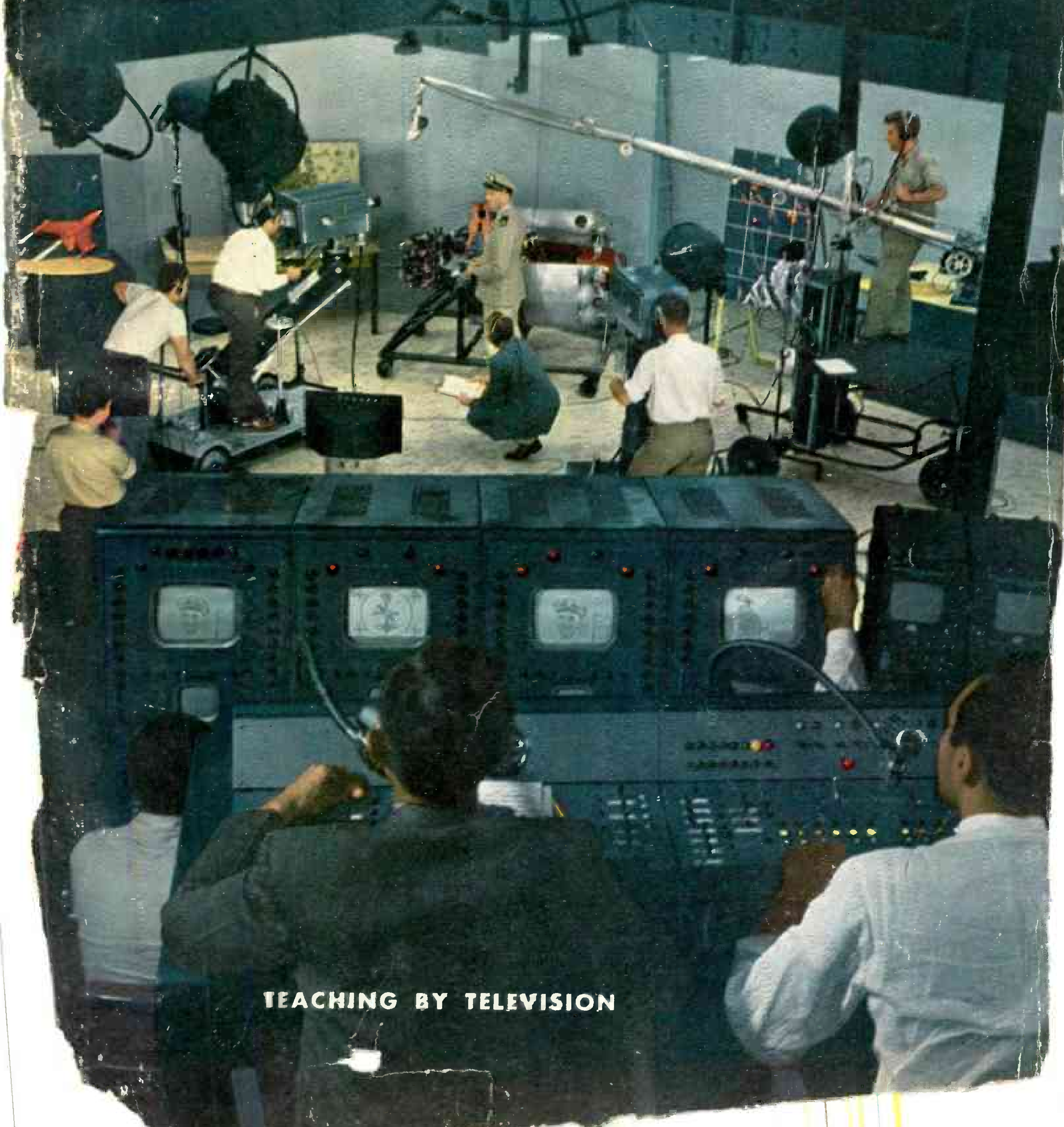
JANUARY · 1949

electronics

A McGRAW-HILL PUBLICATION



TEACHING BY TELEVISION

electronics

A McGRAW-HILL PUBLICATION

JANUARY • 1949

TEACHING BY TELEVISION .... Cover

From this studio at Navy Special Devices Center, Sands Point, Long Island, lectures and demonstrations by outstanding instructors can be telecast to distant classrooms, using microwave and coaxial links to existing TV networks. See p 128. Photo by Syd Karson

NEW CONCEPT OF COMMUNICATION ENGINEERING, by Norbert Wiener 74

A definition of the word "information" and a discussion of the broad aspects of communication

ULTRAFAX 77

Facsimile at half million words a minute uses microwave television and hot photography techniques

6,000-MC TELEVISION RELAY SYSTEM, by William H. Forster 80

Equipment at terminals and two intermediate points between New York and Philadelphia

DISTORTION AND NOISE METER, by Royden R. Freeland 86

Construction and use of audio measuring instrument for broadcast stations, as well as basis of design

RADIOISOTOPES FOR INDUSTRY, by A. P. Schreiber 90

Examples of successful tagged-atom applications for industrial measuring, controlling and tracing

SHUTTERLESS TELEVISION FILM PROJECTOR, by L. C. Downes and J. F. Wiggin 96

Tubes perform several functions in converting 24 frames per second to 30

DARKROOM TIMER, by A. Stuart MacKay and Richard R. Soule 101

Timer, using multiplier phototube for high sensitivity, automatically controls enlarger

F-M RECEIVER DESIGN PROBLEMS, by E. C. Freeland 104

Comparison of limiter-discriminator, ratio and synchronized-oscillator detectors; design trouble-shooting procedures

R-F BRAZING OF RADIO COMPONENTS, by R. A. Nielson 111

Induction heating speeds the assembly of antenna equipment

LOCKED OSCILLATOR FOR TELEVISION, by Kurt Schlesinger 112

Two types of flywheel circuits for control of the horizontal sweep oscillator in a receiver

HIGH-Q VARIABLE REACTANCES, by J. N. Van Scoyoc and J. L. Murphy 118

Wide range and high Q are obtained with a cathode-coupled dual triode

REDUCING STANDING WAVES, by R. E. Grantham 124

Chart shows directly how much the vswr is reduced by a given attenuation

BUSINESS BRIEFS 68
CROSSTALK 73
TUBES AT WORK 126
ELECTRON ART 130
NEW PRODUCTS 134
NEWS OF THE INDUSTRY 138
NEW BOOKS
BACKTALK
INDEX TO ADVERTISERS

MCGRAW-HILL PUBLISHING COMPANY, INCORPORATED, JAMES H. McGRAW (1860-1948), Founder • 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.

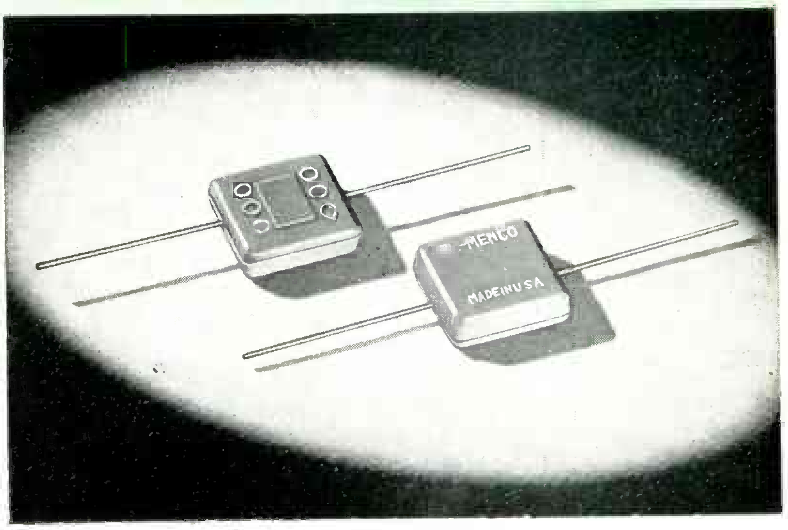
James H. McGraw, Jr., President; Curtis W. McGraw, Vice-President and Treasurer; Eugene Duffield, Executive Assistant for Publications; Nelson Bond, Director of Advertising; James A. Gerardi, Secretary; and J. E. Blackburn, Jr., Director of Circulation. ELECTRONICS. January. 1949. Vol. 22; No. 1. Published monthly, with an additional issue in June, price 75c a copy for U. S. and possessions, and Canada; $1.00 for Latin America; $1.50 for all other foreign countries. Directory issue $2.00. Allow at least ten days for change of address. All communications about subscriptions should be addressed to the Director of Circulation. Subscription rates—United States and possessions, $6.00 a year, $9.00 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. Latin 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 connections 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 3; Cleveland 15; Detroit 26; St. Louis 8; Boston 16; Atlanta 3, Ga.; 621 So. Hope St., Los Angeles 14; 738-9 Oliver Building, Pittsburgh 22. ELECTRONICS is indexed regularly in The Engineering Index.

"Because of a Nail... a Nation was lost...*"

* Because of a nail
a shoe was lost
Because of a shoe
a horse was lost
Because of a horse
a battle was lost
Because of a
battle a nation
was lost.

El-Menco

CAPACITORS, like the nail that lost a nation, are small . . . but their importance cannot be overemphasized. For *dependable* components that never "let a product down" — specify El-Menco.



MANUFACTURERS

Our silver mica department is now producing silvered mica films for all electronic applications. Send us your specifications.

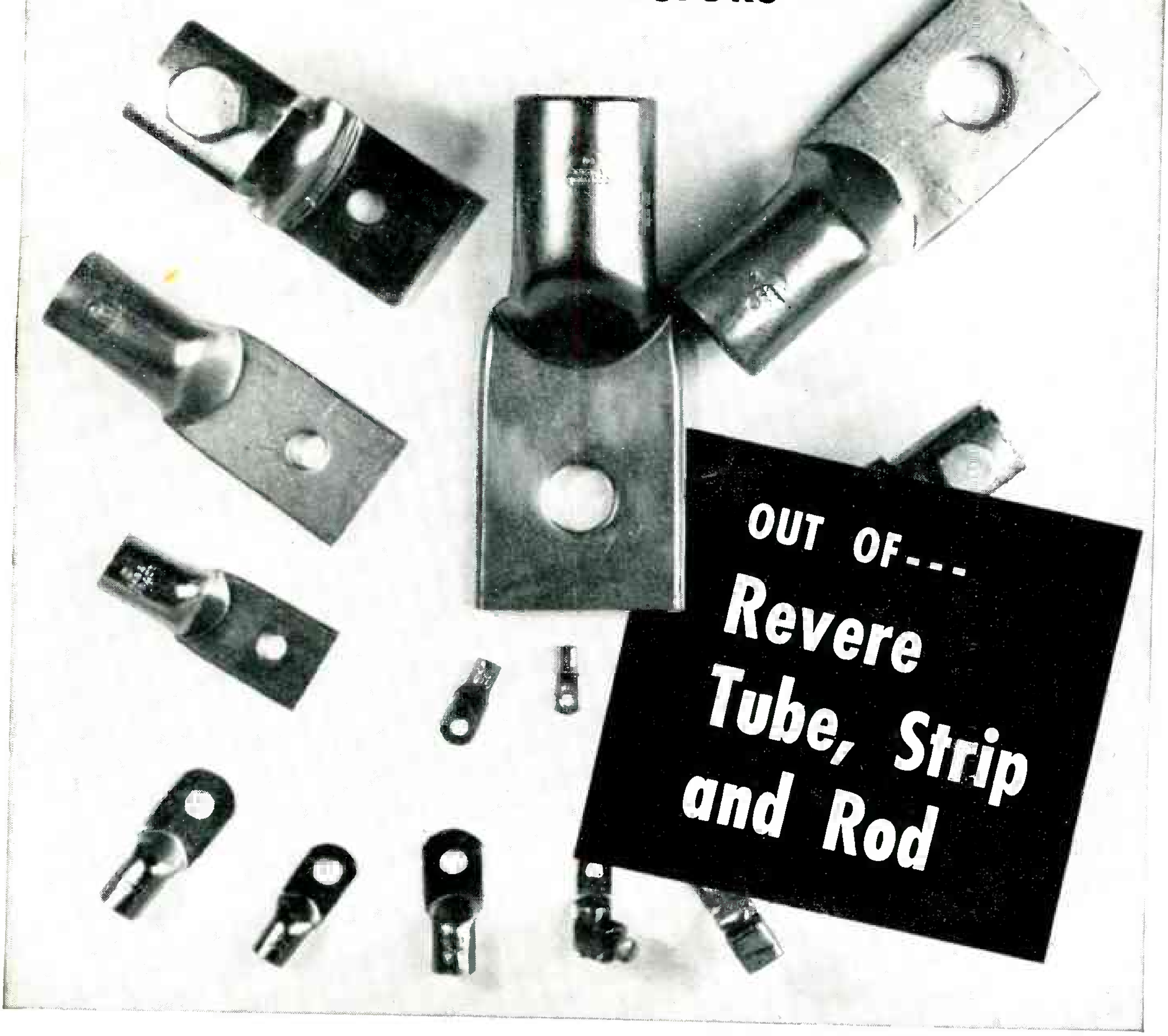
THE ELECTRO MOTIVE MFG. CO., Inc.
WILLIMANTIC, CONNECTICUT

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

JOBBERS AND DISTRIBUTORS
ARCO ELECTRONICS, INC.
135 Liberty St., New York, N. Y.
Sole Agent for Jobbers and Distributors in U. S. and Canada.

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

A MINIMUM OF OPERATIONS MADE THESE CONNECTORS



THESE electrical connectors are but a few out of the hundreds of types being made today out of Revere copper and copper alloy tube, strip and rod.

Soldering lugs are made of Revere seamless tube, and are finished by simple stamping and punching. Solderless connectors are manufactured of tube, strip, bar and rod. The easy workability of the metal, plus the fact that it is supplied in forms requiring a minimum of operations, make Revere a favorite source of supply.

Other Revere products for electrical purposes include: Electrolytic and silver bearing copper commutator bar and segments; O.F.H.C., silver bearing, and electrolytic copper for armatures and rotors of micromotors and fractional h-p motors; Specially Prepared Switch Copper for switches, bus bars and similar applications; Extruded copper shapes for contacts, contact arms, solderless connectors, etc., Free Cutting Rod for parts machined to close tolerances; Tubular rivet wire.

The Revere Technical Advisory Service will gladly work with you in studying your requirements and determining the Revere mill products that lend themselves to the most economical manufacture and best service.

• • •

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

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

Wide-band Amplifiers? High Sensitivity? Intensity Modulation? Amplitude Calibration? Low Price?

20 CPS—2 MC
Type 241
$458

Voltage Calibrator
Type 264-A
$39.50

Portable-22 lbs.
Type 164-E
$127.20

JUST CHOOSE FROM THESE DU MONT *Oscillographs*

Here's an adequate selection of Du Mont instruments to meet any of the foregoing requirements:

If you require a **wide-band amplifier,** there's a choice of either Type 241 (5-inch) or Type 224-A (3-inch). An intensity-modulation amplifier is also featured by the Type 241. The deflection factor of Type 241 is 0.07 rms v/in.; that of Type 224-A, 0.1 rms v/in.

If you require **quantitative measurements,** the Type 264-A Voltage Calibrator is available. It works with any oscillograph. Once attached, it need not be disconnected for operation of the oscillograph.

If **portability** is your main requirement, there is the Type 164-E weighing only 22 lbs. Its frequency response is uniform within 20% from 5 cps to 100 kc.

For a **high-sensitivity** (0.01 rms v/in.) general-purpose instrument, the Type 208-B is recommended. Its frequency response is within 10% from 2 cps to 100 kc.

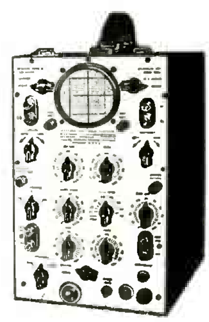
And as a very-low-priced **general purpose** 5-inch oscillograph, the Type 274-A is unsurpassed in its class. Its frequency response is within 10% from 20 cps to 50 kc; deflection factor is 0.2 rms v/in.

Regarding **price,** all these Du Mont oscillographs meet the demand for low price and high quality.

Write for detailed specifications describing all of these important Du Mont instruments.

General Purpose
Type 274-A
$136.50

Sensitive
0.01 RMS v/in.
Type 208-B
$285



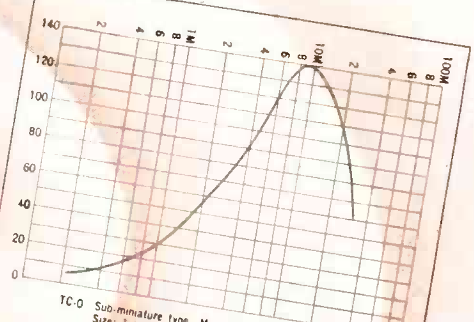
Wide Range
20 CPS—2 MC
Type 224-A
$290

DU MONT *for Oscillography*

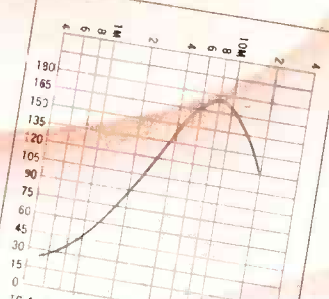
ALLEN B. DU MONT LABORATORIES, INC., PASSAIC, N. J.
CABLE ADDRESS: ALBEEDU, NEW YORK, N. Y., U. S. A.

BURNELL & CO., A LEADER IN THE DEVELOPMENT OF MINIATURE AND SUB-MINIATURE COILS AND FILTERS.. INTRODUCES.. THE 'WEDDING RINGS' WORLD'S SMALLEST HIGH 'Q' TOROIDAL COILS

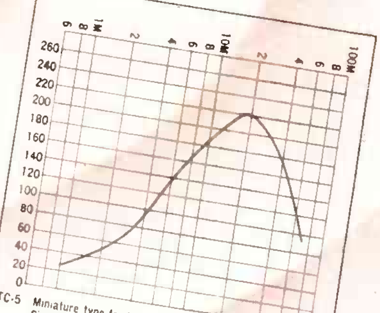
ACTUAL SIZE



TC-0 Sub-miniature type. Max. Q 140 as illustrated
Size: 7/8" D x 3/8" Weight: 3/4 oz.
Available up to 1 henry.



TC-4 Miniature type: Max. Q 170 as illustrated
Size: 1-3 16" D x 9 16" Weight: 2 oz.
Available up to 7 henries.



TC-5 Miniature type for higher frequency range. Max. Q – 220
Size: 1-3 16" D x 9 16" Weight: 2 oz.
Available up to 2 henries.

The characteristics of the types TC-1, TC-2 and TC-3 are available upon request.

Since discovering that toroidal coils are the solution to problems in compactness of communication and control equipment, design engineers have been confronted with the ever pressing problem of miniaturization.

A major step towards a solution has now been found and we take pleasure in presenting to the electronics field, the penultimate in the design of miniature high Q coils, the types TC-4 and TC-5 and the ultimate, sub-miniature TC-0 which is not much larger than a thumb nail.

For many applications, design engineers will benefit from our specialized experience in the manufacture of miniature components and filters by utilizing the performance capabilities, degressively, of their larger associates (Types TC-1, TC-2, TC-3) but compressed into midget proportions, permitting an elegant solution to the importunate problem of miniaturization.

All of the TC series are toroidally wound on molybdenum permalloy cores providing high Q with a stability unattainable by any other material.

EXCLUSIVE MANUFACTURERS OF COMMUNICATIONS NETWORK COMPONENTS

ALL INQUIRIES WILL BE PROMPTLY HANDLED

Burnell & Company
YONKERS 2, NEW YORK
CABLE ADDRESS "BURNELL"

WRITE FOR TECHNICAL INFORMATION

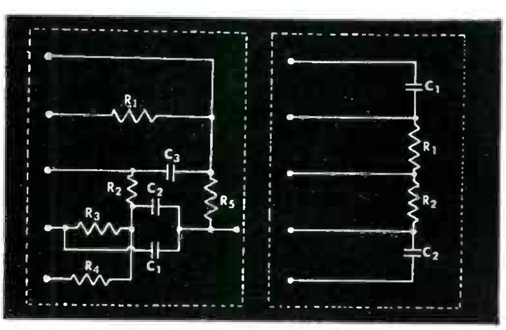
PROGRESS REPORT ON P.E.C.*

How Paravox uses Centralab's amazing *Printed Electronic Circuit* to build small, light, quickly-assembled hearing aids!

Note how CRL's special two-piece "Ampec" fits into the completely-molded Paravox unit. This plastic chassis makes it possible to dismantle or assemble a Paravox hearing aid in one minute — without the use of tools.

Models courtesy of Paravox, Inc.

Two-Piece P.E.C. "*Ampec*" and Model 1 "*Radiohm*" Switch are the Centralab units Paravox uses in its $4\frac{1}{2}$-ounce hearing aid. See below for schematic diagram of this custom *"Ampec"*.



*Centralab's "Printed Electronic Circuit" — Industry's newest method for improving design and manufacturing efficiency!

TIME, space and material savers! That's how Paravox, Inc., Cleveland hearing aid manufacturer, describes Centralab's revolutionary P.E.C. *"Ampecs"*. These tiny audio-amplifying units save time for Paravox by eliminating many assembling operations. They save space and material by reducing the number of components needed. What's more — like all CRL *Printed Electronic Circuits* — they are rugged, dependable, resistant to temperature and humidity.

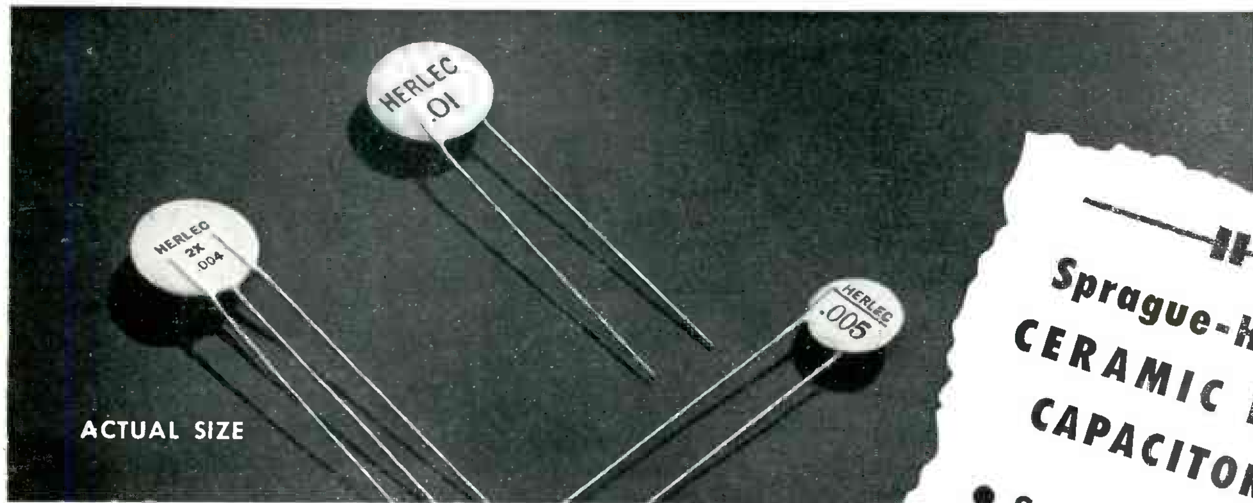
Integral ceramic construction: Each *Printed Electronic Circuit* is an integral assembly of *"Hi-Kap"* capacitors and resistors closely bonded to a steatite ceramic plate and mutually connected by means of metallic silver paths "printed" on the base plate. All leads are always the same length, each plate is an exact duplicate of the original or "master."

This outstanding hearing aid development, illustrated above, was the product of close cooperation between Centralab and Paravox engineers. Working with your engineers, Centralab may be able to fit its *Printed Electronic Circuit* to your specific needs. Write for complete information, or get in touch with your nearest Centralab Representative.

LOOK TO **Centralab** IN 1948!

CRL

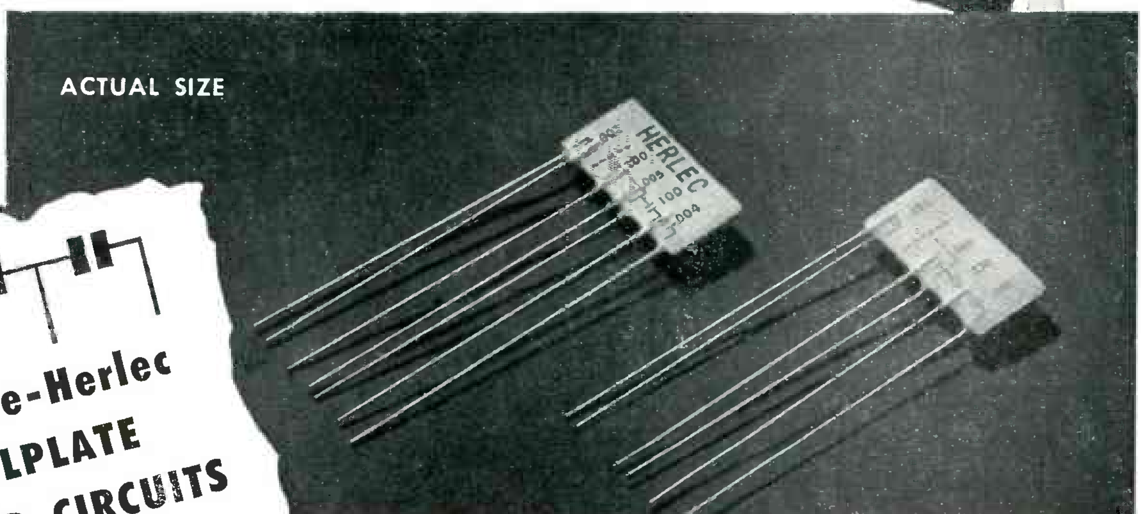
Division of GLOBE-UNION INC., Milwaukee



Sprague-Herlec CERAMIC DISC CAPACITORS

- Small in size
- Light in weight

These little by-pass and coupling type ceramic disc capacitors—shown here in actual size—offer distinct size advantages that warrant careful investigation. Now available in a broad range of values in single- and dual-capacity units that assure small size and a minimum of weight.



Sprague-Herlec *BULPLATE PRINTED CIRCUITS

- Space savers
- Simplify assembly
- Speed production

*Trademark Applied for

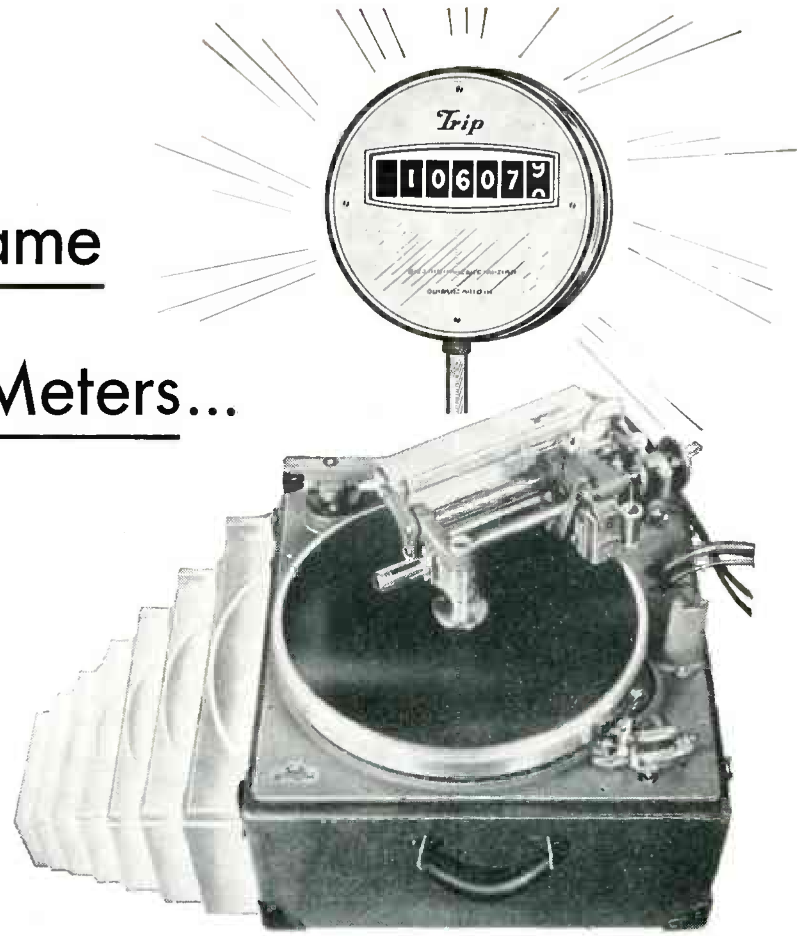
Here, in a unit only 1″ long x ½″ wide and 3/32″ thick, it is possible to obtain a 4-section capacitor incorporating such typical values as 2000, 5000, 220 and 220 mmfd.—and with only six leads to be soldered. Write for details of standard capacity combinations.

SPRAGUE

PIONEERS OF ELECTRIC AND ELECTRONIC PROGRESS

SPRAGUE ELECTRIC COMPANY • NORTH ADAMS, MASS.

If Recorders came with Mileage Meters...



Presto 6N would be *MILES AHEAD*

Yes, day after day and year after year over 3,000 Presto 6N recorders are hard at work in broadcasting stations, recording studios, educational institutions and government agencies throughout the world.

