaders in the industry.



TOTALIZING & CALCULATING INSTRUMENTS*

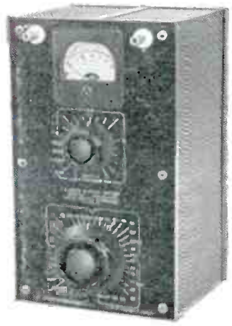


Automatically totalize various dial settings at one point on the face of the unit, where the total can be seen quickly and easily. On units where the decimal point is not fixed, the calculating indicator sets the decimal point in the correct place. Eliminates the possibility of error in calculations. . . . Saves time and effort. Available on bridges, resistance decades, voltage dividers, attenuation networks, etc.

*Patent applied for

POWER OUTPUT METERS

Designed to measure the power output of audio systems. Forty different values of load impedance available between 2.5 and 20,000 ohms providing a convenient method of impedance matching. They may also be used to determine internal impedance or optimum load, to measure insertion loss of a network, to measure noise pick-up level, and to test band width, selectivity and fidelity.

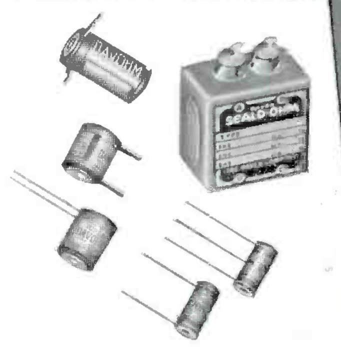


DAVEN ENGINEERED SWITCHES

Featuring extremely low and uniform contact resistance and low noise level. Daven switches are supplied in varied combinations of decks, poles per deck and contacts per deck. Heavy duty, laminated, self-wiping arms need no lubrication; switch contacts and arms are of a special silver alloy (other metals to your specifications); bakelite or ceramic panels; break-before-make or make-before-break wiring.

RESISTORS

Non-inductively precision wire wound SUPER DAVOHM resistors assure optimum permanency of calibration, close accuracy and extremely low temperature coefficients. Supplied in any resistance value from 0.1 ohm to 10 megohms. Built to tolerances within ±0.1%. To meet the most exacting requirements, Seald-Ohm resistors are offered. These hermetically sealed resistors may be obtained with the same characteristics as DAVOHMS.



Other Daven products include: Transmission Measuring Sets, Output Meters, Power Level Indicators, Decade Voltage Dividers, Logarithmic Resistor Boxes, Program Line Equalizers, Ratio Arm Boxes, Power Supplies, Decade Resistance Boxes and Electronic Frequency Meters

Write for the complete Daven Catalog on company stationery

THE DAVEN CO.

191 CENTRAL AVENUE
NEWARK 4, NEW JERSEY

RCA-1P42

—a tiny high-vacuum phototube with unusual possibilities

FEATURES

- Can be used in closely confined spaces
- Head-on structure permits close spacing of tubes in banks
- Excellent sensitivity—single amplifier stage is sufficient for many relay services
- Smooth end terminal permits pin-jack mounting
- High-vacuum insures high stability

THE RCA-1P42 high-vacuum phototube opens up entirely new fields of application to the design engineer—particularly for control purposes where space limitation is a prime consideration. Its extremely small size, combined with the unique "head-on" construction, permits exceedingly close spacing of the tubes in banks for controlling a large number of circuits, or the use of a single tube in closely confined quarters.

The semi-transparent cathode surface on the glass window in the large end of the 1P42 is sensitive to light sources predominating in blue radiation, and has negligible sensitivity to infrared radiation. The tube has an S-4 spectral response and maximum response at a wavelength of 4200 Angstroms.

The RCA-1P42 is especially designed for compact services such as the control of complex business-machine operations. It is also applicable to small equipment for sound-film reproduction.

A technical bulletin on the RCA-1P42 is available on request. RCA tube application engineers will be glad to work with you in adapting this or any other RCA tube types to your equipment designs. Address RCA, Commercial Engineering, Section D-6K, Harrison, N. J.

RATINGS AND CHARACTERISTICS

MAXIMUM RATINGS, ABSOLUTE VALUES:

Anode-Supply Voltage (DC or Peak AC)	150 max. Volts
Cathode-Current Density	14 max. Microamp/sq. in.
Average Cathode Current*	0.4 max. Microampere
Ambient Temperature	75 max. °C

CHARACTERISTICS:

Maximum Dark Current at 150 volts	0.005 Microampere
Sensitivity:	
At 4200 Angstroms	0.020 Microamp/uwatt
Luminous**	25 Microamp/lumen

MINIMUM CIRCUIT VALUES:

DC Load Resistance	1 Megohm

*On basis of the use of a sensitive cathode area 0.19" in diameter.

**Given for conditions where a Mazda projection lamp operated at a filament color temperature of 2870°K is used as a light source. With daylight, the value is several times higher; with light from a high-pressure arc, many times higher.

RCA Laboratories, Princeton, N. J.

THE FOUNTAINHEAD OF MODERN TUBE DEVELOPMENT IS RCA.

TUBE DEPARTMENT

RADIO CORPORATION of AMERICA

HARRISON, N. J.