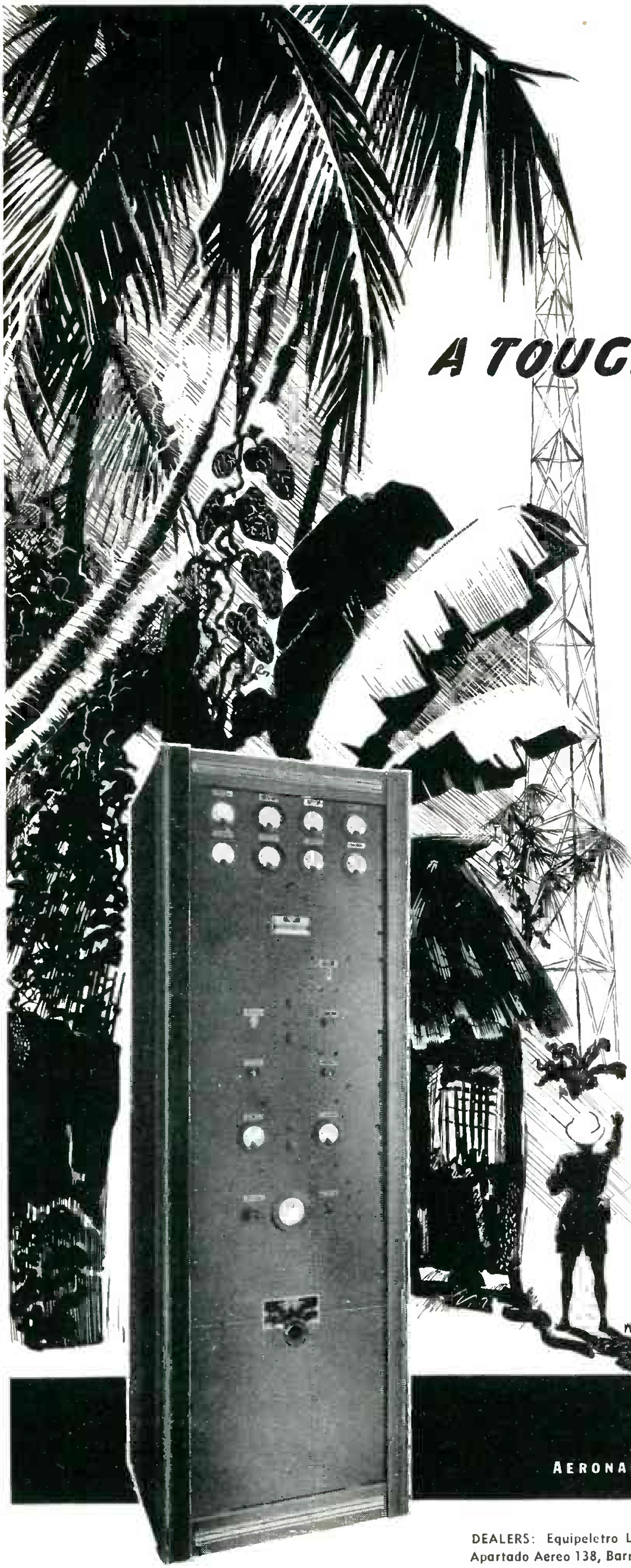
6N recorders purchased ten years ago are performing as well today as when they were new. This outstanding record of the 6N recorder in action is proof again that Presto design is built for hard, continuous duty and Presto materials are the finest obtainable.

So when you're looking for a new recorder, remember: By actual test the best recorder for the most people is Old Faithful, the Presto 6N.

PRESTO RECORDING CORPORATION, Paramus, New Jersey • *Mailing Address:* P. O. Box 500, Hackensack, N. J.

In Canada: WALTER P. DOWNS, Ltd., Dominion Sq. Bldg., Montreal

World's largest manufacturer of instantaneous sound recording equipment and discs



A TOUGH ASSIGNMENT

Down in the tropics that blazing equatorial sun and that dripping jungle humidity promise a short life for the average transmitter . . . but this is just the type of assignment that Aerocom's tropicalized communications equipment takes right in stride . . . You can depend on it to give long, trouble free, economical service. If yours is a tough communications assignment, Aerocom invites your inquiry.

Model 12ACX-2A

The model illustrated is a dual channel crystal controlled radio telegraph transmitter rated at one Kilowatt carrier. Frequency Range from 1.6 to 24 Megacycles. The design stresses reliability, low operation and maintenance costs, and operation in unattended service under most adverse climatic conditions. Accessory unit; High Level Modulator Model GM8 providing telephone operation with carrier power of 750 Watts. Other units: Models VH-50 and VH-200 transmitters, operating range, 118-165 Mcs. (crystal controlled) carrier power 50 and 200 Watts respectively, (A-3, AM.).

COMPLETE ENGINEERING DATA ON REQUEST.

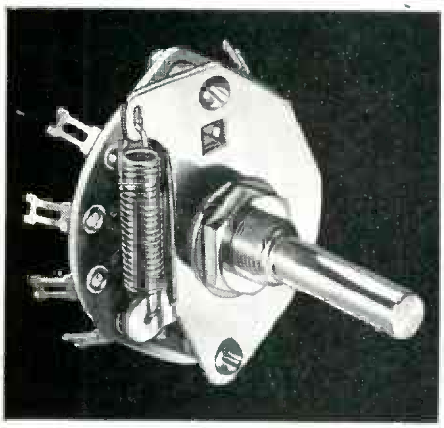
CONSULTANTS, DESIGNERS AND MANUFACTURERS OF STANDARD OR SPECIAL ELECTRONIC, METEOROLOGICAL AND COMMUNICATIONS EQUIPMENT.

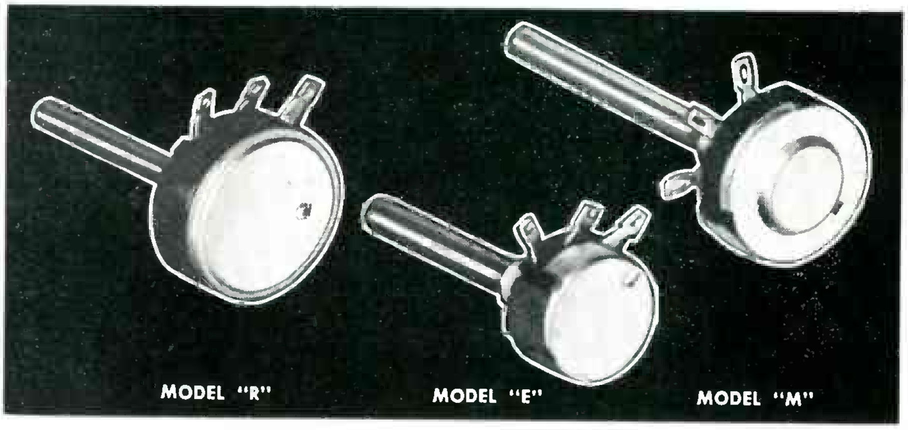
AER-O-COM (Reg. U. S. Pat. Off.)

AERONAUTICAL COMMUNICATIONS EQUIPMENT, INC.
3090 Douglas Road, Miami 33, Florida

DEALERS: Equipelctro Ltda., Caixa Postal 1925, Rio de Janeiro, Brasil ★ Henry Newman Jr., Apartado Aereo 138, Barranquilla, Colombia ★ Radelec, Reconquista 46, Buenos Aires, Argentina

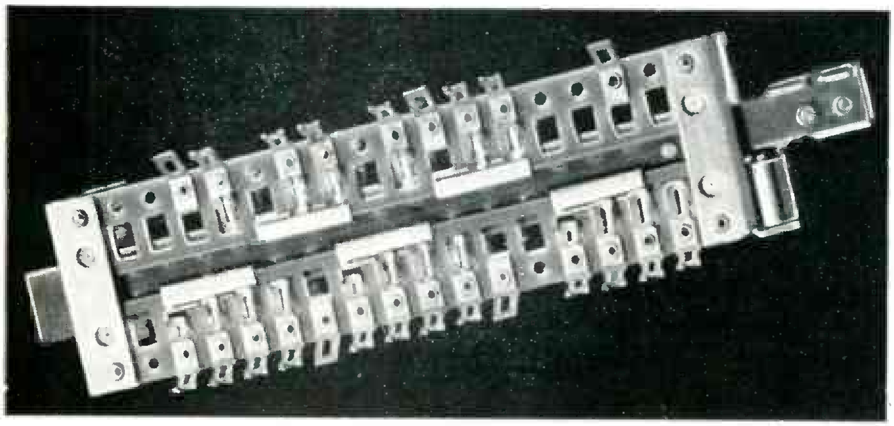
Electronic Industry

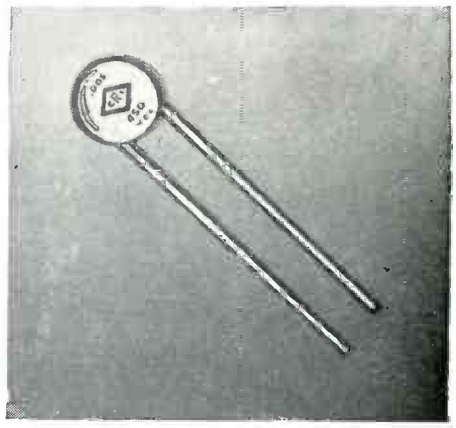




4 Great step forward in switching is CRL's New *Rotary Coil and Cam Index Switch*. Its coil spring gives you smoother action, longer life.

5 Let Centralab's complete *Radiohm* line take care of your special needs. Wide range of variations: *Model "R"* — wire wound, 3 watts; or composition type, 1 watt. *Model "E"* — composition type, 1/4 watt. Direct contact, 6 resistance tapers. *Model "M"*—composition type, 1/2 watt. For complete information, write for Bulletin 697.





6 Centralab's development of a revolutionary, new *Slide Switch* promises improved AM and FM performance! Flat, horizontal design saves valuable space, allows short leads, convenient location to coils, reduced lead inductances for increased efficiency in low and high frequencies. Rugged, efficient. Write for Bulletin 953.

7 For by-pass or coupling applications, check CRL's original line of ceramic disc and tubular *Hi-Kaps*. For full facts, order Bulletins 42-3 and 42-4.

LOOK TO CENTRALAB IN 1949! ***First in component research that means lower costs for the electronic industry. If you're planning new equipment, let Centralab's sales and engineering service work with you. Get in touch with Centralab!***

Centralab

DIVISION OF GLOBE-UNION INC., MILWAUKEE, WIS.

PHILCO

ONE OF THE WORLD'S FOREMOST ENGINEERING ORGANIZATIONS

With a research, engineering and field staff of more than 1000 technically trained individuals, Philco is today applying *more manpower to its farflung engineering activities* than to any other phase of the company's operations except the actual manufacture of its products.

Philco scientists and engineers are engaged in a diversified program ranging from fundamental research in various fields of physics, chemistry, electronics and applied mathematics to design and development work on hundreds of materials, components and finished products. Manufacture of these products—home and auto radios, radio-phonographs, television receivers—refrigerators, freezers, air conditioners—mobile radio-telephone, microwave relays and communications equipment—radar, loran and military devices—calls for additional engineering talents applied to mass production. And still other engineers are making important contributions in such activities as Philco television station WPTZ and a worldwide organization of field service engineers.

Another important phase is the company's participation with leading technical institutions in joint undergraduate cooperative courses and in advanced graduate and postgraduate studies.

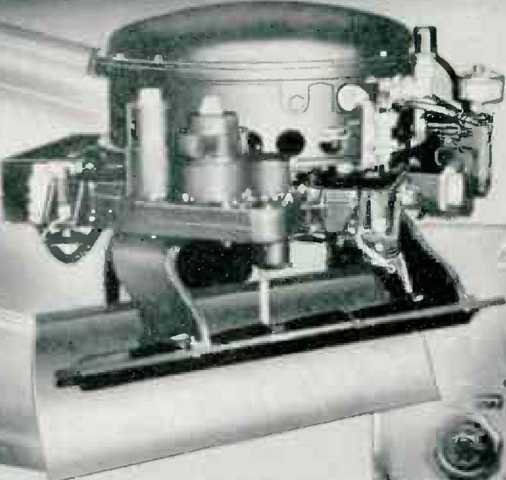
On the pages within are presented some illustrations of the scope and character of the work being done by Philco scientists and engineers to advance the frontiers of knowledge in electronics.

MICROWAVE RELAYS FOR TELEVISION AND COMMUNICATIONS

PRODUCTS OF PHILCO ENGINEERING

GOOD PRODUCTS stem from good engineering. Philco products have established a world-wide reputation for quality during the 56 years of the company's history, and that reputation has been solidly founded on engineering achievement.

Now, as Philco extends its research and engineering scope far beyond the horizons of a few years ago, the men and women of its vast laboratories are engaged in a diversified program of pioneering the new and even better products of tomorrow. Today new opportunities for engineers and research scientists are opening up in Philco's expanding activities in radio, television, refrigeration and industrial electronics.



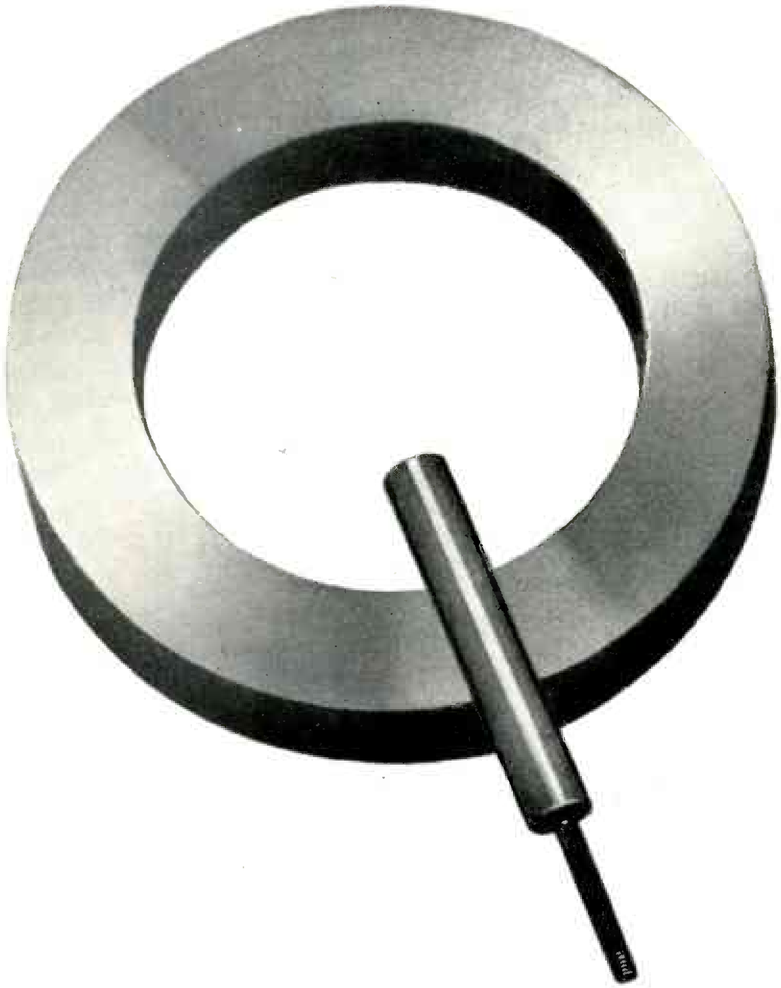
AIRBORNE RADAR

AUTOMOBILE RADIO RECEIVERS AND AM AND FM COMMUNICATIONS EQUIPMENT

LORAN FOR MARINE AND AIRCRAFT NAVIGATION

RECORD PLAYER FOR MICROGROOVE LONG PLAYING RECORDS

TELEVISION, AM, FM, RADIO-PHONOGRAPH COMBINATION



It's the consumer's fault. Last year he wanted signal quality...this year he is demanding it! That is why estimates show that practically all Television sets, *and most of the Radio sets* made in 1949 will contain cores made of Carbonyl Iron Powders. Ask your coil winder. Ask your core maker. There's a hint here for all good designers.

G. A. & F. CARBONYL IRON POWDERS

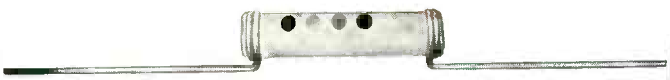
An Antara® Product of General Aniline & Film Corporation
444 Madison Avenue, New York 22, New York

MOLDED INSULATED TUBULAR GP CERAMICONS

Have extremely rugged, molded insulation, axial leads. Capacity range 10-5,000 MMF. Smallest size .250" x .562" max.

DIPPED INSULATED GP CERAMICONS

For use where space is at a premium and radial leads are desired. Capacity range 10-15,000 MMF. Smallest size .240" x .460" max.



NON-INSULATED GP CERAMICONS

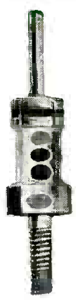
Smallest size units. Have baked enamel coating, radial leads. Capacity range 10-15,000 MMF. Smallest size .200" x .400" max.

INSULATED STAND-OFF CERAMICONS

Rugged, molded insulated construction. Mounts with 6-32 nut. Style 323 mounts 19/32" high above chassis. Capacity range 0.5-700 MMF. Style 324 mounts 27/32" high. Capacity range 710-1,500 MMF. Available with 20 gauge wire lead or post type top terminal.

NON-INSULATED STAND-OFF CERAMICONS

Style 318 (left) mounts ½" high above chassis, has .032" diameter wire top terminal. Capacity range 1-560 MMF. Style 319 (right) mounts .520" high, has .067" diameter top terminal. Capacity range 2-1,000 MMF. Both styles have 3-48 thread.



SIDE-LEAD STAND-OFF CERAMICONS

Wire leads are correct height from chassis for shortest possible connection to tube sockets. Style 2322 (left) 45/64" high. Capacity range 5-2,500 MMF. Style 2336 (right) 15/16" high. Capacity range 6-5,000 MMF.

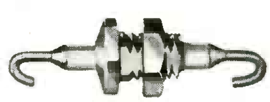
For Any and All By-Passing Requirements ERIE CERAMICONS®

Erie Ceramicons fulfil all the requisites for efficient by-passing—low inductance, compact design, and conservative 500 volt D. C. rating. Erie Resistor offers the most complete line of ceramic by-pass units available. Each design has been thoroughly proven in domestic and military equipment.

Check the products listed on this page for your future designs. Full description and specifications will be sent on request.

FEED-THRU CERAMICONS

By-pass R. F. to ground when feeding through chassis or metal can. Body length ⅝"; mounted with 12-28 nut. Type 362 (above) has 20 gauge feed-thru wire. Capacity range 5-1,500 MMF. Type 357 (below) has 0.55" diameter hooked ends feed-thru wire; capacity range 5-1,000 MMF.



FOR UHF COMMUNICATIONS EQUIPMENT ERIE BUTTON SILVER MICAS

These extremely compact silver mica condensers have 360° current path from short, heavy terminals to ground, providing very low inductance. Made in Stand-off and Feed-thru styles. Capacity range 15-1,000 MMF in .447" diameter, 1,000-6,000 MMF in .651" diameter.

Electronics Division

ERIE RESISTOR CORP., ERIE, PA.

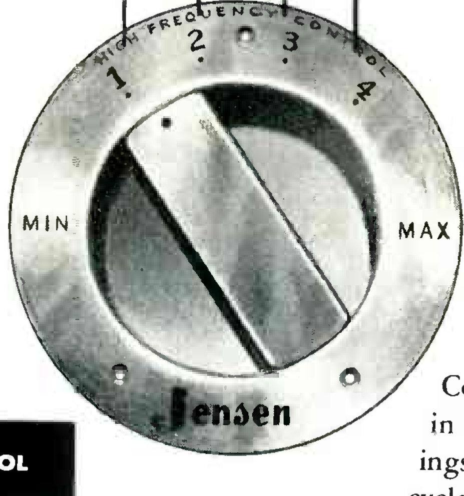
LONDON, ENGLAND • TORONTO, CANADA

2. for average "AM" Broadcast

3. for High-quality "AM", "LP" Records, and Transcriptions

1. for some Phono Records and "SW" Broadcasts

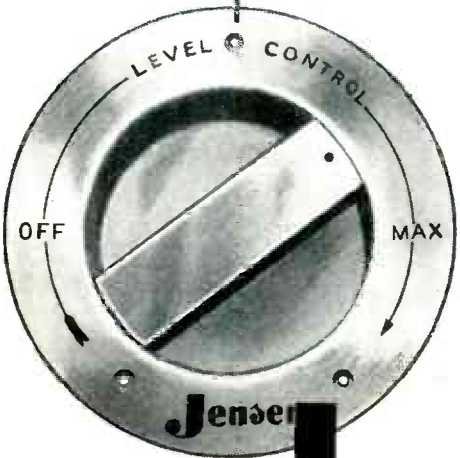
4. for "FM" and Television Sound



FOR GREATER LISTENING PLEASURE

—MATCH YOUR SPEAKER RESPONSE TO THE PROGRAM

OVERALL LEVEL CONTROL



Complete listening enjoyment of the quality inherent in FM broadcasts and high-fidelity phonograph recordings may require loudspeaker response up to 12,000 cycles or more. AM broadcasts may demand response of 5,000 cycles or less, while other program material may call for other high-frequency cut-off points. Matching loudspeaker response to today's wide range of program material is essential for real listening pleasure. Jensen Coaxial speakers (Models HNP-51, JAP-60 and JHP-52) meet this need simply and positively. A 4-position high-frequency selector switch adjusts the speaker response to suit listener preference and a level control adjusts the overall volume of the program. These two controls are exclusive JENSEN features.

Jensen *Coaxial* SPEAKERS

JENSEN MANUFACTURING COMPANY, 6607 S. LARAMIE AVE., CHICAGO 38, ILL.
IN CANADA: COPPER WIRE PRODUCTS, LTD., 11 KING ST., W., TORONTO

Model HNP-51 Coaxial

Without doubt the finest existing 15-inch Coaxial loudspeaker regardless of price. Compression-type h-f unit contributes to an exceptional polar pattern and realistic "presence". Frequency response, in a Bass Reflex enclosure, extends through the entire useful frequency range. Power rating 25 watts maximum speech and music signal input. Input impedance 500-600 ohms.

List price $125.00

Model JAP-60 Coaxial

A superior quality 15-inch Coaxial loudspeaker with excellent polar pattern. Response, in a Bass Reflex enclosure, extends through the entire useful frequency range. Power rating 20 watts maximum speech and music signal input. Input impedance 500-600 ohms.

List price $85.00

Model JHP-52 Coaxial

A high-quality 15-inch Coaxial loudspeaker at an economy price. Frequency response, in a Bass Reflex enclosure, extends through the entire useful frequency range. Power rating 16 watts maximum speech and music signal input. Input impedance 500-600 ohms.

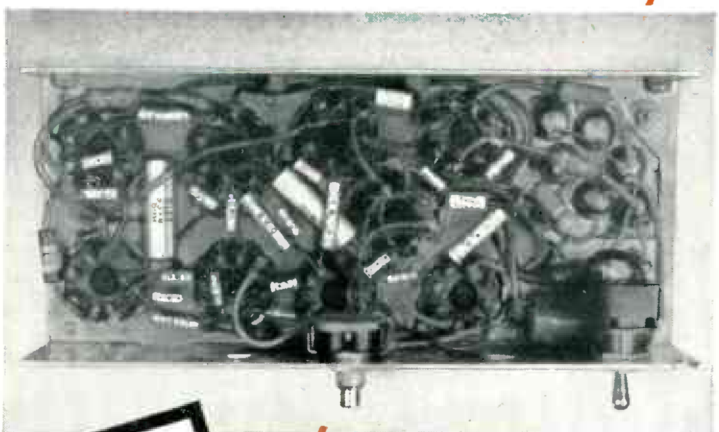
List price $72.00

Model JRP-40 Coaxial

The ultimate in 12-inch Coaxial value. Frequency range, in a Bass Reflex enclosure, from 50 to 12,000 cycles. Power rating 12 watts maximum speech and music signal input. Input impedance 6-8 ohms. "Bridging" type network. H-F range control not included but "shelving" type control (ST-606) may be added by user.

List price $30.00

Specify HI-Q COMPONENTS for MINIATURIZATION



FOR superior performance in a limited space, the utilitarian compactness of **HI-Q** components is sure to meet your enthusiastic approval. Although **HI-Q** components are compact, there is no sacrifice of accuracy, dependability or uniformity. Each component meets or surpasses rigid standards for capacity, tolerance and performance. This compactness is accomplished through application of up-to-the-minute processing techniques, combined with use of highest quality materials and complete control of quality throughout all stages of manufacture. Specify **HI-Q** for *maximum* efficiency in a *minimum* amount of space.

HI-Q MINIATURE G. P. TUBULARS

G. P. Miniatures providing capacities from 5 mmf to 33,000 mmf will cover the majority of your by-passing problems. By the use of our new body 41 the above extended capacity ranges are now available. These smaller units provide closer coupling of leads thus insuring the minimum of inductance and highest self resonant frequencies. Illustration at left is actual size.

HI-Q DISK CAPACITORS

BPD Another example of accurate and dependable miniaturization is this high dielectric by-pass, blocking or coupling Hi-Q Disk Capacitor. Many applications where physical shape is more adaptable than the tubular unit. Available in two standard capacities:
Type BPD-5: .005 mfd guar. min.
Type BPD-10: .01 mfd. guar. min.
Type BPD-1.5: .0015 mfd. guar. min.
Illustration at right is actual size.

HI-Q COMPONENTS BETTER 4 WAYS

PRECISION Tested step by step from raw material to finished product. Accuracy guaranteed to your specified tolerance.

UNIFORMITY Constancy of quality is maintained over entire production through continuous manufacturing controls.

DEPENDABILITY Interpret this factor in terms of your customers' satisfaction . . . Year after year of trouble-free performance. Our Hi-Q makes your product better.

MINIATURIZATION The smallest BIG VALUE components in the business make possible space saving factors which reduce your production costs . . . increase your profits.

HI-Q *Electrical Reactance Corp.*
FRANKLINVILLE, N. Y.

Plants: FRANKLINVILLE, N. Y.—JESSUP, PA.
Sales Offices: NEW YORK, PHILADELPHIA, DETROIT, CHICAGO, LOS ANGELES

GARDNER TRANSFORMER LEADS ARE INSULATED AND PROTECTED

With

NATVAR 400

Gardner distribution transformers are built in the new, modern factory building of the Gardner Electric Manufacturing Company, Inc. in Emeryville, California, "close to the center of the most rapidly growing part of the United States."

It is this rapid growth that taxes distribution facilities to the limit, and places a premium on the ability of the equipment to handle "temporary" overloads far in excess of rated capacity. Gardner transformers are now being used by a majority of the principal Power Companies in this Pacific Coast Area.

Natvar 400 Extruded Vinyl Tubing, approved for 105°F is used to insulate and protect leads, because it meets operating temperature requirements, and in addition, has uniformly superior resistance to oil.

Prompt deliveries can be made either from a nearby wholesaler's stock or direct from our own. Full Underwriters report on request.

Natvar

Natvar Products

- Varnished cambric—straight cut and bias
- Varnished cable tape
- Varnished canvas
- Varnished duck
- Varnished silk
- Varnished special rayon
- Varnished Fiberglas cloth
- Silicone coated Fiberglas
- Varnished papers
- Slot insulation
- Varnished tubings and sleevings
- Varnished identification markers
- Lacquered tubings and sleevings
- Extruded vinyl tubing and tape
- Extruded vinyl identification markers

Ask for Catalog No. 21

THE NATIONAL VARNISHED PRODUCTS *Corporation*

TELEPHONE RAHWAY 7-2171

CABLE ADDRESS NATVAR: RAHWAY, N. J.

201 RANDOLPH AVENUE ★ WOODBRIDGE NEW JERSEY

ELECTRONICS

Designers

NOW AVAILABLE FOR YOUR COMMERCIAL APPLICATIONS

CAPACITOR PULSE-FORMING NETWORKS

Developed by General Electric and proven by the thousands in the war, these compact units are now available for any commercial use. They find application in radar and industrial equipment where the normal capacitor discharge shape is not suitable and where an impulse having a definite energy content and duration is required. The network consists of one or more equal capacitor sections and the same number of inductance coil sections. Both capacitors and coils are hermetically sealed in the same metal container. Networks are treated with top quality mineral oil to provide stability of capacitance characteristics over a wide range of ambient temperatures. Sizes from which you can make your selection range from a 0.5-kw output rating to 4500-kw. Write for bulletin GEA-4996.

DESIGNED FOR BETTER READABILITY

General Electric's new line of 3½-inch thin panel instruments will save space and add to the appearance of your panels. They're dust-proof, moisture resistant, and vibrations normally encountered in aircraft and moving vehicles have no adverse effects. Especially designed for better readability, the scale divisions stand out by themselves. Lance-type pointers and new-style numbers mean faster reading. Available in square and round shapes, depth behind the panel is only 0.99 inches. Construction is of the internal-pivot type, with alnico magnets for high torque, good damping, and quick response. Check bulletin GEA-5102.

GENERAL ELECTRIC

Digest

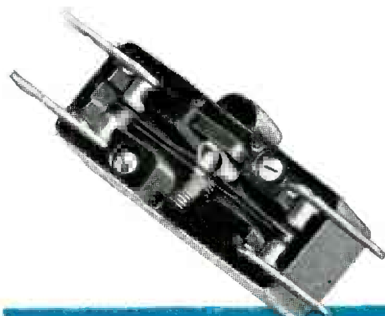
TIMELY HIGHLIGHTS ON G-E COMPONENTS

SIMPLIFY CONTROL WIRING WITH THESE TERMINAL BOARDS

Easy-action hinged covers protect control wiring, help give your product a neat appearance. Hook-ups are easy with the hard-gripping connectors. Simply strip the wire end, screw down the connector on the bare wire. Blocks are durable, too, constructed of strong Textolite with reinforced barriers between poles to insure against breakage. Marking strips are reversible—white on one side, black on the other. These terminal boards are available with 4 to 12 poles, 2 inches wide, 1¼ inches high. Send for bulletin GEA-1497C.

HOLDS OUTPUT VOLTAGE CONSTANT

This latest addition to G.E.'s line of automatic voltage stabilizers comes in 15-, 25-, and 50-va ratings. Output is 115 volts, 60 cycles. The small size of the unit makes it particularly applicable to shallow-depth installations in many types of equipment. You may have a job for this unit which will give you automatically stabilized output voltage at a low cost. There are no moving parts, no adjustments to make; long service is assured. Check bulletin GEA-3634B for more information about this and other G-E voltage stabilizers.



LOOKING FOR LIGHTWEIGHT SWITCHES?

Switchettes* are designed for applications which require a manually operated electric switch in a limited space. Though small, these switchettes are lightning fast in action and are built to withstand severe service. A wide variety of forms and terminal arrangements makes them particularly useful where special circuit arrangements are necessary. Switchette shown above has one normally open and one normally closed circuit, transferable when button is depressed. Check bulletin GEA-4888.

*Switchette is General Electric's trade name for these small snap switches.

FOR YOUR COOLING FANS

Here's a fractional-horsepower fan motor suitable for many uses because of its compact design, low servicing requirements, and extreme quietness. Long, dependable operation is assured by sturdy, totally enclosed construction. These Type KSP unit-bearing motors are of shaded pole type design with low starting torque characteristics especially applicable to fans. A continuous oil circulation system furnishes good lubrication. You can use simple, hubless, low-cost blades with the special mounting arrangement. Write for bulletin GEC-219.

General Electric Company, Section E 642-19
Apparatus Department, Schenectady, N. Y.

Please send me the following bulletins:

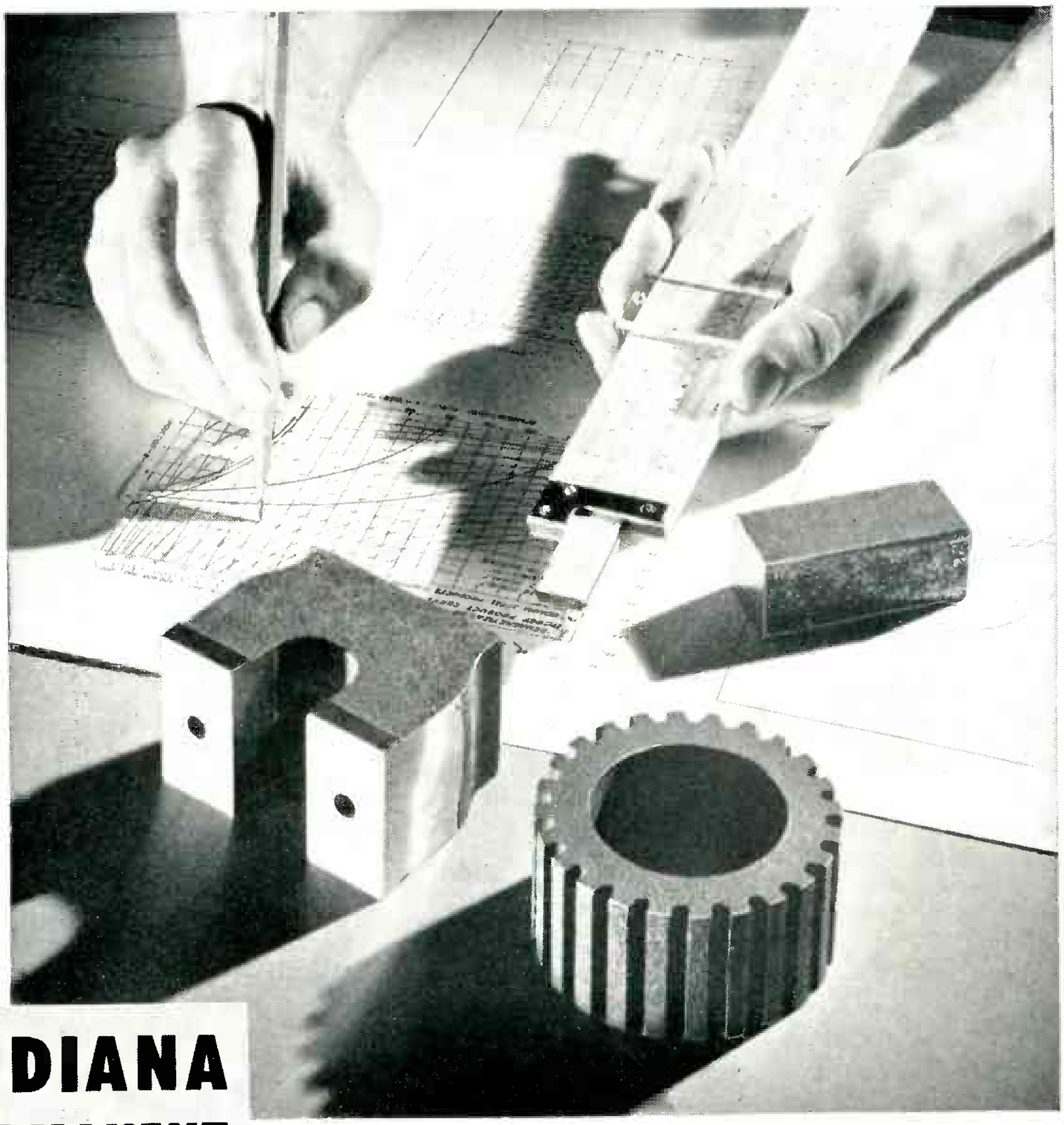
☐ GEA-4996 Capacitor Pulse-forming Networks
☐ GEA-3634B Automatic Voltage Stabilizers
☐ GEA-5102 Panel Instruments
☐ GEA-4888 Switchettes
☐ GEA-1497C Terminal Boards
☐ GEC-219 Unit-bearing Fan Motor

NAME..........

COMPANY..........

ADDRESS..........

CITY.......... STATE..........



INDIANA PERMANENT MAGNETS may be your answer, too...

"Packaged Energy" Saves Size, Weight, and Cost

Every day, *Indiana* permanent magnets are opening new fields, bringing new opportunities to science and industry. From magnetic can openers to cosmic ray research, these permanent magnets—of new designs and increased efficiency—enable equipment to do *a better job.* They add new functions . . . step up performance . . . *cut costs.* These magnet developments can mean extra profits for *you*—for "packaged energy" may have direct application to *your own* methods and products.

Our specialists have a complete range of magnetic alloys for casting, sintering, or forming permanent magnets as large or as small as you need. Strict supervision of *every step* in production assures magnets of *exact* characteristics, both magnetic and mechanical. The experience and know-how of more than 25,000 different applications are at your service. Let us help you with *your* magnetic problems, too. Write today.

● *Indiana*—world's largest exclusive producer of permanent magnets—is the *only* manufacturer furnishing *all* commercial grades of permanent magnet alloys. The most commonly used are:

CAST:
Alnico I, II, III, IV, V, VI, and XII; Indalloy; Cunico; Cobalt.

SINTERED:
Alnico II, IV, V; Indalloy; Vectolite.

DUCTILE:
Cunico; Cunife I and II; Silmanal.

FORMED:
Chrome; Cobalt; Tungsten.

Ask for free Book No. 4-E1 —our new permanent magnet reference manual. A note on your company letterhead will bring a copy to your desk.

ISP

THE INDIANA STEEL PRODUCTS COMPANY

PRODUCERS OF "PACKAGED ENERGY"
6 NORTH MICHIGAN AVENUE - CHICAGO 2, ILL.

SPECIALISTS IN PERMANENT MAGNETS SINCE 1908
PLANTS: VALPARAISO, INDIANA; CHAUNCEY, N. Y.

Illustrated is the new Bendix-Pacific Model TXV-2A Transmitter for 217 mc.

COMPLETE REMOTE INSTRUMENTATION

Bendix-Pacific Telemetering System

Engineered for precise remote instrumentation on guided missiles, aircraft and for industrial uses, Bendix-Pacific Telemetering Systems incorporate time-tested sub-miniature components which offer many special advantages.

Bendix-Pacific Systems have demonstrated their ability to withstand extreme vibration and shock and still accurately measure voltages, current, airspeed, altitude, pressure, R.P.M., gyro gimbal position, temperatures, strain and various motions and movements. In addition to aircraft, these Systems can be utilized in many industrial applications where conventional means of measurement are impractical because of inaccessibility.

Due to the unusually small size of the Bendix-Pacific units, a typical six-channel system complete with power supply and transmitter can be packaged in 130 cubic inches of space and weighs less than 12.5 lbs. They can be used on 80-84 mc or 210-220 mc.

Bendix-Pacific provides complete design and manufacturing facilities to assist in application problems. Information available to qualified companies.

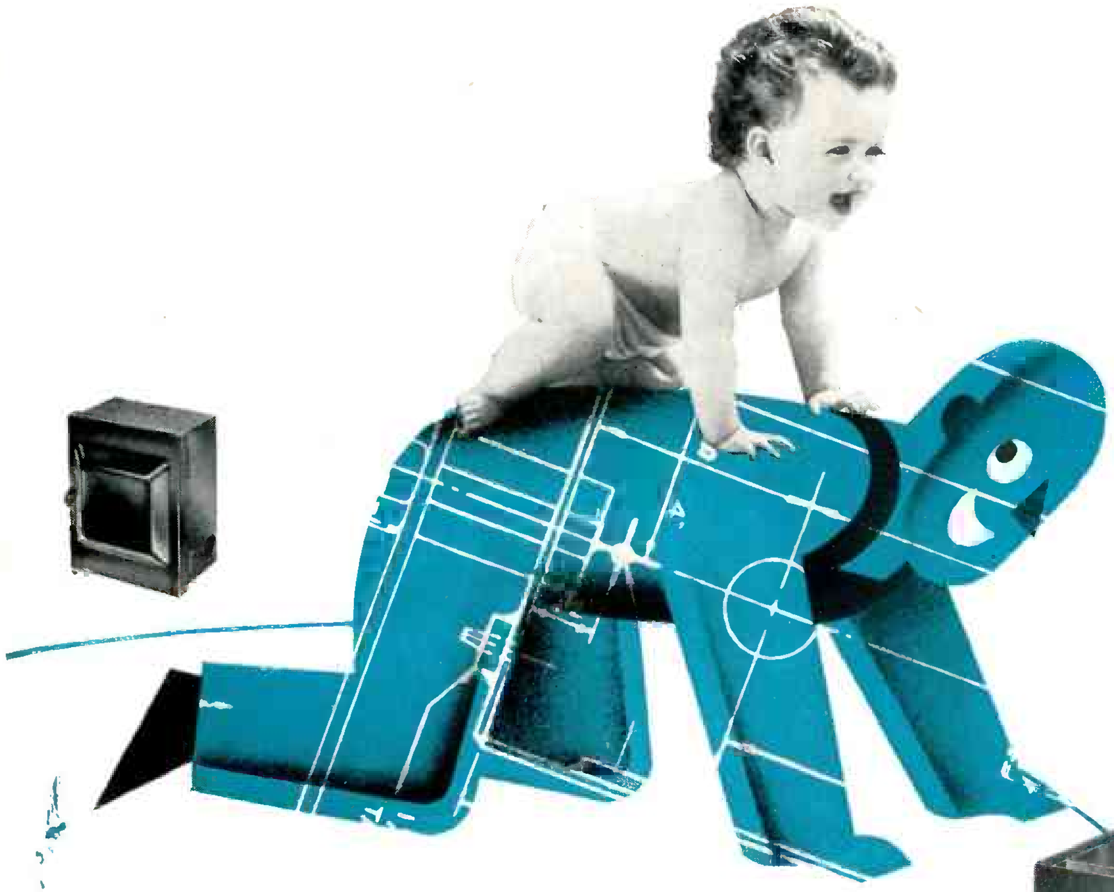
THESE BENDIX-PACIFIC SENSING INSTRUMENTS ARE AVAILABLE

FUNCTION	PHYSICAL SIZE	WEIGHT
Acceleration (Rep. to ± 100G)	1½ dia. x 1½ long	0.6 lbs. (TTG-2A)
Pressure Diff (0-200 psi)	1⁹⁄₁₆ dia. x 1¼ long	0.65 lbs. (TTP-3A)
Pressure (sealed REF. 200 psi)	1⁹⁄₁₆ dia. x 1¼ long	0.65 lbs. (TTP-3A)
Pressure (0-3000 psi)	1½ x 1½ x 1¹³⁄₁₆ long	0.75 lbs. (TTP-6A)
Motion linear or angular	1⅜ dia. x 1¹⁵⁄₁₆ long	0.45 lbs. (TTI-3)
Strain gage Oscillator	6¹³⁄₁₆x long x 1⁷⁄₁₆ x 1⁵⁄₁₆	0.40 lbs. (TOR-4A)
Temperature gage Oscillator	6³⁄₁₆ x 1⁷⁄₁₆ x 1⁵⁄₁₆	0.40 lbs. (TOR-4A)
Voltoge Oscillator	4½ x 1⁷⁄₁₆ x 1⁵⁄₁₆	0.35 lbs. (TOE-8A)
Current Oscillator	4½ x 1⁷⁄₁₆ x 1⁵⁄₁₆	0.19 lbs. (TOX-4A)

Pacific Division
Bendix Aviation Corporation
NORTH HOLLYWOOD, CALIF.

TO MEASURE . . . TO INDICATE . . . TO WARN . . . AT A DISTANCE

Eastern Sales Office: 475 Fifth Ave., N. Y. 17 • Canadian Distributors: Avaition Electric Ltd., Montreal • Export Agents: Bendix International, 72 Fifth Ave., N. Y. 11



We love the little ones

It's true that we do some very elaborate precision work in sheet metal housings, for some of America's most distinguished manufacturers. It's also true that we have just moved into one of the largest and best equipped plants of its kind.

But it's NOT true that our reputation for highest quality has made us "HIGH HAT," or that our prices are too high for small jobs, or that we do not seek plain and simple work.

Just as the world's most famous jeweler is pleased to sell a plain and modestly priced wedding ring as well as a diamond necklace, so it is our policy to handle the simplest jobs as well as the most intricate projects. The very fact that our capacity is so large and our facilities so complete, makes it possible for us to handle all jobs, big or small, simple or intricate.

Whether the job is on a major or minor scale, our prices are competitive. And you will enjoy the same helpful service and cooperation we render all our customers, big or small.

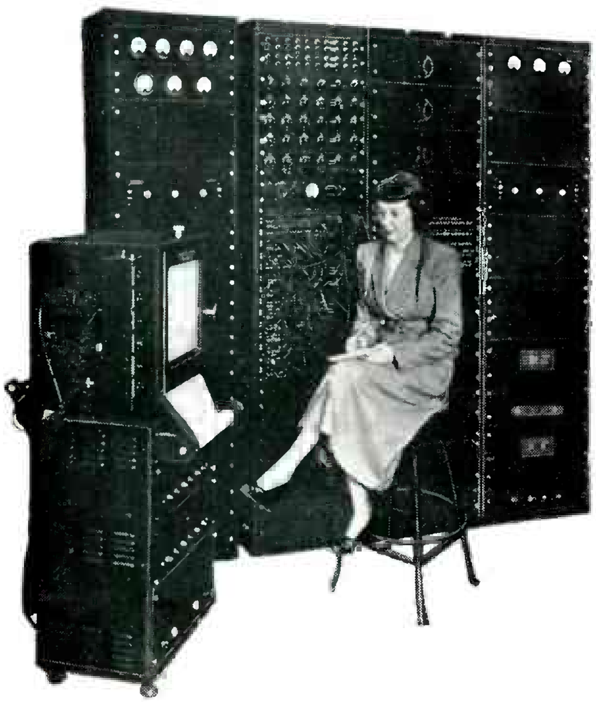
KARP METAL PRODUCTS CO., INC.

215 - 63rd STREET, BROOKLYN 20, NEW YORK

Custom Craftsmen in Sheet Metal

the "electronic brain"...

both A.C. & D.C. voltages accurately held with Sorensen equipment



The Reeves Electronic Analog Computer, known in industry as REAC, is the first standard office size electronic"brain". This machine makes possible the rapid dynamic analysis of high order linear and non-linear differential equations, doing in a few hours computations formerly taking thousands of man-hours.

Nearly all major aircraft companies and many process industries are already making use of this amazing electronic "brain" to speed up computations.

voltage regulator by sorensen A. C. Voltage accuracies in REAC are held to ½ of 1% by a Model 150 Sorensen Voltage Regulator which controls all the servo follow up potentiometers. These limits must be met in order to maintain the high accuracy expected of the computer even though it is subjected to wide line variations.

nobatron by sorensen In the computing amplifiers of REAC are 80 electronic tubes which require ¼ of 1% hum free regulation of the D. C. for filament power. That is ideally done with a Model E-6-40 Nobatron.

If you calibrate meters, need quality control on test lines, work with X-ray equipment or are a research physicist or chemist, there is a *standard* Sorensen A. C. or D. C. unit to solve your voltage problems. With their use you will experience: • *Precise regulation accuracy* • *Excellent wave form* • *Fast recovery time* • *Constant output voltage* and many other advantages. Ask for our latest catalog or put your Voltage Regulation Problems up to our engineers for a specific recommendation.

THE FIRST LINE OF STANDARD ELECTRONIC VOLTAGE REGULATORS.

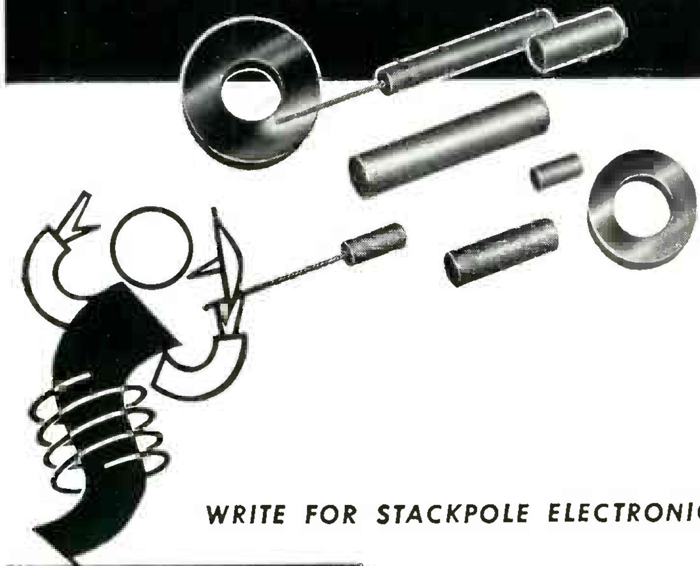
Sorensen at Stamford

SORENSEN & *Company, Inc.*

Stamford, Connecticut

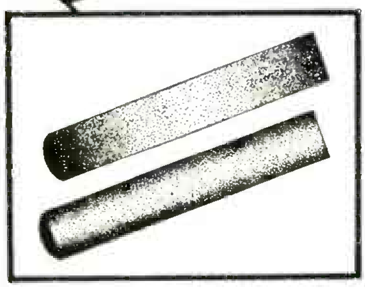
Represented in all principal cities.

IT'S STACKPOLE FOR IRON CORES!



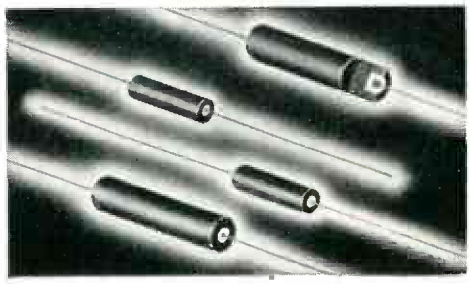
The rapid increase in the use of molded iron cores throughout electronic engineering has resulted in large part from Stackpole engineering that has made new and improved types available at attractive prices. In addition to dozens of standard broadcast, permeability tuning and high frequency types, Stackpole offers numerous others, a few of which are illustrated below.

WRITE FOR STACKPOLE ELECTRONIC COMPONENTS CATALOG RC-7



◀ SIDE MOLDED

Extra density of pressure extends evenly the entire length of the core. Resulting uniform permeability makes Stackpole Side-Molded Cores outstandingly superior for tuning applications. Broadcast band and short-wave types available.



CHOKE COIL CORES ▲

Ideal for audio, "hash," r-f chokes and others. Reduce coil dimensions and increase "Q." Insulated leads connect to coil and permit point-to-point wiring. Frequency ranges from 100 cycles to 175 megacycles.

TRANSFORMER CORES ▶

for filter coils in carrier frequency equipment.

Assure constant inductance over a given frequency range. Widely used where constant inductance, limited only by predetermined saturation point of core, is needed for various currents.

HIGH-RESISTIVITY CORES

Made of a special material showing resistance of practically infinity. Reduce leakage currents and noise troubles, minimize voltage breakdown possibilities between coils and core; and, where cup cores are used, eliminate heavily insulated lead-in wires.

◀ SLEEVE CORES

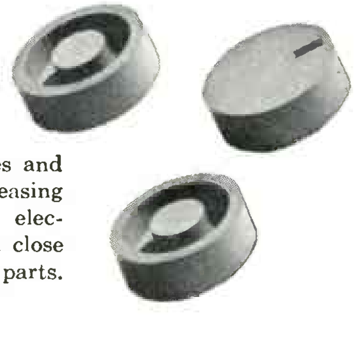
By permitting use of smaller cans of less critical and less costly materials, these cores assure a high order of tuning efficiency in greatly reduced size. In some instances, it may not even be necessary to use cans.

◀ TELEVISION CORES

From horizontal deflection and flyback transformer cores to I.F. and other types, Stackpole offers a complete line. The types illustrated here assure remarkably uniform results, save on assembly costs.

CUP CORES ▶

These unique, self-shielding units are available in a wide range of shapes and sizes and are finding steadily increasing use throughout modern electronics. Can be mounted close to chassis or other metal parts.



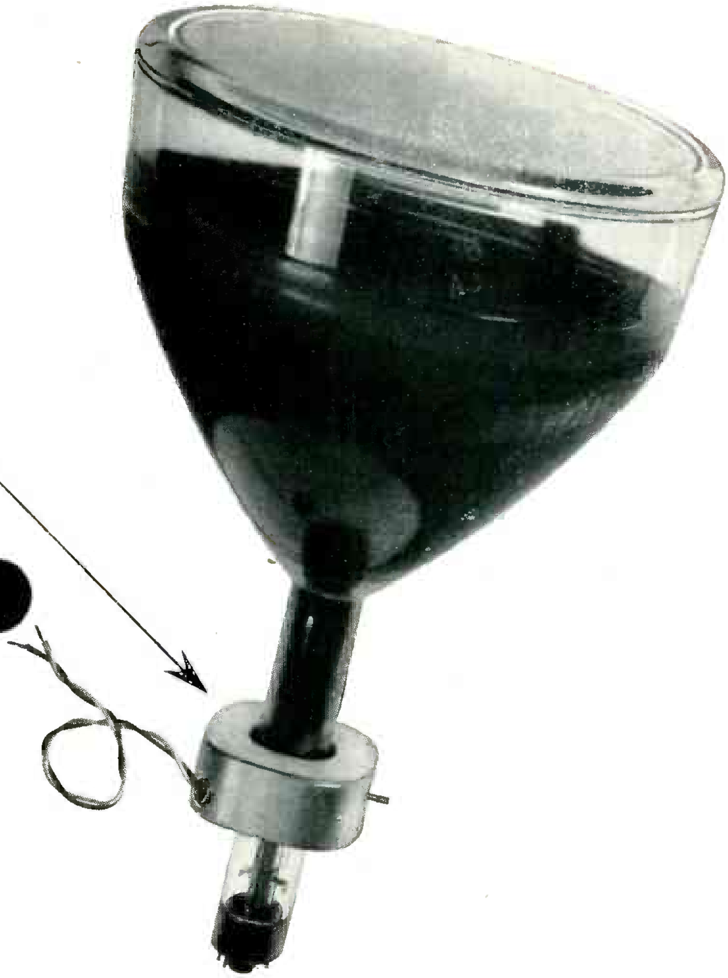
ELECTRONIC COMPONENTS DIVISION

STACKPOLE CARBON COMPANY, St. Marys, Pa.

ONE

OUT OF THREE

IS I•T•E



ONE OUT OF EVERY THREE television sets equipped with magnetic deflection means utilizes an I-T-E Focus Coil! — testimony enough to the dependability, effectiveness, and manufacturing economies to be obtained with these precision-built coils.

I-T-E Focus Coils are made for use with tubes 10″, 12″ and 16″ in size. They are completely *engineered* for quality throughout. Best uniform-cross-section enameled copper wire is wound on a core of acid-free, impregnated paper. Terminals are securely anchored — will actually withstand a 16-lb. pull on each lead. Entire wound assembly is completely enclosed in a pressed-steel case, which is zinc-plated to resist corrosion. The coil center-hole is sufficiently large to allow adjustment of raster on screen.

I-T-E Focus Coils are available in three standard mountings, and specified mountings can be supplied on request.

For complete technical information on I-T-E Focus Coils — or on other I-T-E precision-built wire-wound products — write, specifying your needs.

FOCUS COILS

The Leader In Technical Excellence

I-T-E CIRCUIT BREAKER CO., RESISTOR DIVISION

19TH & HAMILTON STREETS, PHILADELPHIA 30, PA.

SWITCHGEAR • UNIT SUBSTATIONS • ISOLATED PHASE BUS STRUCTURES • AUTOMATIC RECLOSING CIRCUIT BREAKERS • RESISTORS • SPECIAL PRODUCTS

GREATEST ADVANCE IN V.O.M. HISTORY

Beautiful Streamlined Instrument.

Large 5½ Inch Meter in special molded case under panel.

Resistance Scale Markings From .2 Ohm To 100 Megohms . . . Zero Ohms Control Flush With Panel.

Only one switch . . . Has Extra Large Knob 2½" Long . . . Easy To Turn . . . Flush With Panel Surface.

New Molded Selector Switch . . . Contacts Are Fully Enclosed . . . will retain lubrication without dust contamination.

Batteries Easily Replaced . . . New Double Suspended Contacts.

All Resistors Are Precision Film Or Wire Wound Types... Sealed For Permanent Accuracy.

Unit Construction...Resistors, Shunts, Rectifier, Batteries All Are Housed In A Molded Base Built Right Over The Switch . . . Provides Direct Connections Without Cabling . . . No Chance For Shorts.

Inside view cover removed...inverted

NOTE the Sensational Improvements

Model 630

$37.50 U.S.A. Dealer Net

Leather Carrying Case $5.75

ADAPTER PROBE FOR TV HIGH VOLTAGE TESTS EXTRA

A completely new Volt-Ohm-Mil-Ammeter that does more . . . . has proved components . . . . and will give a lifetime of satisfaction.

TECH DATA

D.C. VOLTS: 0-3-12-60-300-1200-6000, at 20,000 Ohms/Volt
A.C. VOLTS: 0-3-12-60-300-1200-6000, at 5,000 Ohms/Volts
D.C. MICROAMPERES: 0-60, at 250 Millivolts
D.C. MILLIAMPERES: 0-1.2-12-120, at 250 Millivolts
D.C. AMPERES: 0-12, at 250 Millivolts
OHMS: 0-1000-10,000; 4.4 Ohms at center scale on 1000 scale; 44 Ohms center scale on 10,000 range.
MEGOHMS: 0-1-100
DECIBELS: -30 to +4, +16, +30, +44, +56, +70
OUTPUT: Condenser in series with A.C. Volt ranges

Precision first...to Last

TRIPLETT

TRIPLETT ELECTRICAL INSTRUMENT CO. • BLUFFTON, OHIO

In Canada: Triplett Instruments of Canada, Georgetown, Ontario

Air-Movers Move Faster
both in PRODUCTION and SALES

. . . when they're assembled "for keeps" with AMERICAN PHILLIPS SCREWS

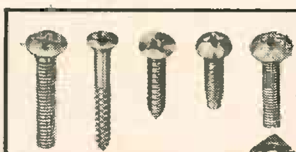
"FAIR WINDS" IN PRODUCTION: These new "wind-tunnel" fans are designed for lasting efficiency, exceptionally handsome appearance, and unbroken silence in operation. So what other fastening method could be used—*except* American Phillips Screws? Now there's no danger of damage to the deep-drawn, sleek surfaces, no burring of screwheads, no lagging production due to fumbled and slant-driven screws. In fact, assembly moves 50% faster than it does with slotted screws.

"FAIR WINDS" IN SALES: Good-looking modern design of American Phillips' universal cross-recess is a definite accent to the modern design of any product in which these screws are used. And salesmen can accent the story of extra vibration-resistance—which protects silent operation and prolongs product-life. See what American Phillips Screws can do for your product, both in production and sales. Write.

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

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

AMERICAN PHILLIPS *Screws*



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

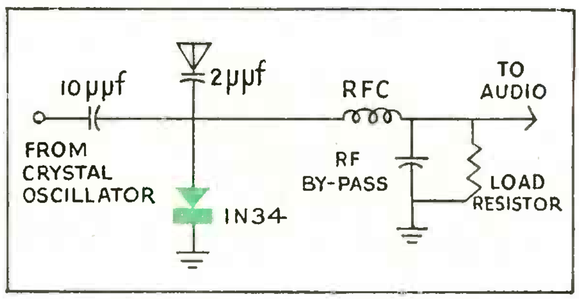
Link FREQUENCY METER USES SYLVANIA 1N34'S AS MIXERS, LIMITERS, COUNTERS

5 Germanium Diodes make readings independent of battery voltage

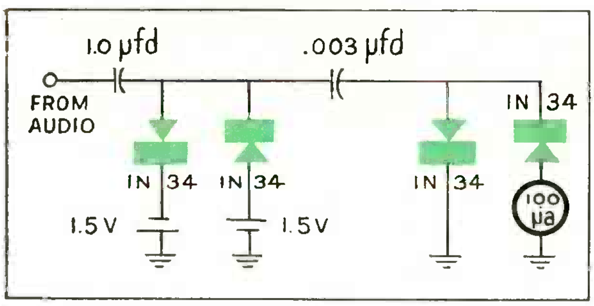
Permanent precision is essential in high-quality transmitter test equipment—such as Frequency Meter Type 2051, made by Link Radio Corp., New York. Meter indicates carrier frequency deviations directly—can also measure relative power output and frequency swing of FM transmitters.

Use of 5 Sylvania Germanium Diodes Type 1N34 helps assure permanent precision by keeping readings independent of battery voltage. Because the 1N34's are heaterless, battery drain is reduced . . . battery service life normally equals shelf life.

Just another of the many ways Sylvania Germanium Diodes are improving performance, reducing size and weight. Why not put them to work in *your* products?



HERE A SYLVANIA GERMANIUM DIODE 1N34 is used as a high frequency mixer. RF signal from a crystal oscillator is impressed on the crystal, and mixed with RF signal from the antenna to produce an audio frequency beat note.



IN THIS PORTION OF THE CIRCUIT, the two 1N34's at the left are used as limiters. They are connected across the audio bus, but are biased so as to pass ± 1.5 volts of audio. Voltages above this level are clipped off by the action of the diodes. The two 1N34's at the right are used in a full wave counter circuit, and provide a d-c output proportional to the frequency input.

GET THE FACTS ON TV USES TOO!

Sylvania Electric Products Inc.
Electronics Division, Dept. E-2901
500 Fifth Avenue, New York 18, N. Y.

Gentlemen:

Please send me your literature on Germanium Diodes and Duo-Diodes, including the series of Engineering News Letters showing their applications in television circuits.

I am also interested in receiving literature covering applications of your other products in the fields of:

☐ *Communications and Industrial Electronics*
☐ *Radioactivity* ☐ *Radar and Microwaves*

Name..........
Position..........
Company..........
Street Address..........
City.......... Zone #.......... State..........

SYLVANIA ELECTRIC

Electronics Division, 500 Fifth Avenue, New York 18, N. Y.

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

SCREEN CHARACTERISTICS AT A GLANCE . . .

The following types of fluorescent screens are available in Du Mont cathode-ray tubes:

P1: Medium persistence green. High visual efficiency. For general-purpose visual oscillographic and indicating applications.

P2: Long persistence blue-green fluorescence and yellow-green persistence. Long persistence at high writing rates. Short-interval excitation.

P4: Medium persistence white for television images.

P5: Extremely short persistence blue for photographic recording on high-speed moving film. Persistence time for energy drop to 50% is 5 microseconds. Available on special order.

P7: Blue fluorescence and yellow phosphorescence. Long persistence at slow and intermediate writing rates. For filtering out initial "flash" and for high build-up of intensity under repeated excitation, this screen may be used with Du Mont Type 216-J Filter.

P11: Short persistence blue. For recording high writing rates. Persistence time for energy drop to 50% is 10 microseconds.

There's a screen for every oscillographic purpose. But *only* Du Mont makes *all* types of screens. By having that extra Du Mont tube with the right screen available, you can cover a wider range of applications more quickly and realize far greater value from your oscillograph, simply by switching tubes.

As a time-, trouble- and money-saver, that extra, dependable, high-quality Du Mont tube should be on hand when you need it. So why not buy it now while you're thinking about it?

And when replacing cathode-ray tubes, always remember that Du Mont tubes are made to RMA specifications and therefore fit *any* standard oscillograph.

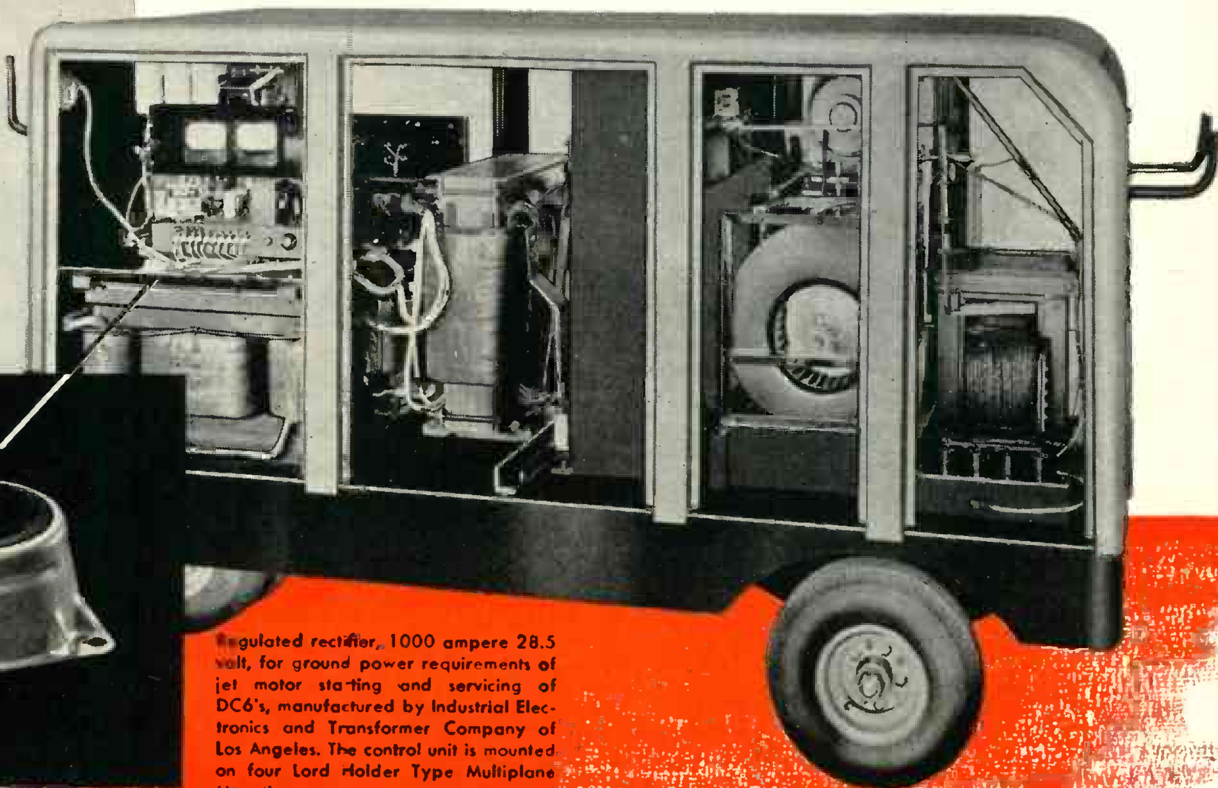
Use the right screen for the right job. Descriptive data on request.

DUMONT *for Oscillography*

ALLEN B. DU MONT LABORATORIES, INC., PASSAIC, N. J.
CABLE ADDRESS: ALBEEDU, NEW YORK, N. Y., U. S. A.

INET

Portable Power . . .
PROTECTED POWER



Regulated rectifier, 1000 ampere 28.5 volt, for ground power requirements of jet motor starting and servicing of DC6's, manufactured by Industrial Electronics and Transformer Company of Los Angeles. The control unit is mounted on four Lord Holder Type Multiplane Mountings.

with a LORD Vibration Control System

INET portable "Ground Power" units carry power to the job. They have an enviable reputation for their rugged dependability in a wide diversity of applications.

The vital and sensitive electronic control is protected from damaging vibration by a Lord Vibration Control System, engineered as an integral part of the unit. Through the protection thus provided stable voltage is assured, tube breakage is minimized, instrument life is prolonged, and maintenance cost of delicate parts greatly reduced.

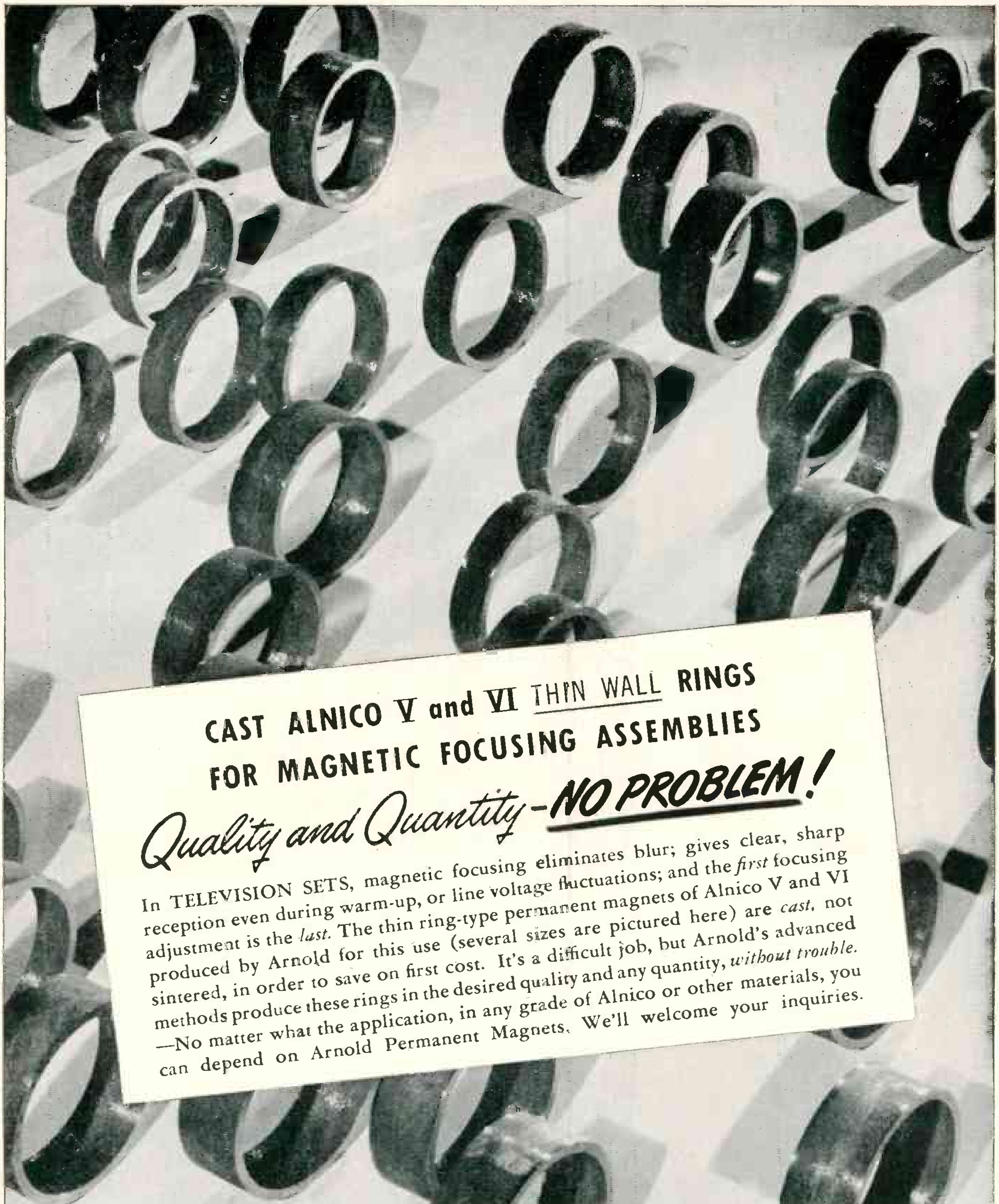
INET thus gives further evidence of the growing recognition of the need for effective Vibration Control to improve performance and prolong life. Have you considered the potential improvement in your product, possible through Lord Vibration Control? Consult an experienced Lord engineer. There is no obligation.

See our bulletin in Sweet's 1949 File for Product Designers or write for Bulletin 900 today. It describes the complete line of Lord products and services.

LORD **Vibration Control Systems**

LORD MANUFACTURING COMPANY, ERIE, PA.

Canadian Representative: Railway & Power Engineering Corp. Ltd.



CAST ALNICO V and VI THIN WALL RINGS
FOR MAGNETIC FOCUSING ASSEMBLIES

Quality and Quantity—**NO PROBLEM!**

In TELEVISION SETS, magnetic focusing eliminates blur; gives clear, sharp reception even during warm-up, or line voltage fluctuations; and the *first* focusing adjustment is the *last.* The thin ring-type permanent magnets of Alnico V and VI produced by Arnold for this use (several sizes are pictured here) are *cast,* not sintered, in order to save on first cost. It's a difficult job, but Arnold's advanced methods produce these rings in the desired quality and any quantity, *without trouble.* —No matter what the application, in any grade of Alnico or other materials, you can depend on Arnold Permanent Magnets. We'll welcome your inquiries.

THE ARNOLD ENGINEERING COMPANY

Subsidiary of

ALLEGHENY LUDLUM STEEL CORPORATION

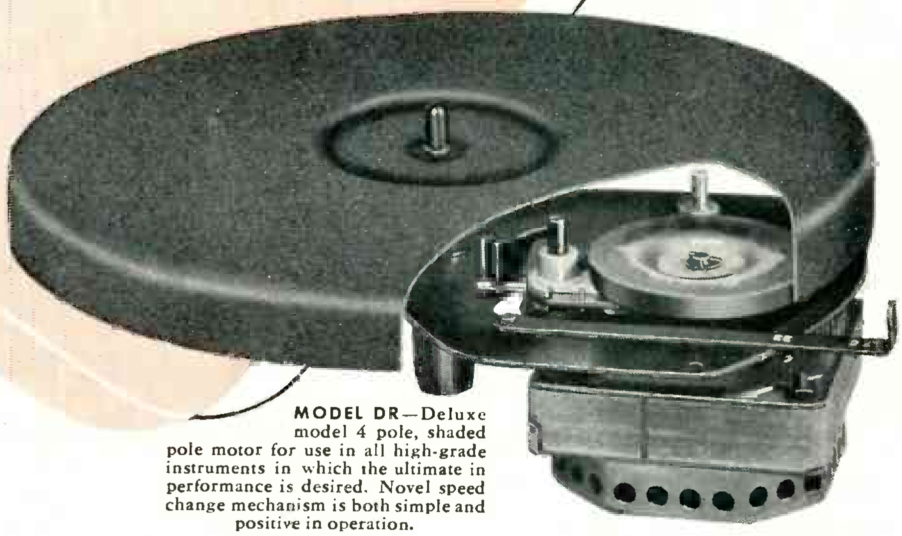
147 East Ontario Street, Chicago 11, Illinois

Specialists and Leaders in the Design, Engineering and Manufacture of PERMANENT MAGNETS

MODEL DM—Compact low cost 2 pole, shaded pole motor designed for portables, table models and other instruments in which space is an important factor. Simple speed change mechanism incorporates a special long-lasting molded neoprene belt.

Only GI offers you *TWO* rim drive

DUAL SPEED PHONOMOTORS



MODEL DR—Deluxe model 4 pole, shaded pole motor for use in all high-grade instruments in which the ultimate in performance is desired. Novel speed change mechanism is both simple and positive in operation.

Here they are . . . not one, but TWO dual speed phonomotors by General Industries . . . for both 33⅓ and 78 R.P.M. operation...for every type of instrument, from inexpensive table model to deluxe console combination.

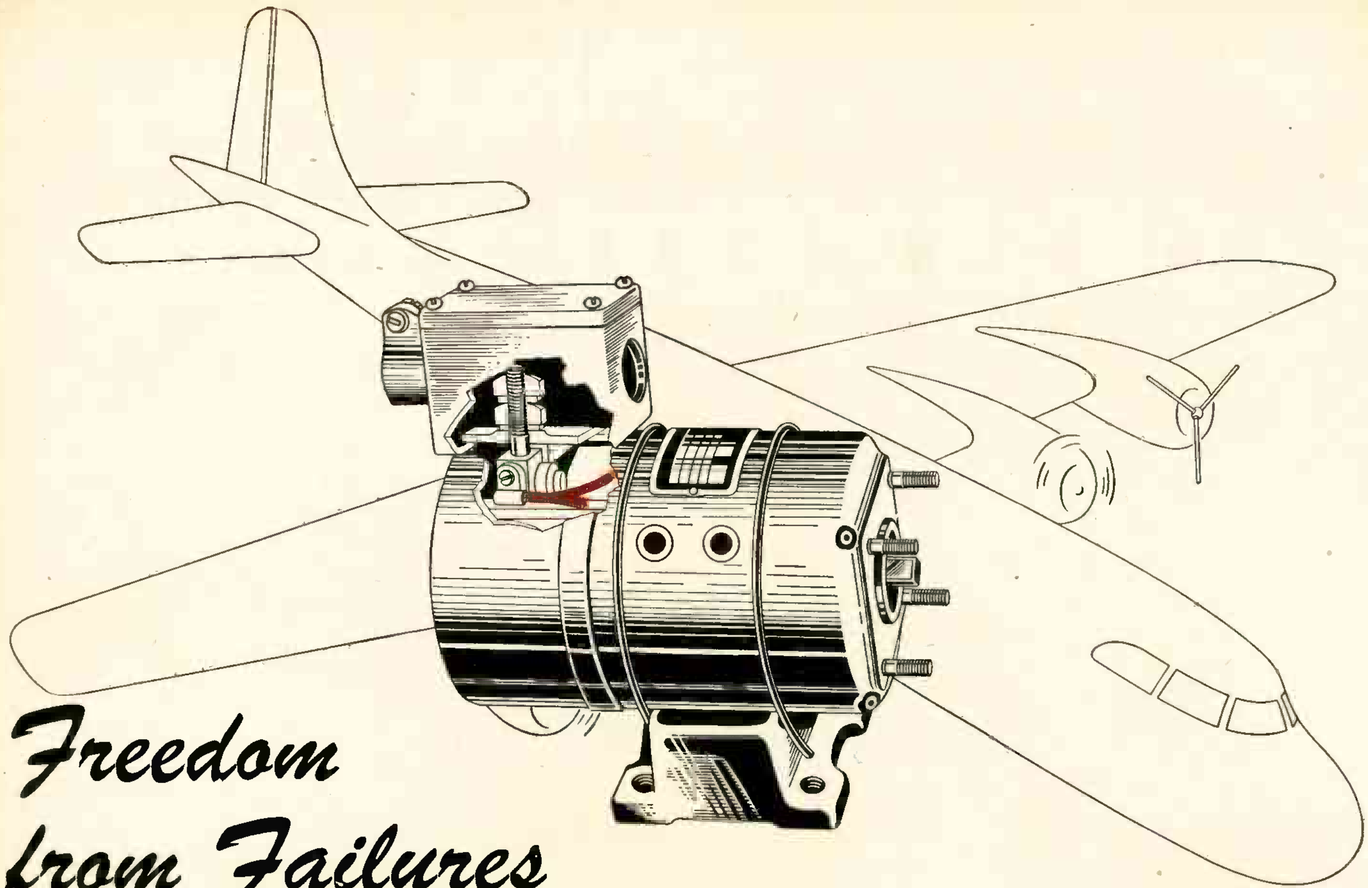
Representing years of research and development, these two motors excellently meet today's needs for dependable rim drive phonomotors that will accommodate both the new long-playing and conventional type records. Both motors have been proved in extensive laboratory tests—and already are being widely used in many leading phonograph instruments.

Like all GI Smooth Power products, both new dual speed phonomotors are built to the highest quality and performance standards attainable. Their cost, however, is surprisingly low.

For additional information, specifications and quotations, write *today* to:

The GENERAL INDUSTRIES Co.

DEPT. B • ELYRIA, OHIO



Freedom from Failures

When an engine halts on a giant transport or airliner plying the skyways, the propeller must be "feathered" to insure a continued, safe flight. An electric motor powering the hydraulic pump which "feathers" the propeller must go into action immediately. Insulation which encases the leads on the motor is constantly subjected to heat and vibration and must be sturdy enough to withstand this wear.

BH Fiberglas Sleeving is used in the Pesco Model IE-777 propeller feathering pump on the leads from the terminal post on the motor to the field coils.

Here is the report from the Pesco Products Division of the Borg-Warner Corp.:

"Bentley, Harris Fiberglas Sleeving was selected because of its greater flexibility and resistance to fraying. In our motors, the sleeving is exposed to heat and vibration. No specific tests were conducted in the selection of this particular sleeving because of our Electrical Engineer's previous experience with this product. As a result of its use, we enjoy freedom from failures in the field coil due to excessive fraying."

If you have a problem of insulation breakdown caused by vibration, excessive temperatures, harmful gases, grease or moisture, try BH Fiberglas Sleeving in your plant, in your product.

Bentley, Harris Mfg. Co., Conshohocken, Pa.

BH *Fiberglas** SLEEVINGS

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

USE COUPON NOW

Bentley, Harris Mfg. Co., Dept. E-31, Conshohocken, Pa.

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

NAME ______ COMPANY ______

ADDRESS ______

Send samples, pamphlet and prices on other BH Products as follows:

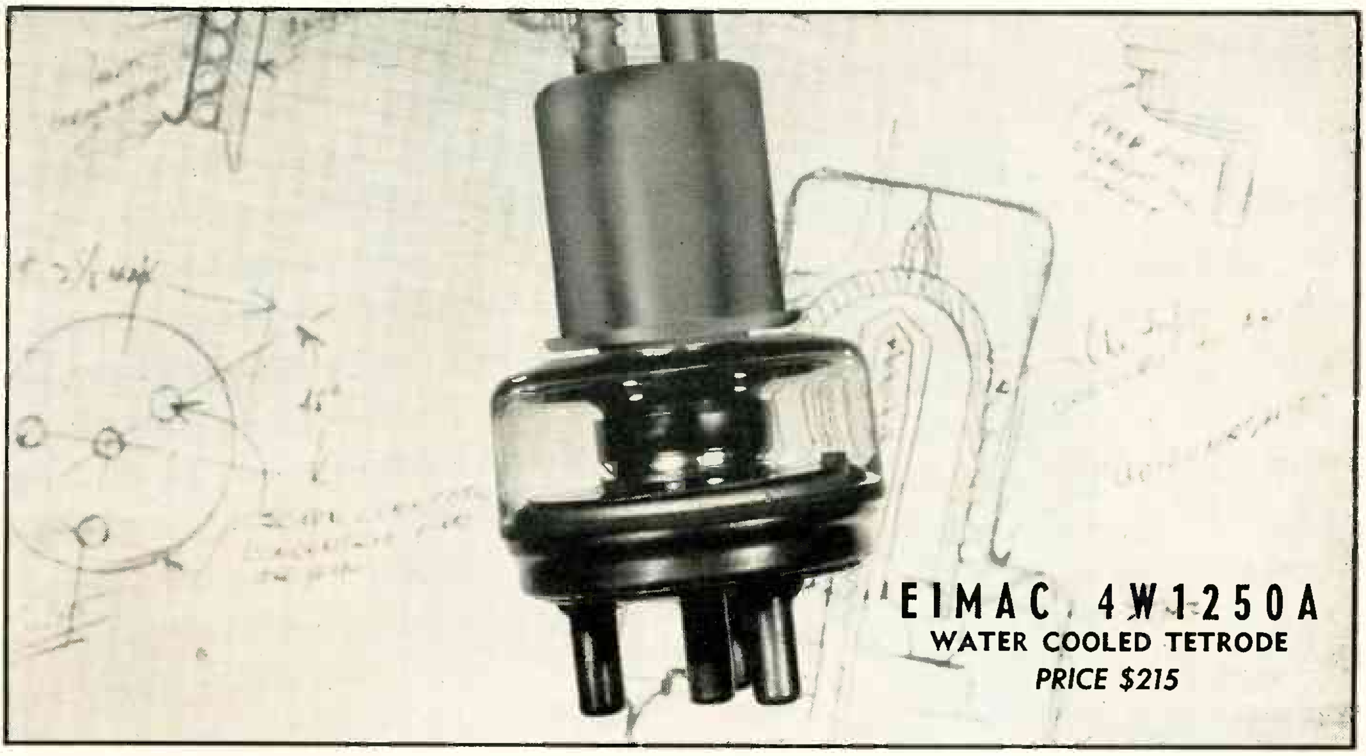
- ☐ Cotton-base Sleeving and Tubing
- ☐ Ben-Har Special Treated Fiberglas Tubing

Follow the Leaders to

Eimac TUBES

The Power for R-F

A NEW TUBE FOR TV



A new tetrode . . . the forerunner of more Eimac developments providing higher power in the upper frequency brackets.

GENERAL CHARACTERISTICS
EIMAC 4W1250A TETRODE

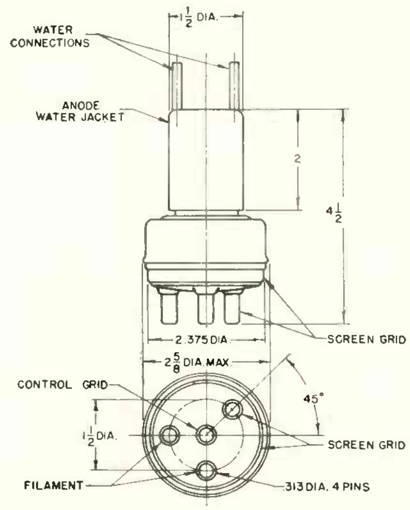
Filament: Thoriated Tungsten	
Voltage	5.0 volts
Current	13.5 amperes
Screen Grid Amplification Factor (Average)	6.2
Direct Interelectrode Capacitances (Average)	
Grid-Plate	0.05 uufd
Input	12.8 uufd
Output	5.6 uufd
Transconductance (i_b=200ma., e_b=2500v., E_{c2}=500v.)	5200 umhos

RADIO FREQUENCY POWER AMPLIFIER

Television Class-B Linear or Grid-Modulated Amplifier.

MAXIMUM RATINGS (Frequencies up to 216 Mc.)

D-C PLATE VOLTAGE	3500 VOLTS
D-C SCREEN VOLTAGE	750 VOLTS
D-C GRID VOLTAGE	– 500 VOLTS
D-C PLATE CURRENT	750 MA.
PLATE DISSIPATION	1250 WATTS
SCREEN DISSIPATION	30 WATTS
GRID DISSIPATION	10 WATTS



For further information on the 4W1250A, write direct

EITEL-McCULLOUGH, INC.

207 SAN MATEO AVENUE, SAN BRUNO, CALIFORNIA

Export Agents: Frazar & Hansen, 301 Clay St., San Francisco, California

"A 'HONEY' OF A THYRATRON...

giving many more hours of superior service!"

GL-5545

RATINGS

Filament voltage	2.5 v
Filament current	21 amp
Peak anode voltage, forward and inverse	1,500 v
Peak cathode current	80 amp
Avg cathode current	6.4 amp
Current averaging time	15 sec
Ambient temp range	—55 to +70c

Outlasts gas-filled control tubes of earlier design (see below) . . . Out-performs them by combining:

- **High anode voltage**
- **High peak-to-average current ratio**
- **Stable control characteristics**
- **Short heating time**
- **"Climate-proof" ambient temperature range**

GENERAL ELECTRIC COMPANY pioneered the thyratron, so that G-E leadership in its design is to be expected. Thus new Type GL-5545's *oversize gas charge* . . . which compensates for anode gas absorption, foremost enemy to long life of thyratrons used for motor-control work. Gas absorption is caused by the inductive load found in both field and armature-control circuits.

Greater inert-gas content—twice that of former types—means that the GL-5545 needs no snubber circuit in motor-control applications. The tube will operate with a commutation factor* at least 100 times that of other gas-filled tubes of earlier design.

This results in longer tube life—in many more hours of performance per dollar of investment. And further assuring Type GL-5545's ability to stand up in hard service, *vibration-resisting strength* features the tube's construction, with key parts internally braced and the grid-anode structure solidly supported both at top and bottom.

Electrically the GL-5545 shows similar progress over older types. A special shielded-grid design cushions any grid effect from voltage surges, making for a stable circuit and reliable tube behavior. The GL-5545's ratings establish its high peak voltage and current capacities, yet the tube can be applied to replace gas-filled types of earlier design—C6J's and 306's—without socket or circuit change.

Get on the bandwagon by phoning your nearby G-E electronics office for further facts about this new General Electric thyratron that *lasts longer* and *does more*. Or wire or write *General Electric Company, Electronics Department, Schenectady 5, New York.*

**Commutation factor is the product of the rate of decay of current in amperes per microsecond just before commutation, and the rate of rise of inverse voltage in volts per microsecond just after commutation.*

GENERAL ELECTRIC

180-H25-8850

FIRST AND GREATEST NAME IN ELECTRONICS

Watch Master

AMERICAN TIME PRODUCTS INC. NEW YORK TRADE MARK

Frequency Standards

GUARANTEED ACCURACY
1 part in 100,000
(.001%)

Uses

Time bases, rate indicators, clock systems, chronographs, geo-physical prospecting, control devices and for running small synchronous motors.

Features

1. **Bimetallic, temperature-compensated fork, no heating or heat-up time is required.**
2. **Fork is hermetically sealed, no barometric effects on frequency.**
3. **Precision type, non-ageing, low coefficient resistors used where advantageous.**
4. **Non-linear negative feedback for constant amplitude control.**
5. **No multi-vibrators used.**
6. **Synchronous clock simplifies checking with time signal.**

Specifications

Accuracy—1 part in 100,000 (.001%).
Temperature coefficient—1 part in 1,000,000 per degree centigrade (or better).
Outputs—

1. **60 cycles, sine wave, 0-110 volts at 0 to 10 watts (adjustable).**
2. **120 cycle pulses, 30 volts negative.**
3. **240 cycle pulses, 30 volts positive and negative. Pulse duration, 100 micro-seconds.**

Type 2121 A.

TERMINATION
Front and Rear
CONSTRUCTION
Standard 8¾" x 19" Panel
HOUSING
8¾" x 19" x 8" Metal Cabinet
WEIGHT
25 pounds

American Time Products, Inc.,
580 Fifth Ave., New York 19, N. Y.
Gentlemen:
Please send descriptive folder, No. 2121A.

Name..

Company..

Address..

City.......................State.......................

product of

AMERICAN TIME PRODUCTS INC.

580 Fifth Avenue **New York 19, N. Y.**

Operating under patents of the Western Electric Company

HAND-SIZE 50-OHM NICHROME* RESISTOR SHRUGS OFF 35,000-WATT WALLOPS!

It is unbelievable that so small a resistor can carry 35,000 watts! But it actually happens, repeatedly, in the case of Ward Leonard Non-Inductive Plaque Resistors wound with Nichrome V wire — used in telephone carrier circuits operating through rural power lines.

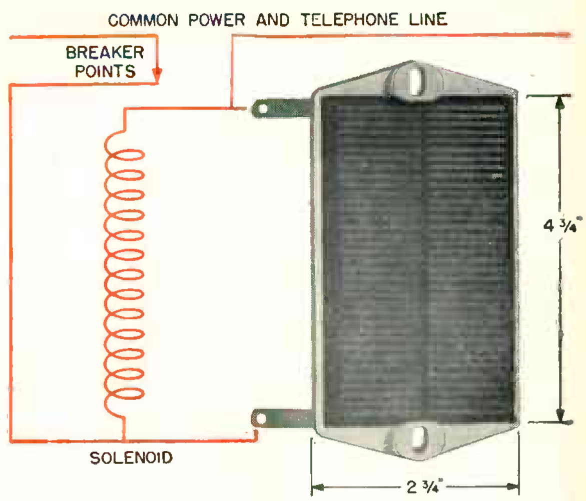
This is the story: Circuit breakers are installed in the power lines to protect them against "shorts" due to falling wires, etc. But the telephone carrier currents are blocked by the high impedance of the breaker solenoids. A low-impedance resistor is therefore used as a by-pass at each solenoid.

When a "short" occurs, the resistor must be momentarily able to carry amperage far in excess of its normal rating, because mechanical lag prevents the circuit breaker from opening instantly. The same applies when lightning, or accumulated static charges, discharge to the ground.

Tremendous strain is imposed upon the winding of the resistor during the instant of high current impact, yet it must stand up.

To assure maximum performance and dependability, Ward Leonard uses windings of Nichrome V. This superlative Driver-Harris alloy sustains tremendous voltage surges without loss of characteristics, retains its superb stability in spite of severe thermal shock, stays on the job even though "jolted" again and again . . . when a breaker makes several attempts to restore an open circuit.

Whatever *your* electrical resistance problems — conventional, unusual, or seemingly impossible of solution — send your specifications to us. We manufacture and draw the most complete line of electrical resistance alloys in the world.



Designed to protect telephone circuits that utilize power supply lines, this resistor, rated at 50 ohms and 125 watts, is intended normally to carry a current of about 1.6 amperes. In the event of short-circuit, however, it will tolerate 16 times this amperage, and a voltage increase producing 35,000 watts, for the fraction of a second required by a power line circuit breaker to operate. Cooling in less than a second after sustaining such an abnormal current impact, the winding, of .010 in. diameter Nichrome V wire, remains unimpaired. In fact, this severe treatment can be administered for 3/100ths of a second per second for 3 successive seconds without damage to the resistor. Made by Ward Leonard Electric Co., Mount Vernon, N. Y.

SPECIAL PURPOSE ALLOYS SINCE 1899 · D/H · TRADE MARK REG. U. S. PAT. OFF.

Nichrome is Manufactured only by

Driver-Harris Company

HARRISON, NEW JERSEY

BRANCHES: Chicago, Detroit, Cleveland, Los Angeles, San Francisco, Seattle
Manufactured and sold in Canada by
The B. GREENING WIRE COMPANY, LTD., Hamilton, Ontario, Canada

*T.M. Reg. U. S. Pat. Off.

CHICAGO...
The Engineer's Transformer

Famous "Sealed in Steel" New Equipment Line

Chicago Transformer's New Equipment Line offers transformer engineering *ahead* of the trends in circuit design. It's the Transformer Line preferred by experts in the P.A., ham, communication and experimental fields, and by broadcast stations and manufacturers.

Check these features—*drawn steel cases* to provide compact, streamlined mounting; *conservative ratings* that meet all RMA and FCC recommendations; *precision characteristics* for stable, uniformly excellent performance—these, and many others. Check the prices—and you'll learn how little more these advanced units cost over conventional transformers.

Typical of the New Equipment Line are the outstanding audio transformers listed below. Get full details on the complete line—write for descriptive catalog today.

Response within .2db, 30 to 20,000 cycles
New Full Frequency Range Output Transformer

No. BO-6
List Price $23.00

No. BO-6. For use in high fidelity amplifiers. Couples push-pull 6L6's (7500 ohms, C-T) to 6/8 or 16/20-ohm voice coil. Center-tapped tertiary winding provides 15% inverse feedback to reduce harmonic distortion to a minimum. In drawn steel case, 4 5/16" x 3 7/8" x 3 11/16", with mounting studs and pin-type terminals.

There's a CHICAGO OUTPUT TRANSFORMER For Every Full Frequency Use

Cat. No.	Application	Impedance	Max. Power	List
BO-1	Single Plate to Line	Pri.—15,000 ohms at 0 to 10 ma d-c *Sec.—600/150 ohms CT	+20 dbm	$13.00
BO-2	P.P. Plates to Line	*Pri.—20,000 ohms CT *Sec.—600/150 ohms CT	+30 dbm	19.00
BO-3	P.P. Plates to Line	Pri.—5,000 ohms CT *Sec.—600/150 ohms CT	+40 dbm	17.00
‡BO-4	P.P. Plates to Line	Pri.—7,500 ohms CT *Sec.—600/150 ohms CT	+43 dbm	18.00
BO-5	P.P. Plates to Line	Pri.—10,000 ohms CT *Sec.—600/150 ohms CT; 16/8/4 ohms	+37 dbm	24.00

‡Tertiary winding provides 15% inverse feedback. *Split and balanced windings.

HIGH Q CHOKES
for Dynamic Noise Suppression Circuits

Two precision-built chokes with inductance values of .8 and 2.4 henrys respectively—accurate to within ± 5% with up to 15 ma d-c. Units have a minimum Q of 20. Exceptionally compact, 1 11/16" x 2 3/8" x 1 7/16".

Write for literature

No.	Inductance	List
NSI-1	.8 h	$10.00
NSI-2	2.4 h	10.00

Television Transformers *to fit today's leading TV circuits*

Because Chicago Transformer is the largest single supplier of transformers to the Television industry, you gain the advantages of "Original Equipment" components when you buy Chicago TV Transformers. Available now, the three units described here are part of a complete new line, soon to be announced.

Vertical Blocking Oscillator Transformer No. TBO-1. 60-cycle unit for creating the vertical sweep "saw-tooth" voltages required in conventional circuits.

Pri. Inductance: 1.15 hy ± 20% at 3 v., 1000 cycles
Pri. Leakage Inductance: 8 mh + 25%, −15%
Ratio, Primary to Secondary: 1 to 4.2

Exact equivalent to R. C. A. Part No. 208T2. List Price, $3.10

TV Power Transformer No. TP-365. Designed to supply 405 volts d-c with two 5U4G's to an 80 mfd condenser input. Copper shorting band around core reduces external magnetic field; cuts image distortion to a minimum.

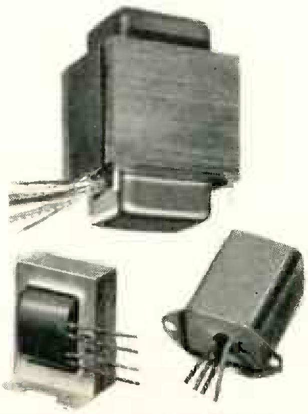
Pri.: 115 v., 60 cycles
H.V. Sec.: 362-0-362 v., a-c, .295 amps d-c
Fil. No. 1: 12.6 v., 5 amps, C-T
Fil. No. 2: 5 v., 2 amps
Fil. No. 3: 5 v., 6 amps

Exact equivalent to R. C. A. Part No. 201T6. List Price, $26.00

Vertical Scanning Output Transformer No. TSO-1. Couples vertical output tubes to picture tube deflection yoke.

Pri. Impedance: 19,000 ohms at 30 v., 60 cycles, 13 ma d-c
Ratio, Primary to Secondary: 10 to 1

Exact equivalent to R. C. A. Part No. 204T2. List Price, $5.90



Write for Descriptive Literature

CHICAGO TRANSFORMER
TRADE MARK REG.

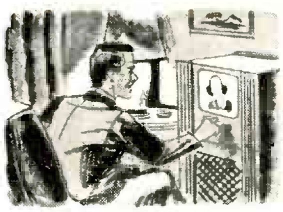
CHICAGO TRANSFORMER
DIVISION OF ESSEX WIRE CORPORATION
3501 ADDISON STREET • CHICAGO 18, ILLINOIS

Millions of nationally-known receivers produced annually are equipped with Chicago Transformers

50 YEARS OF PROGRESS WITH KESTER SOLDER

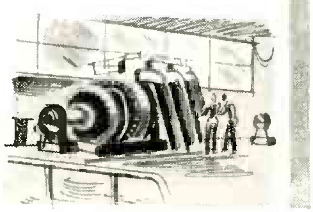
The present type of cored solder used by industry was first made by J. F. Kester in 1899. From the simple beginning of its first application . . . a few soldered connections in the old hand-crank telephone . . . it has continued to grow by keeping pace with new techniques as demanded by industry. Today's modern production would not be possible without cored solder.

Standard for Industry and Home Since 1899



RADIO-TELEVISION—The early commercial, amateur, and professional builders of radios accepted Kester Rosin-Core Solder as standard. Then as now, Kester still leads in this field.

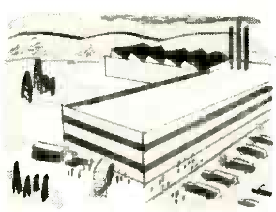
AUTOMOTIVE—Ever since its inception Kester Acid-Core Solder has been and still is the standard in the automotive field and for the trade. Mechanics and repairmen insist upon it.



ELECTRICAL-ELECTRONIC—Kester makes a great variety of "specialized" core solders and solder preforms—even those suitable for the fine touch required in electronic work.

AGRICULTURAL—For a half century Kester Cored Solder has been the farmer's standard for maintenance and repair. He uses Kester because his soldering must be fast and reliable.

HOMECRAFT—In hobbycraft as well as home repair, good solder bonds are essential. Kester Metal Mender and Radio Solder are the standards for all homecraft workers.



INDUSTRIAL—Kester Cored Solders have met every requirement for the past half century. They have earned the reputation for and are recognized as standard for industry.

Over 100,000 Types and Sizes

of KESTER Flux-Cored SOLDER

Free—Technical Manual. Send for Kester's new 28-page manual, "Solder and Soldering Technique." A complete analysis of the application and properties of soft solder alloys and soldering fluxes.

1899 50th Anniversary 1949

KESTER SOLDER

KESTER SOLDER COMPANY
4201 Wrightwood Avenue, Chicago 39, Illinois
FACTORIES ALSO AT NEWARK, NEW JERSEY • BRANTFORD, CANADA

YOU GET QUALITY PLUS ENGINEERING SERVICE WITH G-E PERMANENT MAGNETS

The magnet shown is 10 times actual scale and is the heart of the Magnetic Relay manufactured by Thomas A. Edison, Incorporated, West Orange, New Jersey.

The Magnet that Sounds the Alarm

Here's a unique application for G-E permanent magnets. As the moving element in the Edison Sensitive Relay, a tiny G-E Sintered Alnico 5 permanent magnet completes an electrical circuit . . . instantly sounding the alarm for fire.

Design specifications for this magnet application were severe. Extremely high pole tip density was required. Yet mass had to be low. Cost conscious G-E engineers worked closely with Thomas A. Edison, Incorporated. Costs were cut by redesign and by the use of Sintered Alnico 5 . . . a new magnetic alloy recently developed by General Electric.

Perhaps your permanent magnet costs can be reduced. Our design engineers will be glad to work with you to improve your product. Remember, too, that General Electric produces all grades of CAST and SINTERED ALNICO as well as special magnetic alloys for your product.

Edison Aircraft Fire Detection System—Fast, Safe, Dependable

Here's how the Sensitive Magnetic Relay fits into the Edison Fire Alarm system. An Edison thermocouple detector mounted in the area to be protected generates its own emf when a dangerously rapid rise in temperature occurs. This emf (measured in *millivolts*) actuates the Sensitive Magnetic Relay and sets off a fire alarm. When the fire is out and conditions return to normal, the detectors signal "Fire Out" and are again ready to signal "Fire" rapidly and truthfully.

CHEMICAL DEPARTMENT, SECTION 1A
GENERAL ELECTRIC COMPANY
PITTSFIELD, MASS.

Please send me:
( ) Bulletin, CDM-16, "G-E Permanent Magnet Subassemblies"
( ) Bulletin CDM-2A, "G-E Permanent Magnet Catalog"

Name........................ Title ....
Company........................
Products Mfrd........................
Address........................
City........................ State ....

PERMANENT MAGNETS

GENERAL ELECTRIC

CD49-A1

If it's Electronic . . .

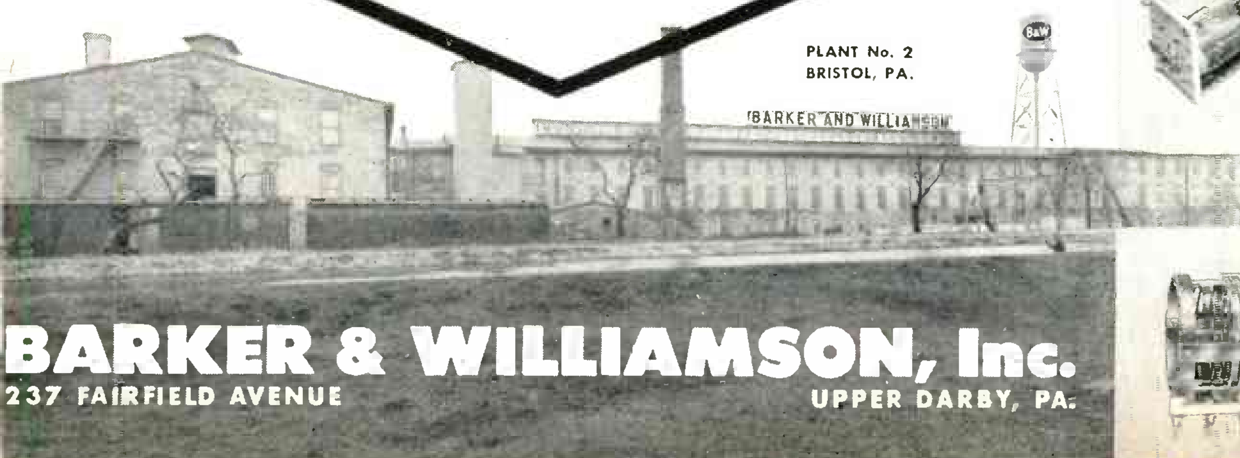
B&W CAN MAKE IT FOR YOU

From small electronic components up to carefully engineered test equipment and complex electronic devices, Barker and Williamson can engineer and manufacture high quality products to your specifications.

Three B&W plants, comprising 150,000 square feet, completely equipped with a competent engineering staff, machine shop, tool room (including all machines for drilling, milling, turning, stamping and forming metals and plastics), and a complete woodworking shop are at your disposal. Your inquiries are welcome. Write Department EL-19 for prompt reply.

NOW IN PRODUCTION AT B & W

COMPLETE RADIO TRANSMITTERS • DUAL DIVERSITY CONVERTERS, CONTROL UNITS and FREQUENCY SHIFT EXCITERS FOR RADIO TELETYPE TRANSMISSION • SPECIAL TEST EQUIPMENT • REDESIGN, MODERNIZATION AND MODIFICATION OF EXISTING EQUIPMENT MACHINE WORK • METAL STAMPING • COILS CONDENSERS • OTHER ELECTRONIC DEVICES IN A WIDE RANGE OF TYPES

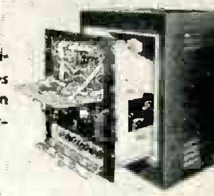


PLANT No. 2
BRISTOL, PA.

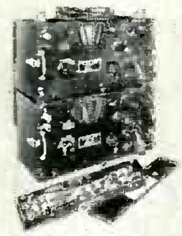
FREQUENCY SHIFT EXCITER—Provides RF drive and frequency shift keying to transmitter.

2 KW AMPLIFIER—Class C R-F Amplifier. Frequency Range 1 to 25 Mc's

CONTROL UNIT—Operate as an electronic repeater in teletype wire lines.

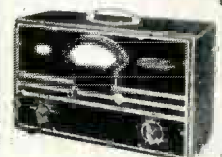


DUAL DIVERSITY CONVERTER—Provides diversity mixing on frequency shift circuits.

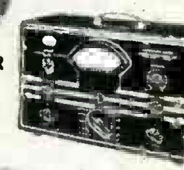


RECEIVER ASSEMBLY—Standard Army BC-342 Receivers modified for Dual Diversity Reception. Coupling Amplifier; bottom, front.

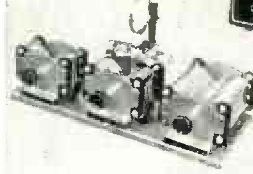
B&W AUDIO OSCILLATOR
Model 200



B & W FREQUENCY METER
Model 300

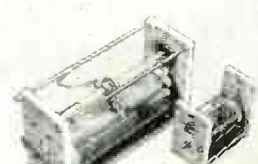


B & W
DISTORTION METER
Model 400

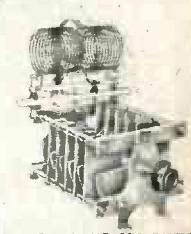


B&W SMALL BUTTERFLY VARIABLE CAPACITORS

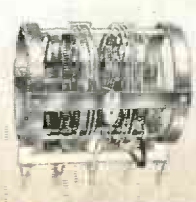
B&W TURRETS



B&W ROTARY COILS



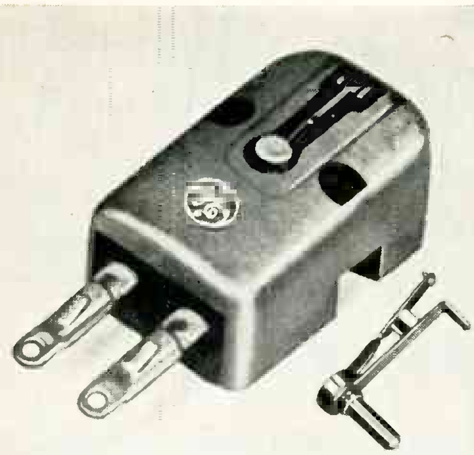
B&W HEAVY DUTY VARIABLE CAPACITORS



B&W 3400 SERIES INDUCTORS

BARKER & WILLIAMSON, Inc.
237 FAIRFIELD AVENUE — UPPER DARBY, PA.

NEW!



G-E VARIABLE RELUCTANCE CARTRIDGE

with the replaceable stylus for Conventional and Long Playing Records

NOW—in one small unit—all the sales and performance advantages of the G-E Variable Reluctance Cartridge plus this additional consumer economy feature—the Replaceable Stylus.

Negligible needle scratch and needle talk, minimum record wear, wide frequency response, freedom from resonance peaks, realistic reproduction—these are maintained at all times, simply, easily, economically with the Replaceable Stylus.

No more changing of the entire cartridge means more frequent replacement of stylus by the consumer because he can do it himself so easily.

Four simple steps—and presto! The worn stylus is replaced and maximum high quality performance is restored for the critical listener.

Note, too, these additional features: 

- **New notched design . . . one-third smaller . . . improved shape . . . more generally adaptable to various tone arms.**
- **More clearance for record changers.**
- **Higher lateral compliance for more faithful tracking.**
- **More economical for the customer—more sales for the dealer.**
- **Cartridges available for LP records with 1 mil stylus; for conventional records with 3 mil stylus.**

For complete information on the new Variable Reluctance Cartridge write: *General Electric Company, Electronics Park, Syracuse, New York.*

1 Simply remove cartridge from tone arm.

2 Use paper clip or wire to force stylus out of the cartridge.

3 Insert new stylus into cartridge with fingers.

4 Press firmly into position with thumb nail.

You can put your confidence in—

GENERAL ELECTRIC

178-H1

for mobile two-way radio

ALLIED'S NEW CO•AXIAL RELAY

NEW RELAY GUIDE
This new folder shows 24 small, compact Allied Relays with a carefully detailed table of characteristics and specifications. Write for YOUR free copy today.

The new Allied "RA" relay transfers 52 ohm antenna transmission line (type RG-8U Cable) from receiving to transmitting position. It is now used in police car radios and is highly recommended for both mobile and stationary applications.

This new relay is equipped with two Co-Axial cable fittings and one insulated transmitter line terminal. Co-Axial fittings for antenna and receiver connection are die cast as part of the metal housing. They will accommodate Signal Corps cable connector PL-259. Auxiliary double-pole, double-throw contacts can be supplied when specified.

ENGINEERING FEATURES OF THE ALLIED TYPE "RA" RELAY

Contact Rating: Antenna transfer contacts will handle a maximum of 75 watts of radio frequency up to 150 megocycles when inserted in a properly terminated 52 ohm line. Auxiliary contacts have a non-inductive rating of 1 ampere at 24 volts D.C. or 115 volts A.C.
Coil Rating: Up to 110 volts D.C. and 115 volts A.C. 60 cycles.

Coil No.	D.C. Volts	D.C. Current	D.C. Resistance
31	6.	.46	13.
34	12.	.22	54.
38	26.5	.083	320.
40	48.	.060	800.
43	110.	.026	4100.

(This table is based on an average power rating of 2.5 watts. Minimum operating voltages are 80% of voltages shown above.)

Dimensions: 2"x2⅞"x1¾". Weight: 4 oz.

ALLIED CONTROL COMPANY, INC.
2 EAST END AVENUE, NEW YORK 21, N. Y.

CONSTANT VOLTAGE

puts the "safety" in safety controls

Without CONSTANT VOLTAGE protection, this self-sustaining link in the chain of relay points that chart the nation's airways, could not successfully perform its safety function.

It is remotely located, at times almost inaccessible to service personnel and solely dependent on local power service. Were it not for a SOLA Constant Voltage Transformer, its delicately engineered electronic and radio equipment would be constantly at the mercy of periodic and unpredictable surges or low voltage levels.

Throughout the entire cross-country system SOLA Constant Voltage Transformers maintain operating voltages at a constant, predetermined level and the nation's air-men fly their courses with confidence.

If you are building electrically energized equipment to operate at precise voltage levels, remember this: *it is more economical to include Constant Voltage protection in your design than to install it later as a remedial measure.*

Revised Bulletin DCV-102
available on request.
Write for your copy.

31 standard types of SOLA Constant Voltage Transformers available in capacities ranging from 10VA to 15 KVA.

SOLA *Constant Voltage* **TRANSFORMERS**

Transformers for: Constant Voltage • Cold Cathode Lighting • Airport Lighting • Series Lighting • Fluorescent Lighting • Luminous Tube Signs
Oil Burner Ignition • X-Ray • Power • Controls • Signal Systems • etc. • **SOLA ELECTRIC COMPANY, 4633 W. 16th Street, Chicago 50, Illinois**

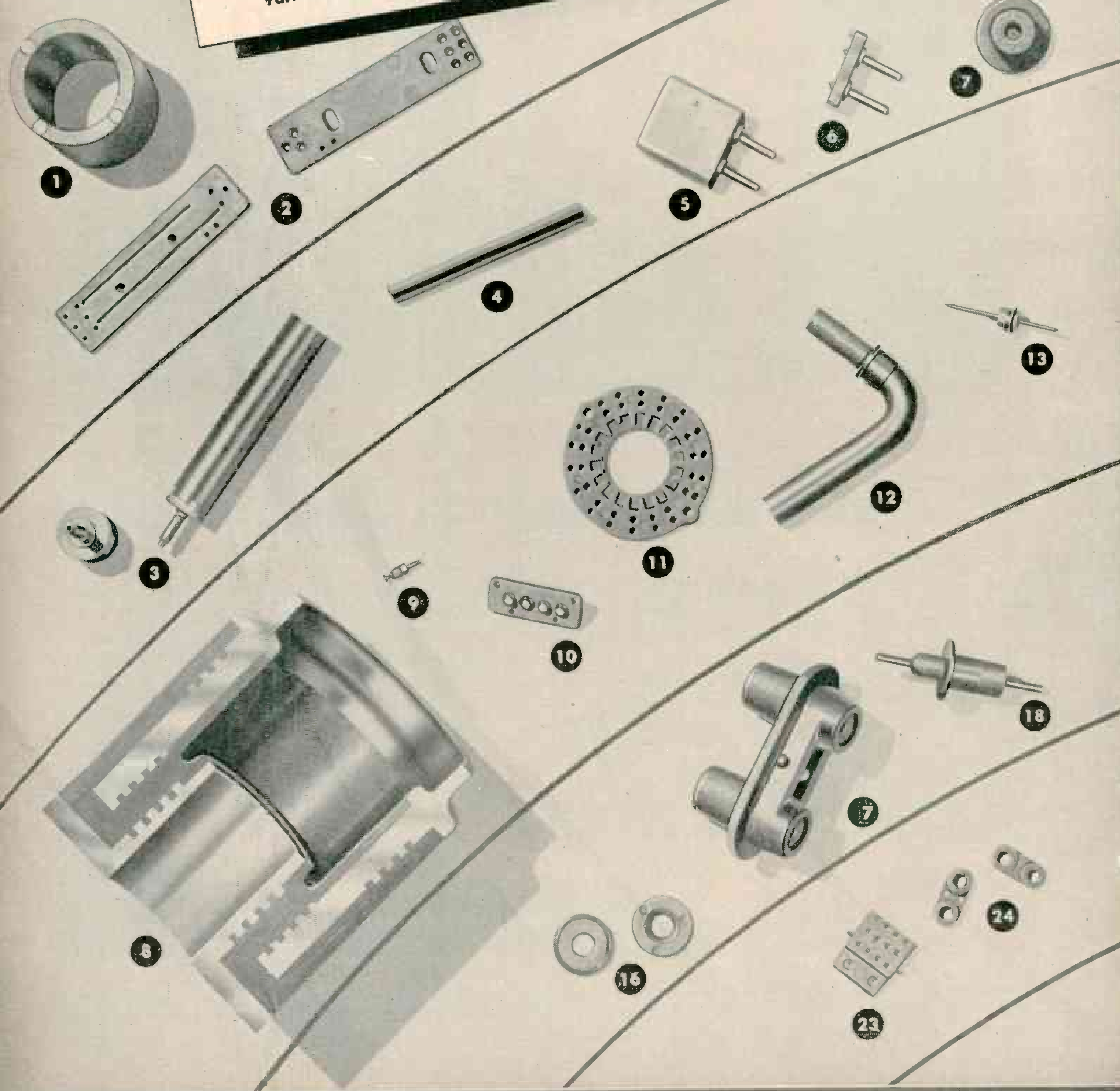
Manufactured under license by: ENDURANCE ELECTRIC CO., Concord West, N. S. W., Australia • ADVANCE COMPONENTS LTD., Walthamstow, E., England
UCOA RADIO S.A., Buenos Aires, Argentina • M. C. B. & VERITABLE ALTER, Courbevoie (Seine), France

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

Memo to...DESIGN ENGINEERS
about...MYCALEX 410 - MOLDED
NOW PRICED TO MEET RIGID ECONOMY REQUIREMENTS

In the design of components or complete equipment for industrial controls or communications—where insulation qualities are of critical importance—where mechanical precision must be a fixed factor—where strength is essential—where electrical characteristics must accurately meet high frequency circuit needs . . . then remember MYCALEX 410 as the insulation that designs-in with your most exacting requirements.

Various parts shown below are some of many made for special applications.



FREED

"PRODUCTS of EXTENSIVE RESEARCH"

No. 1030 by Freed

No. 1110 by Freed

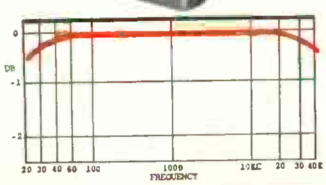
"Q" INDICATOR

Frequency range from 20 cycles to 50 kilocycles. "Q" range from .5 to 500.
"Q" of inductors can be measured with up to 50 volts across the coil. Indispensable instrument for measurement of "Q" and inductance of coils, "Q" and capacitance of capacitors, dielectric losses, and power factor of insulating materials.

INCREMENTAL INDUCTANCE BRIDGE

IMPEDANCE RANGE: One millihenry to 1000 henries in five ranges. Inductance values are read directly from a four dial decade and multiplier switch. This range can be extended to 10,000 henries by the use of an external resistance.
INDUCTANCE ACCURACY: Within plus or minus 1% through the frequency range from 60 to 1000 cycles.

A NEW LINE OF HIGH FIDELITY OUTPUT TRANSFORMERS



Type No.	Primary matches following typical tubes	Primary Impedance	Secondary Impedance	± ½db from	Maximum level
F1950	Push pull 2A3's, 6A5G8s, 300A's, 275A's, 6A3's, 6L6's.	5000 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	15 watts
F1951	Push pull 2A3's, 6A5G8s, 300A's, 275A's, 6A3's, 6L6's.	5000 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	15 watts
F1954	Push pull 245, 250, 6V6, 42 or 2A5 A prime	8000 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	15 watts
F1955	Push pull 245, 250, 6V6, 42 or 2A5 A prime	8000 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	15 watts
F1958	Push pull 6B5, 6A6, 53, 6F6, 59, 79, 89, 6V6, Class B 46, 59	10,000 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	15 watts
F1959	Push pull 6B5, 6A6, 53, 6F6, 59, 79, 89, 6V6, Class B 46, 59	10,000 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	15 watts
F1962	Push pull parallel 2A3's, 6A5G's, 300A's, 6A3's, 6L6	2500 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	36 watts
F1963	Push pull parallel 2A3's, 6A5G's, 300A's, 6A3's, 6L6	2500 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	36 watts
F1966	Push pull 6L6 or Push pull parallel 6L6	3800 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	50 watts
F1967	Push pull 6L6 or Push pull parallel 6L6	3800 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	50 watts

FREED TRANSFORMER CO., INC.

DEPT. JE 1718-36 WEIRFIELD ST., BROOKLYN 27, NEW YORK

"Give us the tools . . ."

For High Wages, Full Employment . . .
Business Must Have Better Tools
and More Money to Pay for Them

So far we have escaped the post-war depression predicted by leading government economists. How can we continue to frustrate gloomy prophets who see only depression ahead?

At the end of World War II the federal Director of Reconversion saw depression immediately ahead. He said we would have 6,000,000 unemployed four months after VJ-Day and 8,000,000 a few months later.

But we did not have depression. We did not because:

First, the American business man, sensing the obligations of a vastly more important post-war America, went ahead to build his plant and equipment to meet expanding domestic and world markets—markets bigger actually and potentially, in terms of world-wide trade and profits than any previously envisaged.

Second, the American businessman was able to get the money to go ahead. Since 1945 he has spent $50 billion building new plants and buying new equipment.

There may be other reasons why we missed a depression in 1946. But—make no mistake about it—what has powered our present prosperity is the $50 billion spent by businessmen since VJ-Day to improve their plants.

It provided jobs directly for 5 million people. It paid for more than half of our record-breaking steel output. It put in place the foundations of great new industries such as television. It strengthened the foundations of the chemical, machinery, plastics, steel and oil industries. It has expanded and improved our power systems throughout the country.

This spending has made the difference between prosperity and slump, between industrial strength and serious deterioration.

In fact, we know now that what business spends for new plants and new tools always makes the difference between prosperity and slump, the difference between national strength and weakness.

The accompanying chart tells the story. When we have spent heavily for new plants and equipment, we have had prosperity and strength. When we have not, we have been in trouble.

We would have been in trouble since VJ-Day except that business used its war reserves, plus two-thirds of its profits, plus borrowed money to improve and expand its facilities. This year industry is spending $19 billion this way.

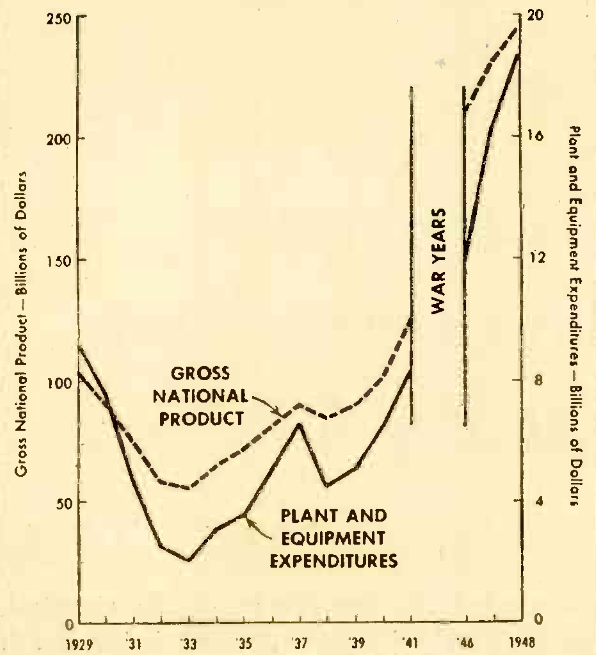
Has this great post-war expansion actually made our economy a "mature economy"? Have we come now to the saturation point the New Dealers mistakenly said we had reached in the '30's?

The answer is no!

Proof of that answer is being developed through a McGraw-Hill national survey of "Business' Needs for New Plants and Equip-

continued on next page

Prosperity and Capital Expenditures in Peacetime



ment" details of which will be given in this editorial series in coming months.

We have a bigger nation, more people, to serve right here at home. Further we must meet human needs which the war created around the world. Also, we must sustain a world position such as this country never assumed before.

Here are immediate things crying to be done.

1. Business still needs billions to expand production because our country and our needs are growing rapidly. Example: To meet the demand for power, electric utility companies must nearly double their present generating capacity in 10 years. That will cost more than $7.5 billion. To fill increasing needs for oil and gasoline, oil companies must spend at least as much.

2. Business still needs billions to get its plants up to date and overcome wear and tear. Examples: Over half a million of our freight cars, a third of the total, are more than a quarter of a century old. About two-thirds of the looms in the textile industry are more than 20 years old. Half of our coke ovens, basic equipment for iron and steel production, are more than 20 years old, and only half as efficient as modern ovens.

3. Business still needs many billions to do new things in dramatic new ways. Example: Machinery that will cut out 80% of the dirty, dangerous work of mining soft coal has been perfected. A new automobile engine plant will reduce the work that goes into engine-building by three-quarters.

Hundreds of similar things that our scientists and engineers have developed could be cited. They can be found in every industry. They hold immeasurable promise of adding to the abundance of American living. In fact, there is hardly a step along the whole route of industry—from roughing out raw materials to delivering finished goods—where there are not new and better ways of doing things standing ready for general use.

But the crucial question now is: Where is the money coming from to put to work these new and better ways of doing things?

Business has used its own resources so far... profits and reserves. The stock market, where industry traditionally has raised money from people willing to risk their savings, has been limping along, giving business no chance to get enough money on satisfactory terms. *Business now must look primarily to its own earnings for the money to carry out the improvements which are necessary if America is to keep itself strong and efficient.* The next editorial in this series will deal with this new and crucially-important role of profits.

But business can not count on profits alone to do the job. Profits are too uncertain.

From now on finding the money... to put new ideas and new equipment to work... to go ahead with the expansion and improvement that will thwart depression and build industrial strength ... *calls for the support of all Americans everywhere.*

This comes right down to *you... for at stake is your chance for steady work, for better pay, for new things like television, and for more of the every-day things, like coal and clothing, of better quality and at less cost.*

By helping business get new and better tools, you will help yourself—and you will help build a more sound, more prosperous, better America.

James H. McGraw, Jr.

President, McGraw-Hill Publishing Company, Inc.

MITCHELL-RAND

announces....

Flexite HITEMP

The flexible, extruded plastic tubing.... to withstand high temperatures above 105° C

FLEXITE HITEMP is the electrical insulation tubing that sets new standards for resistance to extreme high temperatures. Compounded of a plasticized copolymer of vinyl chloride and vinyl acetate and manufactured with a true wall thickness, smooth inside and outside FLEXITE HITEMP PLASTIC TUBINGS offer the greatest resistance to high and low temperatures, are extremely flexible and have great tensile strength.

Other significant properties of FLEXITE HITEMP compare more than favorably with tubings of similar nature. Check the specifications of HITEMP, compare them with the requirements for your products and if you wish against other insulations for identical use . . . HITEMP sets a new high standard for protection against high temperatures, high dielectric, stretching, tearing, abrasion, exposure to acids, oils and alkalies, flammability, etc., etc., etc. — . . . samples and additional information will be sent upon request.

FLEXITE HITEMP PHYSICAL & ELECTRICAL PROPERTIES

a — tensile strength, minimum average .... 2500 PSI

b — ultimate elongation, minimum average 300%

c — dielectric strength, minimum .... 800 v/mil

d — flammability .... non-inflammable

e — heat resistance — after 100 hours at 300° F. the tubing is not brittle and when flexed does not crack.

f — heat endurance — recommended for continuous operating temperatures up to 105° C., and when baked at 125° C. for 2,000 hours does not become brittle.

g — low temperature flexibility .... −30° C.

h — heat shrinkage .... ASTM Standards
#20 — #17 incl. — less than 8%
#16 — # 6 incl. — less than 5%
5 and larger — less than 3%

i — oil resistance — highly resistant to effects of transformer and lubricating oils, does not stiffen when continuously exposed to them.

Colors — black, white, red, green, yellow and blue are standard colors.

Dimensions and Tolerances — standard sizes to fit B & S wires #20 to #0 inclusive, as specified by ASTM Spec. D922-47T.

Wall Thickness — in accordance with ASTM Spec. D922-47T, as follows:
#20 — #10 incl. — .016" ± .003"
9 — # 0 incl. — .020" ± .003"

Standard Lengths — Standard 36" lengths or continuous lengths in coils. Sizes #20 — #10 incl., will be supplied on paperboard spools when so ordered.

Quality — uniform in quality and condition, smooth on both inside and outside, free of defects such as pin-holes, blisters, foreign inclusions and other imperfections.

Test Methods — properties enumerated in above specifications shall be determined according to Tentative Methods of Testing Nonrigid Polyvinyl Tubing, American Society for Testing Materials, Designation D876-46T.

And for a Plastic Tubing to Withstand Normal High Temperatures Mitchell-Rand Offers . . . Flexite-Norm . . . write for specifications.

MITCHELL-RAND INSULATION CO. Inc.

51 MURRAY STREET · COrtlandt 7-9264 · NEW YORK 7, N. Y.

A PARTIAL LIST OF M-R PRODUCTS: FIBERGLAS VARNISHED TUBING, TAPE AND CLOTH · INSULATING PAPERS AND TWINES · CABLE FILLING AND POTHEAD COMPOUNDS · FRICTION TAPE AND SPLICE · TRANSFORMER COMPOUNDS · FIBERGLAS SATURATED SLEEVING · ASBESTOS SLEEVING AND TAPE · VARNISHED CAMBRIC CLOTH AND TAPE · MICA PLATE, TAPE, PAPER, CLOTH, TUBING · FIBERGLAS BRAIDED SLEEVING · COTTON TAPES, WEBBINGS AND SLEEVINGS · IMPREGNATED VARNISH TUBING · INSULATED VARNISHES OF ALL TYPES · EXTRUDED PLASTIC TUBING

BUSINESS BRIEFS

By W. W. MacDONALD

New Year Predictions on which we are willing to stick our neck out, speaking of the overall field of electronics, are as follows:

Sales. About the same as in 1948. Few factors indicate any startling increase. Pessimism, on the other hand, appears to be based largely upon the contagious idea that just because the curve has been so steadily rising it must soon turn down. There is such a thing as a plateau. We think we are on it, and that the line will stay nearly flat for some time. Then it may rise.

Costs. One more increase, probably. But a small one compared to those experienced in the past two years.

Prices. About the same.

We Are Inclined to agree with those who think that the key to success in this year's market will be production and sales rather than design effort. Looking backward, like the whiffle bird, it seems to us that 1947 was a design year, 1948 a tooling-up year, and that 1949 will be remembered as the year in which intense sales effort supported mass production.

First Meeting of government and electronics industry leaders concerned with mobilization planning resulted in the expected stalemate. Appointment of a subcommittee which will be charged with the responsibility of ironing out differences between four suggested schemes (Dec., p 62) hung fire, so nothing much can now be accomplished before mid-January at the earliest.

The country is better prepared for any possible military contingency than it has ever been before but, as in the past, seems incapable of going anything like all out in that direction unless and until war clouds actually precipitate. The Services are, as usual, naively trying to whip up industry enthusiasm for paper planning on the basis of appeals to patriotism. The industry is, as usual, adopting a too-hard-boiled attitude with respect to anything short of actual orders.

Speaking Of Preparedness, engineers are currently studying ways and means of shortening the time between design and production of military gear should war come. Closer coordination between men who build prototype models on breadboards and those who have to turn them out on a quantity basis is one method under consideration.

We Refrained from mentioning it last month, because we had only a few scattered examples, but now we know that the government is stockpiling a lot of military equipment not entirely to its liking but nice to have on hand in the event that war clouds gather.

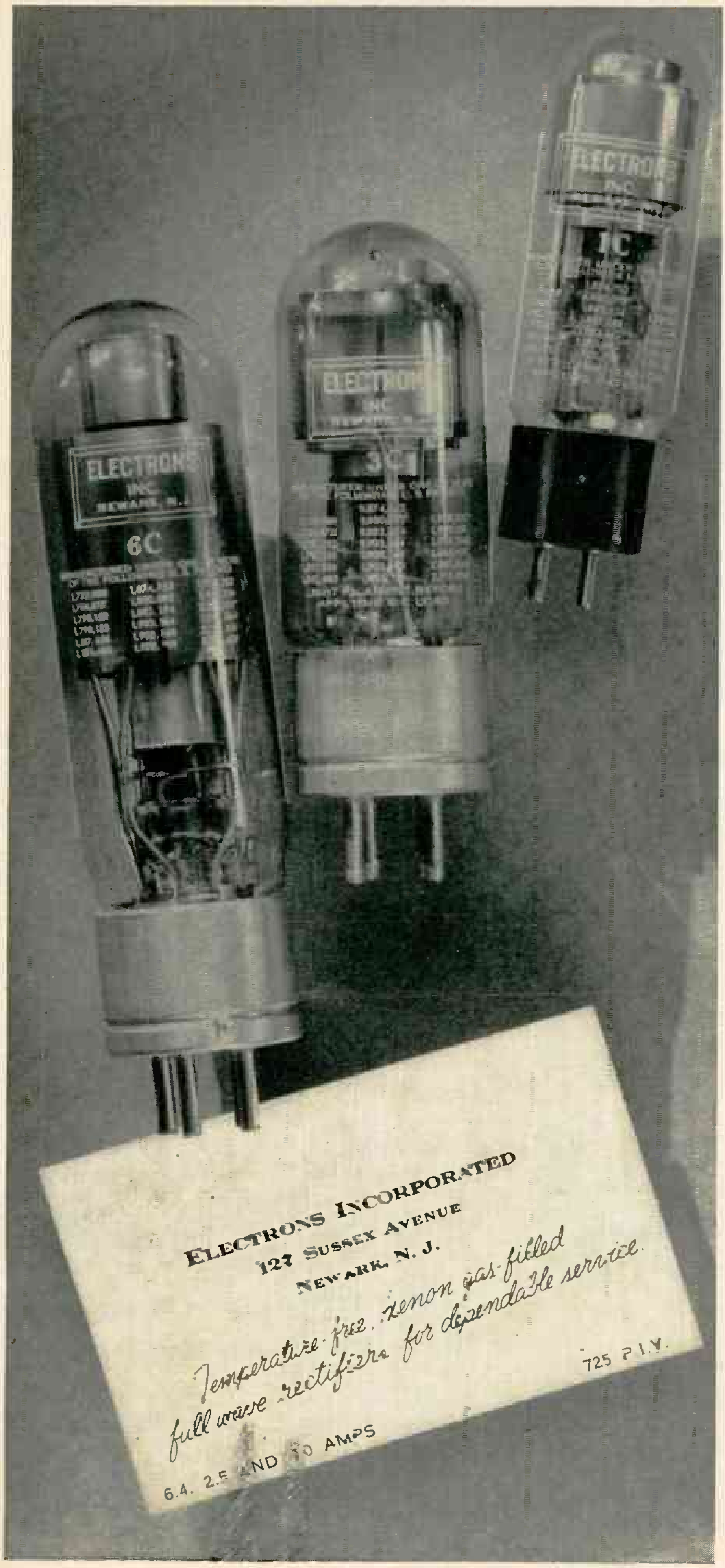
Many manufacturers are being asked to bid on new equipment not much different from designs dumped on the surplus market not so long ago, and some suspect that minor differences were deliberately written into the specs to stop industry from selling back to government what government recently sold to industry rather than because changes are essential.

The military, like the rest of us, likes to save face.

We've Heard of people tuning in on radio broadcasts using no equipment other than the fillings in their teeth and in December (p 64) told about a medical instrument that plays sweet music without benefiit of communications design. Now we read in the papers that a Mrs. Sechrist of York, Pennsylvania has a gas range that does the trick.

But can it cook?

Tape Recording is making rapid inroads into the wire-recording business, insofar as the handling of speech and music is concerned. It is interesting to note, however, that in at least one instance a manufacturer who fully intended



to drop wire for tape has decided to produce both types of instrument.

Wire, it seems, is desirable for laboratory and industrial uses where accurate timing of programs is essential. There is less slippage at the capstan, and wire does not expand or contract as much as tape with changes in temperature and strain.

Telemetering experimenters, in particular, like the solid stuff.

Amateur Equipment Makers are not too happy. Apparently many of them geared up to handle a substantial increase in business right after the war and it did not materialize.

Major reason why business did not boom as expected despite a sharp increase in the number of ham licenses was because many of the newcomers had no deep-rooted interest in the game and dropped out in a hurry. We question whether a survey of the field would show many more active amateurs than there were before the war. Availability of surplus gear further nicked into the market, and after-midnight operation calculated to avoid trouble with neighbors who own television sets is doing manufacturers relying upon hobbyist business no good right now.

Tele Installations are pressing manufacturers hard. The Veterans Employment Service reports that RCA has filed job orders for 1,000 men, to work in New York, Newark, Louisville, Washington, Providence, Miami, Albuquerque, Atlanta, Bloomington, St. Louis, Memphis, Columbus, Charlotte, Dallas, Indianapolis, Lancaster, Omaha, Toledo, Wilmington and Seattle.

And, as we have recently pointed out, they'll soon press harder.

Canadian Tele Plans mark time while the freeze is on in our own country. Reason: Standards north of our border will be like ours, not English, to facilitate interchange of programs and to minimize interference.

Too bad our northern cousins

won't be able to buy many of our sets, due to currency restrictions. It'll cost them more to roll their own.

This Issue is loaded with television. It is no accident. And no "special." The industry itself is currently hipped on the subject, and the editors are splitting a gut to give the boys what they want. More, much more, in coming numbers.

Ralph Brengle, president of the National Association of Relay Manufacturers, estimates that 300 million relays were manufactured in 1948, and that there were 18,000 different types. Standardization, now under way, will probably involve interchangeable coils, and should substantially reduce the number of required types.

Best Way To Sell electronic accessories for many machines is, it seems, to sell it to the users of such machines rather than to the manufacturers. Once users fall in love with the accessories they start asking machine makers why such accessories are not built in. And even conservative machine makers eventually take the hint if they have any competition.

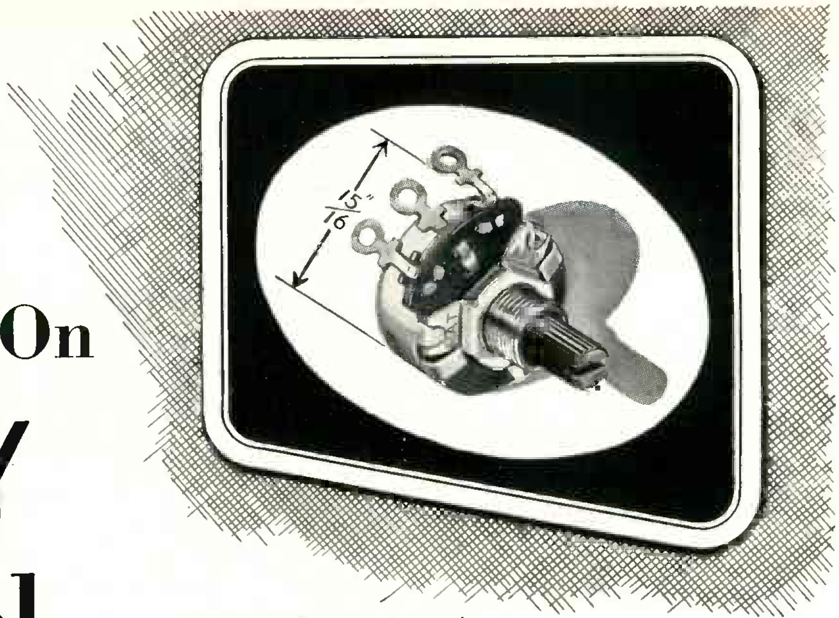
In The Foreseeable Future the cost of operating an electronic hearing aid may be brought down to a cent an hour, far under what it is at present. If and when that happens such aids may sell in numbers comparable to eyeglasses.

In England, 5,000 people have already received free electronic hearing aids from the government. An estimated 145,000 more will be required.

Now We Can Answer the query from a reader who wanted to know who made an electronic calculator that would automatically figure out a horse's chances of winning from his past record. Such a gizmo is made by the Dev-Ro Company of 6750 Stony Island Avenue, Chicago. No kidding.

Definition: Economist . . . One who arrives at the wrong answer by elaborate means.

The Spotlight's On
P. R. MALLORY & CO. Inc. MALLORY
Midgetrol



The little BIG addition to the Mallory Line of Television Controls.

Mallory has done it again. Here is an all-new, revolutionary control that is perfect for television application. Only 15/16" in diameter, it is Mallory's answer to the designer's cry for smaller and smaller controls.

Don't be deceived by its compact size. It's all Mallory through and through. For instance: Shaft is completely insulated from chassis. Good for higher voltage applications—can't get a shock. The insulated shaft is knurled for easy adjustment—has screw-driver slot for back panel applications. Thoroughly tested, the Mallory Midgetrol has come through with flying colors for television applications.

The Mallory Midgetrol is typical of Mallory superiority in controls. Today, Mallory has a control, carbon or wire-wound, required for any specific usage, for every television application.

The dependability of today's television receivers which is responsible for the great public demand has as one of its bases the precision performance built into Mallory controls by special skills, long experience and devotion to quality ideals.

And with all this superiority, Mallory offers service—quick delivery for both standard and special applications—and low price.

MALLORY CONTROLS FOR TELEVISION APPLICATION

1. For volume
2. For focusing
3. For height of picture
4. For linearity
5. For centering picture on tube, horizontal or vertical
6. For contrast or brightness
7. For horizontal and vertical "hold" controls
8. For audio tone control

You Expect More And Get More From Mallory

Precision Electronic Parts—Switches, Controls, Resistors

P. R. MALLORY & CO. Inc. MALLORY

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

SERVING INDUSTRY WITH

Capacitors — Rectifiers
Contacts — Switches
Controls — Vibrators
Power Supplies
Resistance Welding Materials

CROSS TALK

▶ **EXECS** . . . The management of the electronics business must deal with technical intricacies on a wide scale, more so than any other branch of technology save possibly the field of nucleonics. This situation calls for engineering talent in the top levels, the lack of which has been lamented in the past. But, according to one index at least, many technical men have penetrated into top jobs. According to the records compiled in the 1948 I.R.E. Yearbook, more than half of the 260 living members of fellow grade are in top management. Since the grade of fellow is conferred only for distinguished engineering achievement, quite irrespective of business judgment, this is indeed encouraging. The list breaks down as follows: presidents and heads of manufacturing corporations, 32; vice-presidents of same, 33; chief engineers and engineering managers, 71. The non-managerial groups are: professors and consultants, 57; practicing engineers outside management, 52; miscellaneous and unclassified 15. There is no doubt that each of these men has sound engineering judgment. To the extent that they use that judgment, particularly when the dictates of the marketplace might lead them along other paths, will our industry prosper.

▶ **INTERCARRIER** . . . On September 7, 1948, the U. S. Patent Office issued a grant, number 2,448,908, to Louis W. Parker of Woodside, N. Y., covering the use of an i-f amplifier carrying television picture and sound signals simultaneously. Thus, after many months of obscurity (the patent was applied for July 13, 1944), the inventor of the important intercarrier system of television reception has emerged. Mr. Parker elected to wait until his patent was issued before submitting a manuscript on the system to us. This manuscript we were unable to publish because it covers material previously published from other sources. This being the case, we feel a strong obligation to place the credit for the invention where it now clearly belongs.

In so doing we wish to cast no reflection on the work of Robert B. Dome who first publicly disclosed this system at the Rochester Fall Meeting in 1946 and published a paper in these pages in January, 1947. Bob Dome's work on this subject was entirely independent and his early disclosure of it assisted the industry very materially in understanding and applying the intercarrier principle. So the Dome circuit becomes the Parker circuit, or perhaps, more gracefully, the Parker-Dome circuit.

The moral of this story, it seems to us, is that the U. S. Patent office deserves additional personnel and facilities to process patent applications more quickly. When and if Congress grants this aid, it should not be necessary for a period of over four years to elapse between the application and the granting of a patent. The appreciation of the importance of new inventions and their subsequent application will then be accelerated, to the benefit of all concerned.

▶ **HALF** . . . Our suggestion some months ago of a word to cover the family of semiconductor devices (transistors, thermistors, varistors, crystal detectors and barrier-layer photocells) has come to grief. We suggested "semicon". But a correspondent in Paris informs us that "con" is French for half-wit. Said correspondent begs us to cease and desist. A friend at Bell Labs also objects. He says the "istor" family of words suffices and is more descriptive. Shaken by these protests, we're willing to forget the whole thing. But we insist, and hear no objection, that these gadgets are part and parcel of the electronic world, be it in Paris or Murray Hill.

▶ **OBSOLETE** . . . After a tour of the surplus market, Arthur Van Dyck was moved to remark recently that the radio engineer misses many of the enduring satisfactions of the civil engineer. The bridge builder can look at the work of his youth and find it still useful. The radio engineer's brain child finds its way to the junk heap at least once every ten years. Fast moving business, this electronics!

A New Concept of COMMUNICATION ENGINEERING

Information, the commodity of communication, is shown to be measured by the number of choices made from a set of alternatives. This method of measurement permits evaluating systems on a rigorous basis and leads to a broader concept of the communication art

By NORBERT WIENER

Department of Mathematics
Massachusetts Institute of Technology
Cambridge, Mass.

ELECTRICAL ENGINEERING is divided into two main branches, termed Power Engineering and Communication Engineering.

For power purposes, the construction of dynamos, motors and transformers involves apparatus that carries considerable energy. The purpose of the whole system is the economical use of energy. On the other hand, although it is true that considerable power is used to transmit information, communication engineering is not directly concerned with power. Except for the infinitesimal remnant that actuates the receiving apparatus, this power is wasted. The use of transmitters of high power belongs to a passing phase of communication engineering development. Powerful low-frequency transmitters, which characterized the early days of transatlantic radio telegraphy, are being supplanted by transmitters of relatively high frequency, moderate power output and astounding range of reliable reception.

Energy vs Information

The distinction between these two types of electrical engineering is that power engineering is primarily concerned with the transmission of energy as a usable commodity which must not be wasted unnecessarily, while communication engineering is concerned with the transmission of information.

There is no vagueness in the definition of energy, so that power engineering is a field in which the objectives have been fully understood for a long time. On the other hand, most books on communications say nothing about information, and the average communication engineer does not have a definite measure of information. He studies communication circuits as they are affected by sinusoidal inputs, but he does not discuss the relation between sinusoidal and information-carrying inputs. Only within the past few years have a few engineers begun asking what information is and using the concept of information as a basis for design.

Choice of Alternatives

What, then, is information? One important feature of information is that it cannot be described or measured merely by specifying any single message. Obviously information is significant only if there are several courses of action open to the recipient and if the information might have been something else. The least amount of information a message gives is whether it is sent or not. This minimal message is, however, entirely abnormal and, if sent, need occupy no long time. A continued message, sent for example by telephone, telegraph or wigwag, presents a sequence of successive decisions. It is fair to state that the amount of information transmitted is proportionate to the number of decisions made.

Because information depends, not merely on what is actually said, but on what might have been said, its measure is a property of a set of possible messages, or of what is called an *ensemble* in statistical mechanics. Such an ensemble is more than a set taken simply; it is a set to which is attributed a probability measure. We thus have a situation that is closely akin to that in statistical mechanics, more especially in the form which Gibbs gave it (see for example "The Collected Works of Josiah Willard Gibbs," Longmans, Green & Co., New York, 1928).

In statistical mechanics, many of the statements that we ordinarily suppose to refer to completely concrete situations refer to ensembles. Consider a glass filled with water. The statement that the glass is filled would seem, from a naive point of view, to be specific. However, according to statistical mechanics, the water in the glass consists of an arrangement of molecules, and there are many arrange-

CYBERNETICS

The nervous system, as well as cable and radio channels, is a communication device; each one transmits information. Norbert Wiener, one of the leading mathematicians of our day, has devoted himself to a broad study of communications, making notable contributions to our understanding of the subject. The full potentialities of pulse code modulation, for example, were not appreciated until the new theory revealed its special advantages.

Professor Wiener presents here some new thinking which is developed at length in his recent book "Cybernetics", published by The Technology Press and John Wiley and Sons, New York.

As Dr. Wiener states, "If the seventeenth and early eighteenth centuries are the age of clocks, and the later eighteenth and the nineteenth centuries constitute the age of steam-engines, the present time is the age of communication and control."—The Editors

ments consistent with the naive observation that the glass is full of water. To say that it is full does not assert that it is in any one state. Rather, the statement asserts something generic about the states of the water in the glass, and can be interpreted only if we consider simultaneously all possible fine-grained states that lead to the same coarse-grained appearance.

Statistical Mechanics

Furthermore, from the dynamics of particles, Gibbs was able to obtain a probability such that he could assign a definite probability-measure over the ensemble of all possible distributions of a system of particles. In other words, the type of concept needed for treating information and communication engineering is very close to that needed for Gibbsian statistical mechanics.

As previously mentioned, the amount of information that is transmitted by a system is measured by the number of decisions made. This statement should be qualified by adding that the decisions that are to be made in the first instance are between alternatives that have equal a priori probabilities. If we make n independent decisions in such a case, the number of classes into which we divide our universe is 2^n, and all these are equally probable. Thus the probability of each of these is $1/(2^n)$. If we take the logarithm of this probability to the base 2, we get $-n$. Hence, the amount of information n is numerically proportionate to the negative of the logarithm of the probability of the subdivision that we have fixed by our successive decisions.

The introduction of the logarithm of a probability is nothing new in statistical mechanics; it is called entropy and measures the disorder of a statistical state. Its negative, which we are here calling an amount of information, is thus a measure of order. This identification of order and information is entirely natural.

So far, we have been giving a definition of the amount of information that is contained in a situation where we restrict our a priori distribution to the points of a particular set. In other words, our information may be more or less restricted, but, as far as it goes, it is complete.

Perfection of Observation

There is another situation in which the information itself is incomplete. We may not know with certainty that an entity, which we are considering, belongs in a certain region, but only that, with certain probabilities, it lies in a number of specified subregions. In this case, our information is associated, not with a class of contingencies, but with a statistical distribution of contingencies. We must superimpose on an a priori probability, corresponding to the measure of the probability of the decisions in the case already discussed, a second probability depending on the perfection of our observation.

In this case, to define the entropy or negative amount of information, we employ the same formula that is used in thermodynamic entropy. If a manifold is split into parts that have separately the a posteriori probabilities $P_1, \ldots, P_n$, the entropy of the whole situation is

$$\Sigma P_n \log P_n + C$$

where C is a certain normalization constant depending on the zero of entropy left free. This relation would suggest that in the corresponding situation the amount of information would be

$$-\Sigma P_n \log P_n - C$$

and if we change the probabilities of our subdivisions from P_n to p_n, the gain of information should be

$$\Sigma P_n \log P_n - p_n \log p_n$$

Being thus able to measure information, we can answer several questions that are important to the communication engineer. In all these cases we reach results completely accordant with those obtained by C. E. Shannon (see, for example, A Mathematical Theory of Communication, *Bell System Tech. Jour.* No. 3 and No. 4, Vol 27; July and Oct., 1948).

Evaluation and Design

The particular question that interests us most is: How much information from the message do we retain in the presence of a noise? Now, we are supposing that we have (1) an a priori distribution of noise and message given simultaneously and (2) some mixture of noise and message by addition or otherwise. From the distribution of noise and message, we know the simultaneous distribution of true and corrupted message. For each value of the corrupted message, we then determine the distribution of the true message, and compare it with the true message when the noise varies statistically over its complete range, using the formula suggested above. This procedure gives us the gain of information.

This illustration is merely one of the uses to which we can apply the notation of amount of information. In closely related ways, we can use it to estimate the relative efficiency of different types of modulation, and we can see how they affect the carrying ability of a channel. If we have all possible methods of coding at our disposal before putting the message in the channel, it will turn out that, in the presence of a fixed amount of channel noise of a certain degree of regularity, we cannot get better results than those obtainable by amplitude modulation. On the other hand, if we wish to evaluate the efficiency of a particular transmission method for a message that must be in a highly specified form, such as that of sound, we must bring into the picture such apparently external considerations as the efficiency of the coding of such messages by voice or by musical instruments, and the complete receptor apparatus, including, for example, the ear and the auditory cortex. Such studies are difficult, but they can be made. They illustrate the need for applying the idea of communication engineering to the study of the conduction of messages inside the nervous system, as well as outside. This is not merely a need for the physiologist, but equally a need for the engineer.

Cybernetics

To indicate our recognition of this need for a more inclusive treatment of the problem, we have introduced the word cybernetics (pronounced si'bernetics), from the Greek for steersman, to cover the whole communication and control engineering nexus when it is desired to put equal emphasis on the physiological and engineering sides. This fusion also indicates the recognition that the transmission of information, whether it be speech via radio waves or printing-press registration via levers, is a common and basic consideration of many devices.

The statistical concept of the message is not only important for the evaluation of different means of communication, but it is equally important for their design. A piece of communication apparatus should be designed to perform a certain mathematically described function as well as is possible in view of the ensemble of messages to be transmitted. The constants of the apparatus are then so determined as to minimize some specific quantity depending upon the statistics of the messages and these constants.

The branch of mathematics that teaches us to minimize such expressions is called the calculus of variations; it leads to specific methods for determining the unknown parameters. Professor Y. W. Lee and myself have carried out such minimization leading to the design of predictor mechanisms, wave filters and waveform compensators. There is a very considerable future in this field of work, which reduces what previously have been purely empirical processes to a true scientific discipline.

Control and Communication in The Animal and The Machine

CYBERNETICS is defined in the Introduction of Dr. Wiener's book by describing the contribution of the individuals, fields of thought and specific problems that led directly to its chronological development, and by projecting its influence a bit into the future. For many years Drs. Rosenblueth and Wiener had shared the conviction that the most fruitful areas for the growth of the sciences were the neglected hedgerows among the established specialized fields. To investigate these boundary regions, which offer the richest opportunities to the qualified investigator, discussion groups met with leaders from each of the specialized sciences. These teams of scientists, in collaboration, could attack the problems more effectively than each working alone. Dr. Wiener writes:

"My close contact with the program of computing machines developed by Dr. Vannevar Bush, and my own joint work with Dr. Yuk Wing Lee on the design of electric networks . . . proved important. . . . I turned a large part of my attention to the development of computing machines for the solution of partial differential equations . . . as contrasted with the ordinary differential equations so well treated by Dr. Bush on his differential analyzer. . . . I had also become convinced that the process of scanning, as employed in television, gave the answer to that question, and in fact that television was destined to be more useful to engineering by the introduction of such new techniques than as an independent industry.

"It was clear that the scanning process must vastly increase the number of data dealt with. . . . To accomplish reasonable results in a reasonable time, it thus became necessary to push the speed of the elementary process (by using electronic techniques) to a maximum. . . . It also became necessary to perform the individual processes with so high a degree of accuracy that the enormous repetition of the elementary process would not bring about a cumulative error so great as to swamp all accuracy. . . .

"It has long been clear to me that the modern ultra-rapid computing machine was in principle an ideal central nervous system to an apparatus for automatic control; and its input and output need not be in the form of numbers or diagrams, but might very well be, respectively, the readings of artificial sense-organs such as photoelectric cells or thermometers, and the performance of motors or solenoids. With the aid of strain-gauges or similar agencies to read the performance of these motor organs . . . we are already in a position to construct artificial machines of almost any degree of elaborateness of performance. . . . The automatic factory, the assemblyline without human agents, are only so far ahead of us as is limited by our willingness to put such a degree of effort into their engineering as was spent, for example, in the development of the technique of radar. . . .

"Perhaps I may clarify the historical background of the present situation if I say that the first industrial revolution . . . was the devaluation of the human arm by the competition of machinery. . . . The modern industrial revolution is similarly bound to devalue the human brain at least in its simpler and more routine decisions. . . ."

In the chapters that follow this provocative beginning, Dr. Wiener discusses in greater detail such contributing fields of endeavor as communication, feedback and oscillation, computing machines and nervous systems, showing their interrelations and points of common interest.

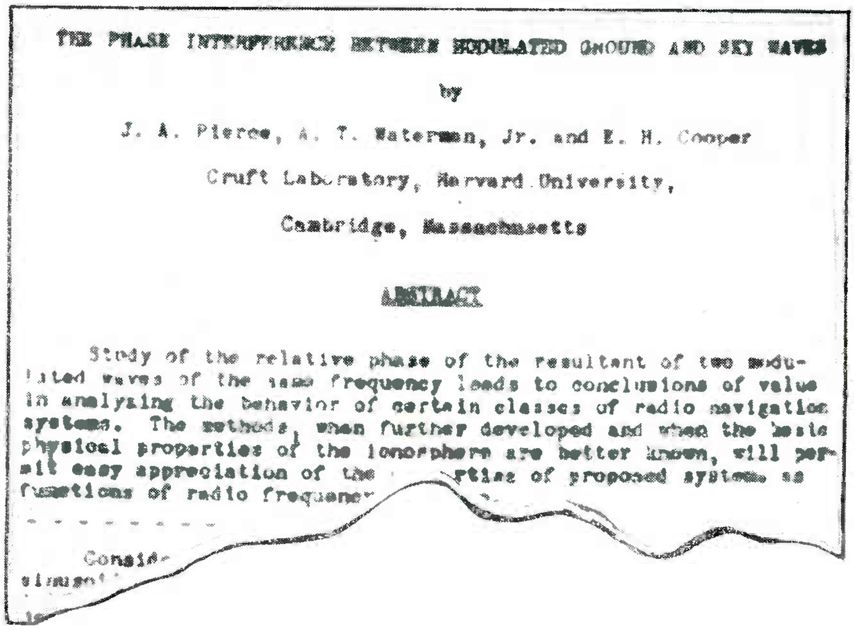
ULTRAFAX

A new facsimile method uses cathode-ray tubes as light sources at both transmitter and receiver. Ultimate high-speed transmission depends upon 10-megacycle microwave relay chains. Receiving device uses photographic film that can be developed in a few seconds

ULTRAFAX is the name coined to describe a technique that combines facsimile, television, and "hot" photography for the extremely rapid transmission of intelligence in written or printed form by radio.

The first public demonstration of an experimental system was staged by Radio Corporation of America and Eastman Kodak Co. at the Library of Congress, Washington, D. C. on October 21, 1948. As emphasized by its proponents, the information revealed constitutes a progress report, together with some speculations as to the practicability of general use of the system, and a statement of the requirements necessary to attain the goal of "a million words a minute."

Equipment and methods described are those used in the demonstration and their limitations should not be construed as obstacles to a working system. At the same time, there is no commercial equipment now available, nor are there suitable channels assigned for use of the medium. It might be expected that military expediency and economic feasibility will shape the form of the ultimate equipments and methods.


THE PHASE INTERFERENCE BETWEEN MODULATED GROUND AND SKY WAVES

by

J. A. Pierce, A. T. Waterman, Jr. and E. H. Cooper

Cruft Laboratory, Harvard University,

Cambridge, Massachusetts

ABSTRACT

Study of the relative phase of the resultant of two modulated waves of the same frequency leads to conclusions of value in analyzing the behavior of certain classes of radio navigation systems. The methods, when further developed and when the basic physical properties of the ionosphere are better known, will permit easy appreciation of the rties of proposed systems as functions of radio frequenc

Consid-

Portion of message received and developed during demonstration

System Components

Elements of the system outlined in the simplified block diagram of Fig. 1 indicate its close relationship to conventional facsimile practice. The material to be transmitted is first reduced from page size to a dimension such that the page width corresponds to the useful width of a 35-mm film strip. The individual pages are spaced out along the

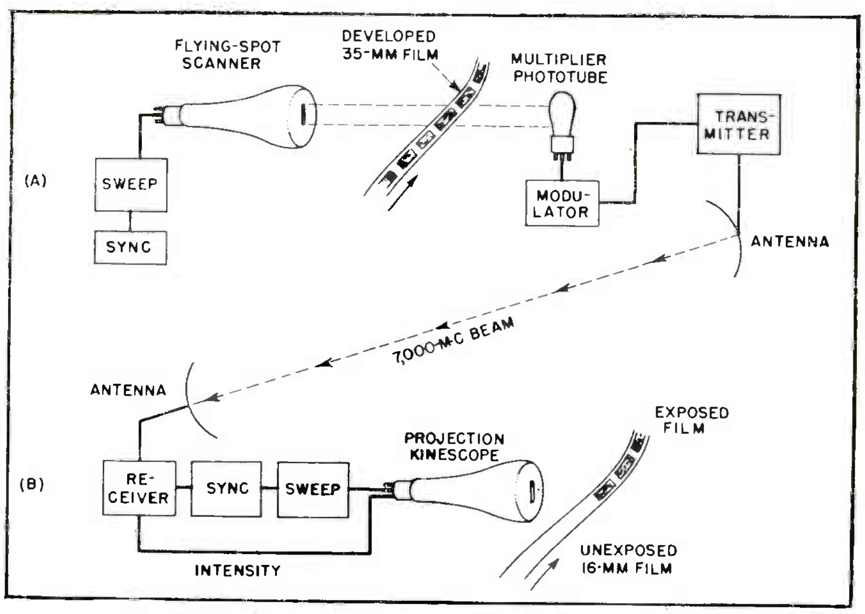


FIG. 1—Simplified block diagram of the system. Details of the photographic aspects are omitted

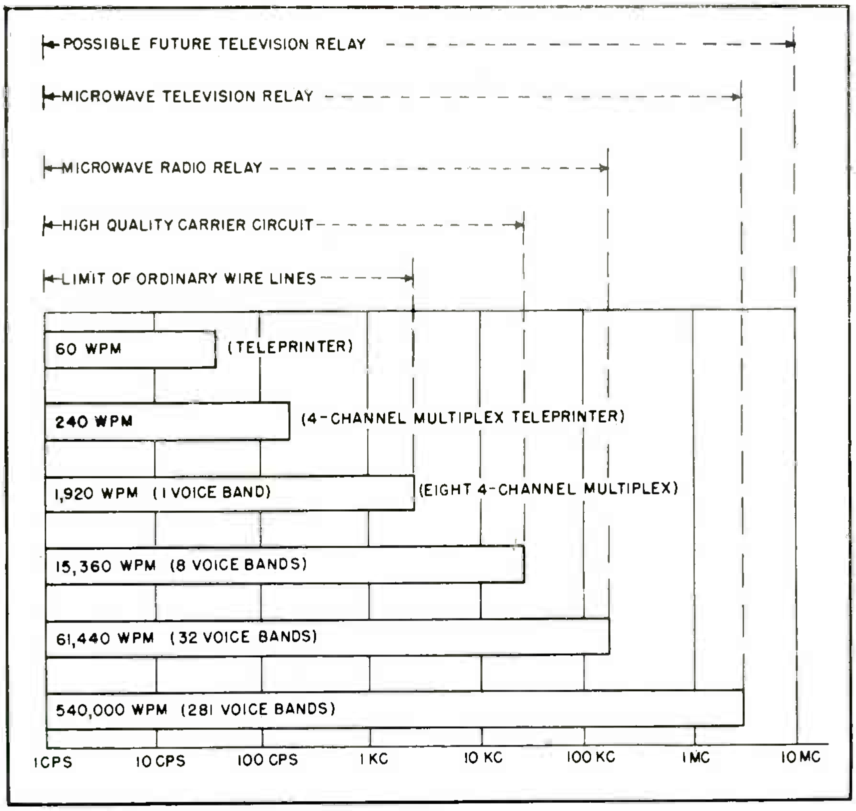


FIG. 2—Representative communications methods, showing their capacities and required bandwidths. Ultrafax demonstration system using 4-mc bandwidth shown at bottom

length of the film at convenient intervals. There is no reason, however, why the information can not be continuously presented (without gaps between pages) as in a teletype page printer.

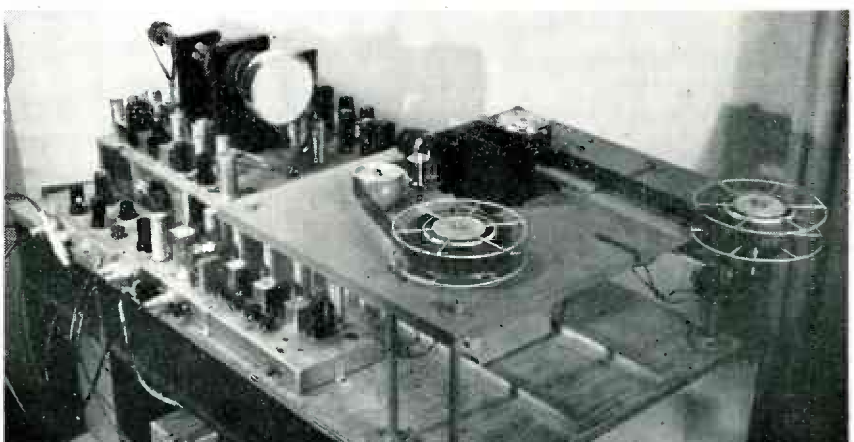
As the film is moved between a lens system and the multiplier phototube at a rate of 15 "frames" or pages per second, the film width is scanned at a rate of 6,300 cycles per second, using a special flying-spot scanner tube as a source of illumination. This tube is similar in many respects to the recently-announced type 5WP15 except that the spot is about half the diameter and the phosphor is a new material developed especially for this service. Phosphor persistence must naturally be short as compared with conventional television picture-tube characteristics in order to avoid blurring the elements scanned by the spot. Resolution corresponding to better than 1,000 lines is obtained provided the circuits used have a bandwidth of 10 megacycles. Post-accelerator voltage in the order of 27 kilovolts is employed.

The multiplier phototube used is the type 1P21, nine-stage, S-4 tube with maximum response in the region of 4,000 Angstroms. Output from the phototube goes to a modulator and transmitter. In the demonstration, a 7,000-mc television relay equipment with integral transmitter and parabolic reflector was used atop the Wardman Park Hotel, three miles distant from the Library of Congress where a companion receiving unit picked up the signals.

Although the demonstration receiving equipment occupied two relay rack cabinets, the basic equipment needed comprises that indicated in the simplified diagram in Fig. 1B. A single synchronizing signal suffices to initiate the single line trace and blank out the return trace. The moving spot of the projection kinescope tube is modulated in accordance with the intensity of the signal picked up by the multiplier phototube and transmitted over the microwave circuit. This tube also employs voltages in the order of 27 kilovolts and has a spectral response suitable for exposing the 16-mm film (as contrasted with 35-mm film used at the transmitter) which is pulled past the kinescope and lens system at a rate of 15 frames per second.

The relative longitudinal speed of the film at transmitter and receiver is not critical. During the demonstration, the remote transmitter was synchronized with commercial 60-cycle power and that at the receiver was operated at a nominal 60 cycles from a motor-generator run off d-c mains.

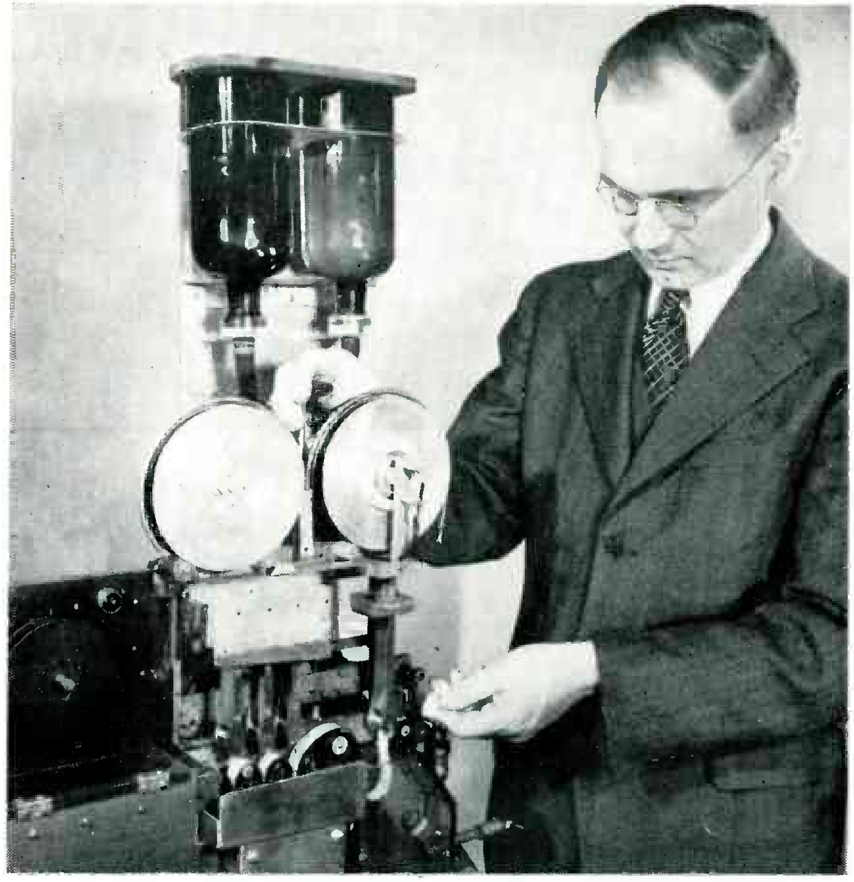
Although the system uses a minimum of television techniques and requires transmission of only a horizontal or line synchronizing pulse, the complexity of the equipment must be somewhat greater in certain respects. Since the burden can be shared at each end of the circuit, as compared with broadcast television in which the receiver costs must be minimized, the overall difficulties are not great.



The experimental transmitter employs 35-mm film as data source. Flying-spot scanner at left. Phototube in box at center

Among the major problems are the absolute elimination of 60-cycle hum in the line signal circuits, and clamping of the black level at the transmitter. Broadcast television operations have been criticized in this latter respect, but the characteristics of the human eye in viewing a broadcast are not nearly so rigorous as those of a piece of inanimate film. Accordingly, the black level of the transmitter is reset to an absolute value immediately after each synchronizing pulse and just before the scanning of the next line is begun.

An idea of the definition possible with the experimental system can be gained from the illustration of a typical piece of transmitted text presented here. The cut was made from an enlargement of a frame recorded on 16-mm film during a rehearsal of the demonstration. The fundamental limit to the overall resolution of the equipment at the present state of development is set by the use of 16-mm film.



Charles Kunz of Kodak feeds a leader strip through the experimental high-speed hot developing machine used at the receiver

Hot Photography

The photographic aspects are fully as important as the development of the electronic system because the speed of reception depends upon a memory device most conveniently furnished by a moving film. The experimental system depends upon film at the transmitter and photographic printing of the final message. As with the electronic gear, the photographic techniques are assembled from already successful principles. They include Recordak, the 16-mm documentary film system, wartime V-mail that reduced the weight of air mail 99 percent, and the little-known PPPI (photographic plan position indicator). The latter system can be considered the closest cousin to Ultrafax photography because, by hot development of a film exposed to a special high-voltage radar screen a dry negative became available in a matter of seconds.

The equipment illustrated is a developmental model convenient for use during the demonstration, with a speed of 8 feet per minute. Each frame of heat-resistant film is moved in 15 seconds through developing solutions at temperatures about 125 F. The finished film, which can be recorded as either a positive or a negative, is completely dried in an additional 25 seconds, after which it may be handled freely, viewed, or run through a printing machine for enlarged paper copies of its message. A continuous flow of solutions from the bottles shown eliminates chemical problems of film processing.

Transmission Facilities

Facilities for the transmission of Ultrafax messages do not now exist in any great number, nor is their geographical extent of significance. The chart in Fig. 2 shows some typical methods of intelligence transmission and the limitations imposed by conventional communications media. In practice, the figures may be found to vary somewhat from the averages shown. Coaxial cable, for instance, imposes a bandwidth of 2.7 megacycles with repeaters every 8 miles. One uhf relay system operating near 2,000 mc provides channels about 20 mc wide, as does another operating at 1,300 mc. Still another system using frequencies at 4,000 mc will pass 5-mc transmissions. As demonstrated, the Ultrafax equipment used a 4-mc band to transmit about half a million words a minute. A rate of a million words is estimated to require a 10-mc band.

It is not unlikely that nationwide television relay facilities now in the process of growth will encompass at least a 10-megacycle bandwidth in order to take care of future developments in higher-definition television as well as color television with definition at least as good as is now available in black and white. Ultrafax could use a standby circuit during television programming, idle broadcast program channels during the night hours, or combinations of both.

Acknowledgment

We acknowledge with thanks the kind cooperation of C. E. K. Mees of Kodak, E. W. Engstrom, and particularly that of D. S. Bond of RCA Laboratories, Princeton, N. J., in the preparation and review of this material.—A. A. McK.

6,000-MC Television Relay System

Utilizing the super-high-frequency allocation for television, programs can be relayed through Neshanic, N. J. and Mt. Laurel, N. J. from New York to Philadelphia over two-way circuits. Repeaters and terminal equipment are described

By **WILLIAM H. FORSTER**

Project Engineer
Philco Corporation
Philadelphia, Penna.

INSTALLATION of a New York-Philadelphia microwave television relay circuit was completed in June 1948.

This relay equipment is frequency modulated and is designed to operate in the common-carrier band from 5,925 to 6,425 mc. It has all of the general characteristics of shf systems: high-gain, narrow-beam antennas; line-of-sight propagation; freedom from interference; and freedom from multipath in which the time delay between interfering rays approaches a video period. In addition it has the specific characteristics which are necessary for television: a 5-mc video passband and a high signal-to-noise ratio.

The equipment requires an r-f channel 20 mc wide. Adjacent channels for a single installation are spaced 40 mc on centers. The four channel frequencies for the two-circuit New York-Philadelphia network are shown in Fig. 1. Four channels are necessary because the two circuits are independently reversible. This two-circuit system can be operated simultaneously in both directions, utilizing these same four channel assignments, merely by installing additional repeater equipments at Neshanic and Mt. Laurel. The 20-mc channel permits a 12-mc peak-to-peak deviation of a television video signal with 5-mc components.

All of the antenna plumbing is designed for operation throughout the 500-mc-wide common carrier band. Four by eight foot truncated paraboloidal antennas, driven by horn feeds, are used for all installations. These antennas have a 38-db gain over an omnidirectional radiator. The horizontal and vertical patterns for this type of antenna are shown in Fig. 2. The horn feed is specifically designed to produce low side lobes to minimize crosstalk between side-by-side and back-to-back dishes. The antennas are mounted with the long dimension vertically, giving a vertical beam width of 1.5 degrees and a horizontal beam width of 3 degrees. The mounting system permits rapid and accurate adjustment of the antenna direction.

Standard $1\frac{1}{2}$ by $\frac{3}{4}$-inch brass waveguide lines are used to connect the antennas with the equipments which are generally installed in houses on the ground. The attenu-

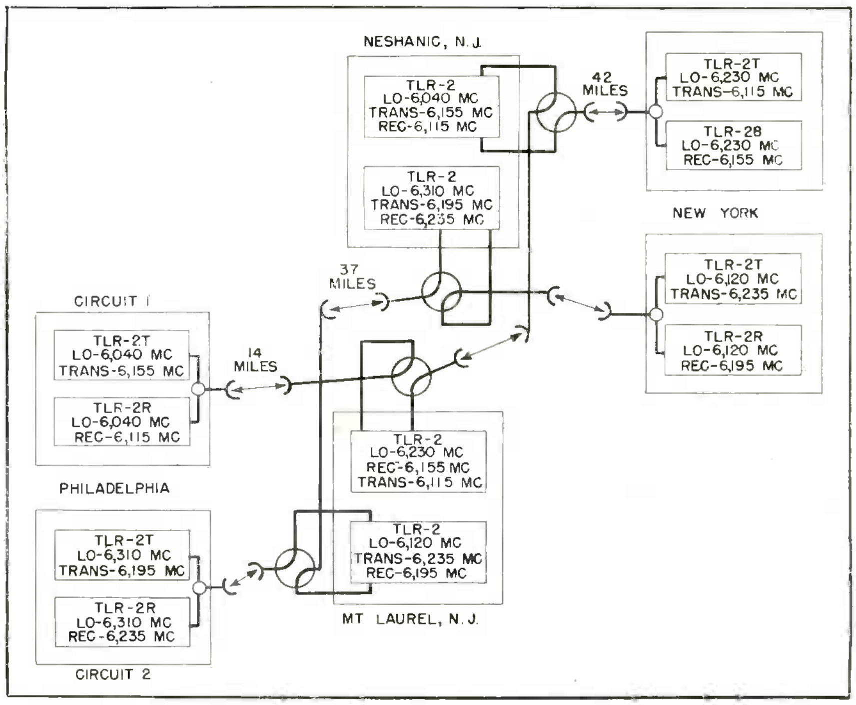


FIG. 1—The 6,000-mc two-channel television relay system, reversible, linking New York and Philadelphia

Antennas, horns, and waveguides installed on Western Union tower at Neshanic, N. J.

ation of the silver-plated waveguide is 2 db per hundred feet and lengths up to 150 feet are used. This adds up to 6 db of attenuation per relay hop, but the convenience of having the entire equipment on the ground more than compensates for the loss. The lines are pressurized from the equipment racks to the antenna horn to prevent dirt and water from increasing the line attenuation.

Antenna Switching

As indicated on the system schematic map in Fig. 1, the two pairs of antennas for the two circuits at each repeater station are connected to reversing switches. The rotor of each switch has built into it a pair of 90-degree flexible waveguide bends. The four input waveguide couplings are oriented 90 degrees apart. The east and west antenna lines are connected to opposite inputs and the transmitter and receiver lines to the intermediate couplings. A solenoid drive then turns the rotor through a 90-degree arc, reversing the antenna and equipment connections.

Waveguide chokes between the inside of the coupling flanges and the rotor eliminate the necessity for mechanical contact. As a result, the rotor is mounted on ball bearings and turns very freely. A toggle maintains the rotor position under spring tension and a commutator switches the solenoid connections to avoid ambiguity of control and eliminate standby power.

The interior of the barrel is lined with a high-loss dielectric material to provide 50 db of isolation between the transmitter and receiver circuits. This is necessary only to prevent the transmitter from overloading the receiver crystal mixer. The antenna reversing switch is mounted on top of the equipment cabinet but it is part of the antenna line system and hence is pressurized.

A block diagram of the Philco TLR-2 relay equipment is shown in Fig. 3. In basic system philosophy it is very similar to the Philco 1,400-mc television relay[1] which is also in service between New York and Philadelphia. Except in minor details, the equivalent components in the 6,000-mc system are identical and hence they will be described generally only for completeness.

Microwave Head

The r-f head of the 6,000-mc equipment is particularly well adapted for microwave cross-country relaying of wideband intelligence, hence it will be discussed more thoroughly.

This system is basically designed for long-distance service in which a circuit would consist of many repeaters with a terminal equipment on each end. Consequently the basic unit is the repeater, shown by the solid-line blocks in Fig. 3. The terminal equipments are made by adding to the repeater the two video units, shown as dashed-line blocks. A unit which includes all these components can be operated as a repeater or as either a relay receiver or a relay transmitter. Such an equipment in a relay chain can be used to retransmit a received r-f signal, for obtaining a video signal from an r-f signal which is being relayed through the repeater, or for injecting a video signal into the relay circuit.

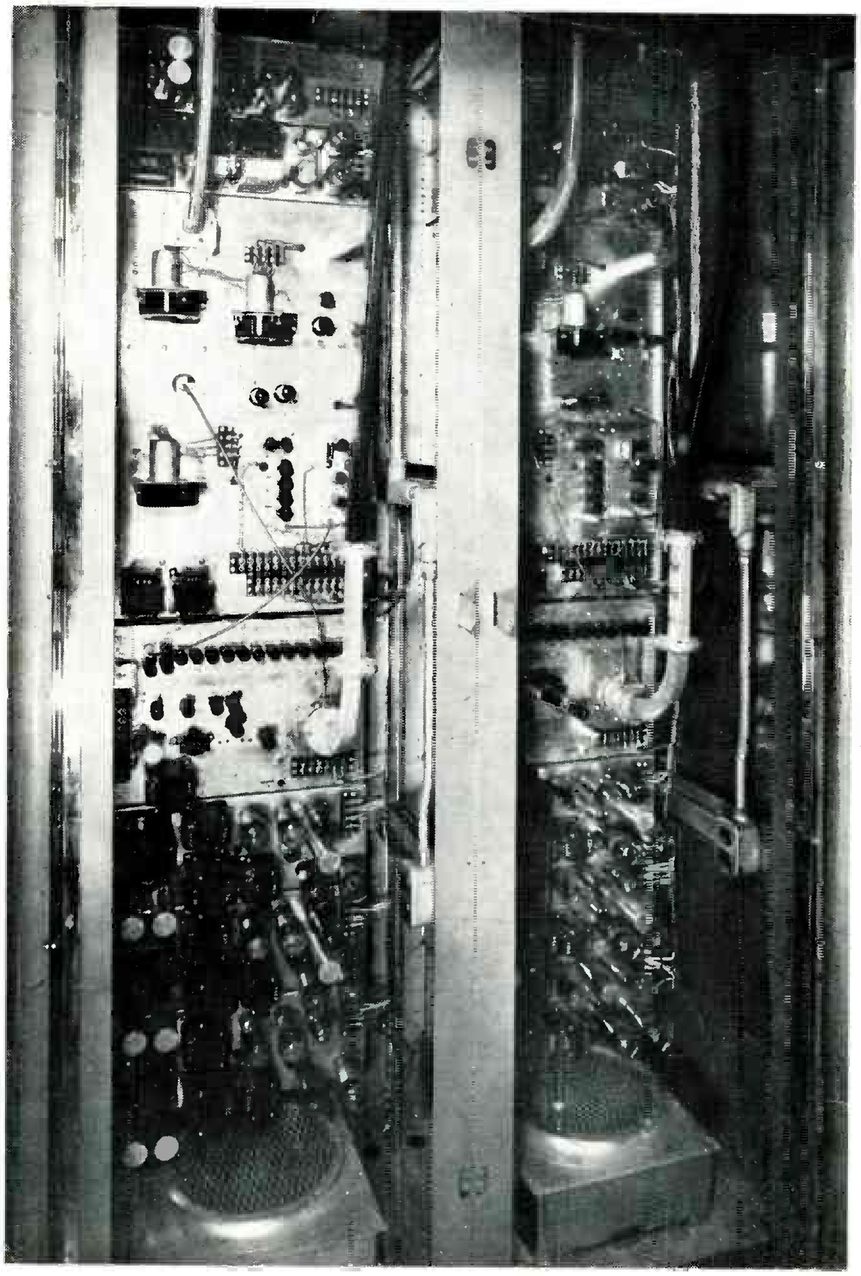
The chassis units are designed for 19-inch relay rack mounting. A pair of repeaters is housed in a double-rack cabinet 48 inches wide, 20 inches deep, and 84 inches high. At the four terminals of the two reversible circuits, as shown in Fig. 1, a relay transmitter and a relay receiver are installed in a similar double cabinet. The transmitter takes the full 77 inches of rack space and the receiver shares a full rack with a video picture monitor. Both the repeater and the relay transmitter require 1,000 watts of single-phase, 115-volt power; the receiver requires 500 watts.

Repeater Circuits

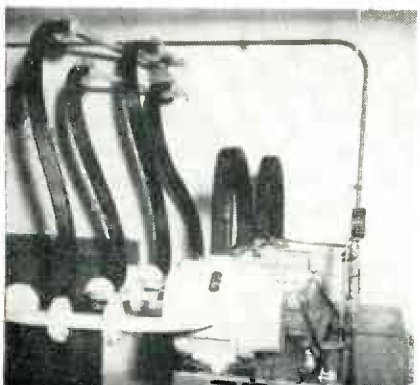
The operation of the repeater is illustrated in the block diagram of Fig. 3. The 3-section waveguide filter is built into the receiver line between the waveguide switch, which is mounted on top of the cabinet, and the receiver crystal mixer. This filter uses inductive post resonators with capacitive tuning screws to provide a 25-mc passband with 20 db of attenuation 30 mc from band center. This selectivity is necessary for a multi-circuit installation in which transmitter and receiver channels are spaced 40 mc apart.

A flexible waveguide section connects the filter output into the shock-mounted receiver chassis. A single-ended mixer, using a 1N23B crystal diode, matches the waveguide line and is excited by the r-f local oscillator mounted on the transmitter chassis. This oscillator has an exceptionally high Q which eliminates the necessity for using a balanced mixer to reduce local oscillator noise.

A single-stage 75-mc preamplifier is mounted on the mixer to improve the noise figure. Output from this preamplifier drives a 90-ohm cable



Rear view of a pair of 6,000-mc repeater racks at Neshanic



Top of cabinet installation at Neshanic, showing complete antenna switch for 6,000-mc television relay system

which is terminated by a constant-impedance network on the 75-mc i-f amplifier strip. The latter has fourteen 6AK5 stages, stagger-tuned to produce a gain of 104 db and a bandwidth of 22 mc. The use of single-tuned stages throughout the preamplifier and the i-f strip makes it necessary to use many stages, but results in simplicity of alignment.

Following the 6AK5's, a 6AG5 as a pentode stage drives a discriminator and an additional 6AK5. Video output from the discriminator at a level of 0.2 to 0.4 volt is amplified by a two-stage video amplifier terminated by a pair of cathode followers. Two video outputs, with individual gain controls, are provided to drive a pair of 75-ohm terminated cables. In the repeater this video output is normally used only for monitoring, but in the relay receiver the cathode followers provide the video output from the relay system. At any point video may be obtained without affecting the signal which is being relayed through the system.

Crystal Control

The 75-mc i-f output is derived from the 6AK5 in parallel with the discriminator. This stage is designed to drive a 50-ohm cable

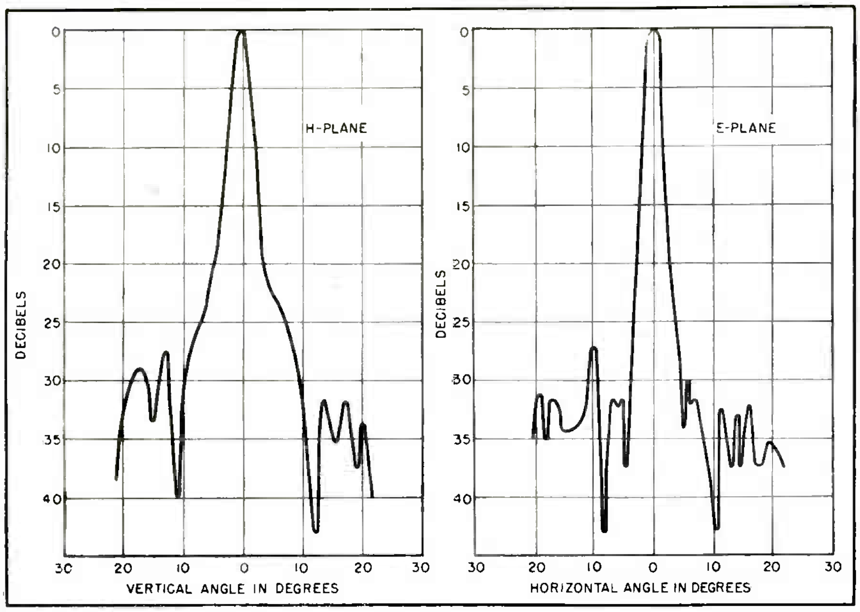


FIG. 2—Vertical and horizontal antenna patterns of 6,000-mc television relay antennas

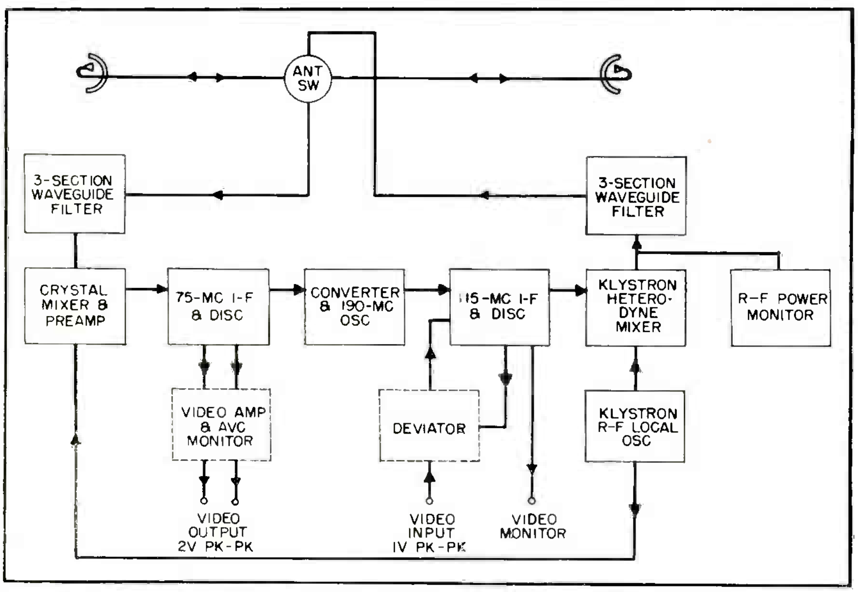


FIG. 3—Block diagram of 6,000-mc television relay repeater

which is terminated on the converter and 190-mc oscillator unit on the transmitter chassis. Constant-impedance networks are used here, as in the receiver section, to terminate the cable and provide voltage step-up to the first grid. Signal from a 15.883-mc crystal oscillator is multiplied up to 190 mc and fed to the 6AK5 converter. The output frequency from the converter is the difference frequency, 115 mc.

The double i-f system simplifies the problem of providing 120 db of stable i-f gain and is a convenient method, in conjunction with a common r-f local oscillator for both transmitter and receiver, of shifting the r-f channel by 40 mc by producing a 40-mc shift in the i-f.

The 75-mv, 115-mc signal is amplified by a seven-stage stagger-tuned amplifier with a 20-mc bandwidth. The first four stages are single-tuned 6AK5's, the fifth stage converts to push-pull 6AK5's, the sixth stage uses a pair of 6AG7's and the last stage is an 829B. The push-pull stages are all double-tuned and are aligned by an i-f sweep generator using grid current as a tuning indication. The push-pull output of the 829B is converted to a single-ended signal by a phase inverter circuit[1], which is connected to the cathode of the klystron heterodyne mixer. The output level is adjustable from 120 to 180 volts peak-to-peak. A monitor discriminator is lightly coupled to the output stage. In addition to providing a video monitor point for the repeater it provides signals for monitoring deviation and for afc of the deviator of a relay transmitter.

The r-f section of the transmitter is designed around a pair of type SAC-19 klystrons which were developed for Philco by the Sperry Corporation. The SAC-19 is a two-cavity klystron with a 400-mc tuning range centered at 6,180 mc. When operated as an r-f amplifier with a beam voltage of 500 volts and a beam current of 100 ma, it delivers 4 watts with an output bandwidth of 25 mc and an overload power gain of 5.

Oscillator

The buncher and catcher cavities are both matched into 1½ by ¾-inch waveguide and equipped with standard plain coupling flanges. As shown in the schematic of Fig. 4, the first tube is operated as a stabilized r-f oscillator and the second as a heterodyne mixer.

The stabilized oscillator is approximately a microwave equivalent of a low-frequency crystal-controlled circuit. An Invar cavity with an unloaded Q of 40,000 is connected in the feedback circuit of a conventional two-cavity klystron oscillator. Half of the output power from the oscillator catcher line is fed back through the feedback cable to the stabilizer.

The stabilizer cavity is matched to the klystron's buncher cavity line, to which it is connected by a 2-inch flexible waveguide section. The loop coupling from the feedback cable is then matched into the cavity when loaded by the buncher. As a result the loaded Q averages about 10,000. Depending upon the effective line length back to the junction between the catcher line and the feedback cable, which is a function of the operating frequency, the loaded Q may be either higher or lower. For all conditions, however, the stabilizer Q is high compared to the Q's of the buncher and catcher cavities which have bandwidths between 18 to 30 mc.

The phase of the r-f feedback,

which is adjusted to optimum by the phaser on the catcher line, is controlled primarily by the tuning of the stabilizer cavity. Phase shifts caused by detuning in other parts of the circuit are compensated for by phase shift in the stabilizer cavity. This requires only a slight shift in operating frequency. The mechanical and thermal stability of the cavity stabilizes the frequency of oscillation in spite of drift in the buncher and catcher cavities and in the beam voltage. The klystron cavities are temperature-compensated by the tuning screws to better than 30 kc per degree C and the beam voltage is electronically regulated so that the combination provides a low-drift oscillator.

This stability is obtained without the use of an auxiliary afc system. It has the further advantages that it eliminates the possibility of out-of-channel signals because the oscillator will only oscillate within 0.5 mc of the resonant frequency of the stabilizer cavity.

As mentioned previously, the high Q of the feedback circuit reduces local oscillator noise and simplifies the receiver mixer. The oscillator is quite independent of load impedance, as would be expected of a high-Q system. This makes it feasible to drive both the receiver mixer and the transmitter heterodyne mixer without buffer amplifiers.

Power output from the stabilized oscillator averages 2 watts. A small fraction of this power is loop-coupled into a 50-ohm cable and fed to the receiver mixer. The major fraction is fed through a variable attenuator into the buncher cavity of the heterodyne mixer. This attenuator has a range of 6 db, which is sufficient to optimize the r-f drive on the heterodyne mixer which requires approximately 0.6 watt for normal operation.

Mixer

The heterodyne mixer is basically a phase-modulated r-f amplifier. It is operated from the same regulated power supply as the oscillator and operates with the cavities grounded and the cathode at −500 volts. As a straight amplifier it would deliver 4 watts of r-f power.

Phase modulation is accomplished by superimposing the 160 volts peak-to-peak frequency-modulated i-f drive on the cathode potential. This modulates the beam velocity at the 115-mc rate. It produces a slight amount of amplitude modulation, but its major effect is to modulate the transit time of the bunches traveling through the drift space between the buncher and catcher grids. This effectively phase-modulates the r-f with the i-f signal.

Normal phase modulation sidebands, spaced from the carrier by integral multiples of the i-f frequency, are produced. These sidebands contain the f-m intelligence of the i-f signal. In repeater operation, the catcher cavity of the mixer klystron is tuned to either the first upper or first lower sideband, that is, the sum or the difference frequency.

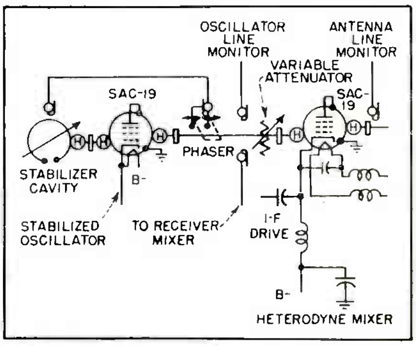


FIG. 4—Schematic of r-f head of Philco 6,000-mc television relay equipment

Mixer Output

The optimum phase modulation for a phase-modulated heterodyne mixer[2] is 1.84 radians. The transit time through the drift space in the SAC-19, when operated with a beam potential of 500 volts, is approximately 4 cycles or 25 radians at 6,200 mc. To produce 1.84 radians of phase modulation requires a ±7-percent modulation of the beam velocity. Since the velocity is proportional to the square root of the beam voltage, this requires ±14-percent modulation of the cathode voltage, which for 500 volts is approximately 140 volts peak-to-peak. This optimum i-f drive is supplied by the 115-mc i-f amplifier.

The efficiency of this phase-modulated klystron mixer, for sideband power output, is one-third the efficiency of the klystron operated as an ordinary amplifier[2]. When phase-modulated with 1.84 radians, one-third of the r-f power appears in each of the two principal sidebands and the remaining one-third is divided between the carrier and the higher order sidebands. The four-watt amplifier delivers over a watt of modulated r-f power.

The carrier and the undesired sidebands are suppressed by the selectivity of the catcher cavity and also by the three-section waveguide filter in the transmitter line. This filter is similar to the filter in the receiver line, has the same 25-mc passband and produces 55 db of attenuation 115 mc from band center. As a result all spurious r-f radiations are at least 70 db below the signal.

The components of the r-f head, insofar as possible, are laboratory or factory prealigned. The transmitter waveguide filter is pretuned and the tuners are soldered in place as in the receiver filter. The stabilizer cavities are basically precision wavemeters and are calibrated as such. They can then be set according to calibration curve for operation on any frequency in the band.

Both oscillator and mixer klystrons are pretuned to the specific channel frequencies. This is done under realistic operating conditions to an accuracy of ±0.5 mc. Considering the bandwidth of the cavities and the stabilizing action of the oscillator feedback circuit, this accuracy is entirely adequate. No further tuning is required in the field.

The only adjustments required when changing tubes are the optimizing of the feedback phase, which is monitored by the detector on the oscillator line, and the optimizing of the r-f drive on the mixer buncher cavity. For this adjustment the variable attenuator is set to produce maximum r-f power output as indicated on the r-f monitor on the antenna line.

The relay receiver utilizes the same components as the repeater receiving section: the waveguide filter, crystal mixer, 75-mc i-f amplifier and video amplifier. In addition a stabilized local oscillator, similar in design to the oscillator in the repeater transmitter section, is necessary.

The combination of the deviator chassis and the transmitter section of the repeater makes a relay transmitter. The input video signal to the deviator is amplified and fed push-pull to the reflectors of a pair of reflex klystrons. These tubes, type 2K28, are tuned to 3,235 and 3,350 mc by external cavities and are loaded resistively to linearize their frequency versus reflector voltage characteristic.

Relay Transmitter

Output from the two klystrons is fed into a crystal mixer in which the plate circuit is tuned to the difference frequency, 115 mc. In normal television operation, the sync tip is anchored by levelers and a sync tip afc circuit to 123 mc. Twelve mc of peak deviation from the sync tip level sets the peak white level at 111 mc and the normal black level at 120 mc.

The monitor discriminator on the 115-mc amplifier has a crossover at 123 mc and a sharp peak at 111 mc. The crossover is used as a reference frequency for afc of the sync pulse, and the 111-mc peak serves as a deviation indicator. While viewing the monitor output on an oscilloscope, the operator can adjust the deviation control until peak whites begin to saturate at the 111-mc peak. The receiver discriminator is linear over the full 20-mc channel so that the saturation shown on the monitor discriminator does not appear in the system video output.

A 15,750-cycle sawtooth generator is built into the deviator unit for checking the system alignment. Since it has the same repetition frequency as the television horizontal sync pulse it actuates the afc circuit and is useful in setting up the afc.

Monitoring

Heterodyne modulation, without demodulation to video and remodulation to i-f or r-f at the repeaters, makes the equipment well adapted for unattended operation. The only operating controls in the entire system are the main power switches and a deviation control on the relay transmitter. Two monitor relays, one on the avc bus in the receiver circuit and a second on the r-f power monitor on the antenna line, are built into the units. Order wire signals, controlled by these relays, can be used to give remote indication of equipment failure. The main power switches can also be controlled remotely by the same order wire.

At the New York terminal of circuit 1 the relay equipment is on the 75th floor of the Chrysler Building and is controlled and monitored from the WCBS-TV control racks on the 74th floor. At the other installations provision has not yet been made for remote control.

Power supplies, video and i-f units are designed on the small chassis or sub-chassis philosophy. These units can be aligned independently and individually replaced rather than repaired in the field.

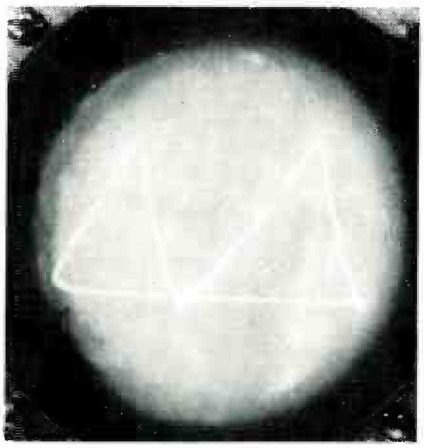


FIG. 5—Sawtooth looped through system

The rms-signal to rms-noise ratio of the three-hop circuit, operating in either direction, is 36 db under normal propagation conditions. It is determined primarily by the received signal strength over the middle hop, between Neshanic and Mt. Laurel. As a result, the signal-to-noise ratio for the system under conditions of tropospheric fading is also determined largely by the space loss over this path.

Transmitter power and receiver avc have been recorded on this link since the circuit was first put into operation. Variations in signal strength of about ±5 db, which are not detrimental to the system performance, occur frequently at night but it is too early to generalize about this particular New York-Philadelphia path. Measurements made by other laboratories[3] indicate that satisfactory and reliable performance on relaying can be expected in this 6,000-mc band.

System Tests

To determine for test purposes the transmission characteristics of the relay circuit, the antenna switches at the New York and Philadelphia terminals of circuit 1 were temporarily replaced by branching filters. Circuit 2 receiver r-f components were installed at New York and circuit 2 transmitter r-f components were installed in the circuit 1 relay transmitter in Philadelphia. By connecting the 75-mc i-f signal from the Philadelphia relay receiver into the converter unit of the relay transmitter, the signal which originated in New York was looped and sent back to New York on circuit 2. New York could have been looped in the same way so that the system could have been broken at any point for sending a signal in one direction and receiving from the opposite direction.

Figure 5 shows a sawtooth signal looped around the system and monitored on an oscilloscope with a 5.5-mc passband. The rms-signal to rms-noise ratio, as estimated from the scope trace, is 33 db. For one-way operation between Philadelphia and New York, the signal-to-noise ratio is 36 db, rms-signal to rms-noise.

Systems tests show that this radio relay circuit performs satisfactorily for the three-hop service. The loop tests show that this particular equipment could probably be extended to a chain of 10 hops. But the principles of its design, heterodyne modulation, a stabilized common r-f oscillator, and stagger-tuned, linear phase characteristic i-f amplifiers, are applicable to relay systems of transcontinental length, development of regional television networks and linking of stations in areas of smaller population with metropolitan telecasters.

References

(1) W. P. Boothroyd, UHF Television Relay, Electronics, 20, March 1947.

(2) W. P. Boothroyd, The Application of Heterodyne Modulation to Wideband Frequency Modulated Television Relays, *AIEE Technical Paper* 47-171, May 1947.

(3) A. L. Durkee, Results of Microwave Propagation Tests on a 40-Mile Overland Path, *Proc. IRE*, 36, p 197, Feb. 1948.

Test equipment, housed in cabinet, could equally well be mounted in rack. Upper lefthand terminals are for connecting oscilloscope; righthand terminals are for input. Three lower controls are, left to right, power switch, attenuator and frequency switch. Upper pair of controls are for bridge resistance, middle one is level control

Distortion and

By ROYDEN R. FREELAND

Chief Engineer
KOCY and KOCY-FM
Oklahoma City, Oklahoma

AUDIO DISTORTION and noise measurements, such as must be made on broadcast stations and should be made on public address and other installations, can be taken with the instrument to be described here. It covers the audio range from a fundamental frequency of 50 cps through harmonics up to 50,000 cps and reads noise levels down to −60 db directly.

The rms distortion is measured by suppressing the fundamental frequency and then measuring the remaining part of the output wave from the equipment under test with a square-law vacuum-tube voltmeter. The rms distortion D_{RMS} of a wave is defined as the effective value of the harmonics divided by the effective value of the fundamental; that is

$$D_{RMS} = (I_2^2 + I_3^2 + I_4^2 + \ldots)^{1/2}/I_1$$

where I_2, I_3, I_4, . . . are the effective values of the distortion harmonics and I_1 is the effective value of the fundamental. On the one hand, distortion measuring instruments based on the suppression of the fundamental are simpler and less expensive than other types. On the other hand, they give only the total rms distortion and are normally convenient only when measuring a few specified fundamental frequencies, such as required by the new FCC rule 3.46(e).

Null T-Bridge Suppresses Fundamentals

The basic suppression circuit of the instrument is a null T-bridge and when balanced it has zero transmission at the balance frequency but very high transmission for harmonics, if the values of the components are properly chosen. With resonant circuits having Q's of three to five, the fundamental can be suppressed while the second harmonic is attenuated less than a decibel. The value of R_S (Fig. 1) must be low if harmonic attenuation is to be kept low.

To obtain balanced conditions of the null bridge, the following equations must be satisfied

$$\omega L_S = 2/\omega C$$
$$R_S = 1/R\,(\omega C)^2$$

For a fixed value of L_S and R_S, R will become larger as C becomes smaller. This will cause R to vary widely when using a single inductance to cover several frequencies. In practice, R may be controlled somewhat by slightly increasing R_S.

The complete circuit for the noise and distortion meter is shown in Fig. 1. The T-bridge uses three inductances for measuring the eight fixed frequencies, which are chosen to conform to FCC regulations. A different amount of capacitance is required in the bridge for each fundamental and is placed in the circuit by the BRIDGE FREQUENCY SWITCH. The resistance R comprises two variable resistances for coarse and fine adjustment. Some frequencies require additional resistance for balance and this is also placed in the circuit by the frequency switch.

All of the bridge elements were obtained from local radio stocks. It was found impractical to calculate the values of the components and then attempt to purchase them. A variety of ready-made inductances could not be found. Most of the inductances available had too high a resistance to produce a usable Q.

For the low frequencies, an ordinary iron core filter choke was tried, but its value changed readily with varying input levels to the bridge. By taking a 15-henry choke and removing the end portion of the core this change in inductance was reduced to a negligible value. The inductance of the modified choke was 4.8 henries.

Values of components for the bridge at the eight frequencies as selected by the bridge frequency switch are tabulated in Fig. 1. Actually the values of the components can be varied widely to suit the parts available as long as the circuit Q is sufficiently high (the second harmonic of any null frequency must be attenuated less than 1 db).

Function and Range of Instrument

The T-bridge is widely used in commercial distortion meters, and is a convenient circuit since one side can be grounded. This allows the bridge to work directly into a vacuum tube as shown.

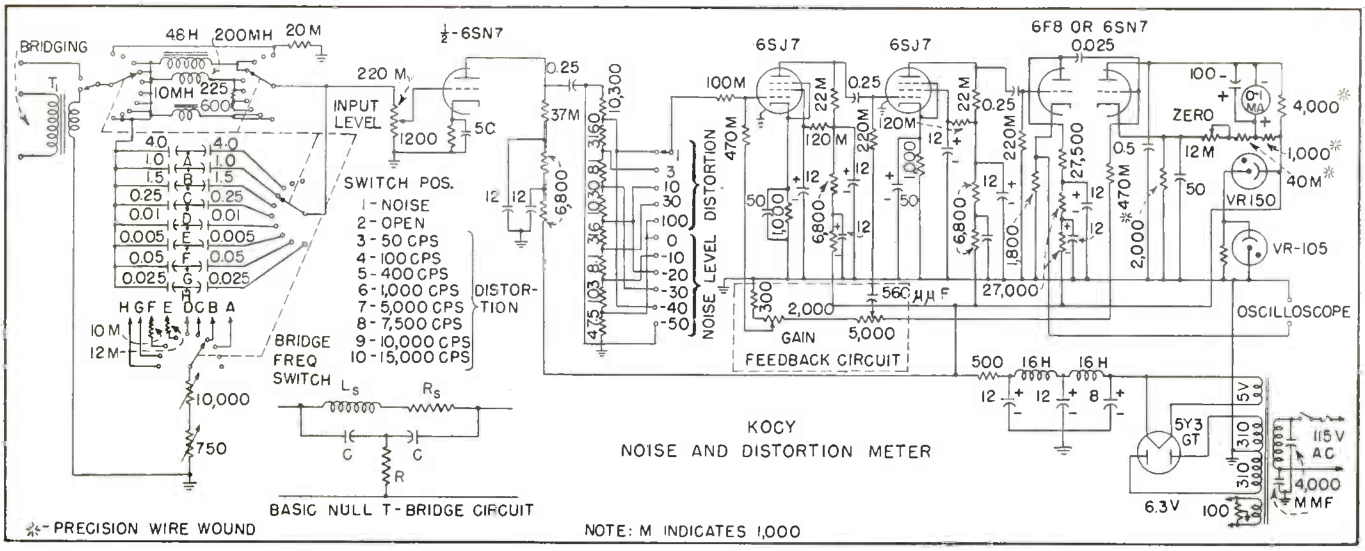


FIG. 1—Complete circuit diagram of noise and distortion checker shows ganged switch for setting rejection frequency of null bridge, distortion and noise level switch and high gain amplifier terminating in detector and meter circuit. The 4.8-henry inductance was made by removing the end portion of the core of a 15-henry choke. Bridge circuit components may be varied to use available parts as long as the Q is kept high enough for less than 1-percent attenuation of any null frequency second harmonic

Noise Meter for Testing Broadcast Equipment

High selectivity possible with standard components in a null T-bridge filter circuit is made use of in a simple, easily built meter for checking noise and distortion of broadcasting and other audio equipment. Suggestions are made for construction and operation

The vtvm portion of the meter uses four voltage amplifiers and a detector-meter stage. A small amount of current, controlled by ZERO ADJUSTMENT, is fed through the meter to buck out the no-signal current of the detector. The FEEDBACK CIRCUIT provides control of the high frequency response as well as the circuit GAIN. The potentiometer following the null bridge controls the INPUT LEVEL to the vtvm and is used for setting the meter reference level. The setting of the step-attenuator, which precedes the first 6SJ7, plus the meter reading gives the total value of distortion or noise. There are six attenuator steps for noise measurements, giving full scale readings of 0, −10, −20, −30, −40, and −50 db. The combination of attenuator setting and meter reading allows noise measurements to below −60 db. Noise measurements to lower values can be made by operating the equipment under test at a level lower than the desired reference level. That is, if the desired measurement is the noise below −60 db, the equipment can be operated, for example, with an output level of −10 db. If the noise were −65 db with a 0 db reference, it would be −55 db with a −10 db reference, which can be read on the instrument.

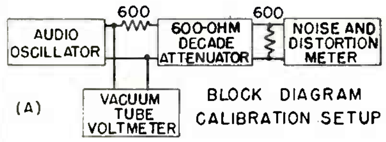
The attenuator has five steps for measuring distortion. These are calibrated for full scale values of 100, 30, 10, 3, and 1 percent. The 100-percent position is that used for calibration.

The accuracy of the instrument depends upon the accuracy of the attenuator resistors and of the meter scale calibration. Close tolerance resistors can be purchased for the attenuator, or, as done in this case, each value can be made up of several ordinary carbon resistors using a resistance bridge to determine the correct value.

Minimizing Hum and Input Loading

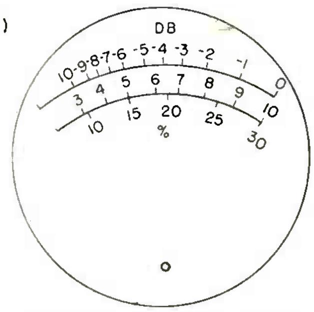
In constructing the noise and distortion meter, precautions were taken to minimize hum pickup by the bridge inductances. The two larger inductances were mounted at slight angles, determined experimentally. No trouble was had with the smallest inductor. High-Q toroidal inductances could be used in such a bridge to minimize hum pickup. However, the small addi-

(A)



BLOCK DIAGRAM CALIBRATION SETUP

(B)

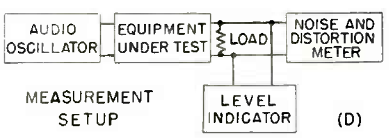


MEASURED RMS OSCILLATOR DISTORTION

(C)

FREQUENCY IN CPS	COMMERCIAL METER	KOCY METER
50	2.8%	2.8%
100	1.8	2.0
400	1.0	1.0
1,000	1.0	1.0
5,000	1.1	1.1
7,500	1.2	1.2
10,000	0.7	0.6
15,000	0.2	0.3

ALL DATA TAKEN FOR 0 DB EQUALS 6 MILLIWATTS IN 600 OHMS



MEASUREMENT SETUP (D)

FIG. 2—(A) When the instrument is calibrated, the meter scale will appear as shown (B). Measurements made with the instrument (C) in a test setup (D) compare favorably with those made with a commercial meter

tional hum reduction did not seem to warrant the expense of these coils over those used.

Any hum picked up in the inductances raises the minimum input levels at which satisfactory measurements can be made. Where it is planned to use such an instrument for high-level audio measurements, levels below 0 db will seldom be encountered. At these high levels the small amount of hum picked up by the inductances causes little trouble. The meter described has a hum level down more than 60 db with gain control in the maximum position. Because the bridge inductances are out of the circuit during noise measurements, their hum pickup has no effect on these measurements. Residual noise in the meter is more than 80 db below 0 dbm signal.

It can be seen that the balance resistance varies widely. For normal audio measurements where balanced circuits are encountered, a bridging type input transformer must be used to prevent loading of the circuit under test. The capacitive impedance of the bridge required that a transformer having a low impedance secondary be used to avoid resonant peaks in the low-frequency characteristics of the circuit. The T-bridge may be connected directly across an unbalanced circuit for measurements. The impedance of the circuit connected to the bridge input has very little effect upon the operation of the bridge circuit. Under these conditions the loading effect of the T-bridge on the circuit being measured is substantially that of the balance resistance. At the extreme low frequencies the impedance looking into the bridge increases and is capacitive. As can be seen from the balance equations, R can be increased by increasing L_s and decreasing C while R_s remains constant. To increase R at the low frequencies presents a problem without specially wound inductances.

Calibration and Performance Testing

To calibrate the scale of the output meter, the instrument was set up as shown in Fig. 2A. It was assumed that the audio oscillator had zero internal impedance. The noise-distortion meter was adjusted for a full-scale meter reading with a 1,000-cps signal. The attenuator box was then adjusted to place 10-db attenuation in the circuit in 1-db steps. After the insertion of each db attenuation the meter scale was carefully marked.

Two scales were calibrated for distortion measurements using the standard vtvm to indicate the correct input voltage ratios. The meter scale is shown in Fig. 2B. One scale for noise measurements is marked from 0 db to −10 db. The two distortion scales are marked between 30 percent and 10 percent, and 10 percent and 3 percent. These two distortion scales serve for reading all five distortion attenuator settings.

The frequency response of the meter for each position of the bridge switch was plotted to determine the harmonic frequencies contained in each measurement. The overall response is shown in Fig. 3A. This response curve shows that the meter exceeds the specifications set forth by the FCC.

Response curves for the eight nulls are shown in Fig. 3B. Note that the second harmonic of any null frequency is attenuated less than 1 db.

A direct comparison of the operation of the meter with a commercial instrument was made by making distortion measurements on an inexpensive audio oscillator with both meters under the same conditions (Fig. 2C).

Distortion Measurements

The meter described is used in measurements similar to other noise and distortion meters. An audio oscillator of low harmonic output is connected to the equipment under test as shown in Fig. 2D. The output of the equipment is terminated in its correct load impedance and the bridging input of the meter is connected across this load. The bridge switch of the meter is set to the desired frequency and the equipment is adjusted for the desired operating level. The meter level is then adjusted for full scale reading with the attenuator in either the calibrate or 0-db position.

FOR DISTORTION MEASUREMENTS the oscillator frequency is then varied for null reading of the meter. The null is obtained by simultaneously adjusting the oscillator frequency and the bridge resistance. After the bridge has been adjusted for null on the lowest attenuator setting possible, the calibration level is rechecked before taking the reading. For distortion measurements, it is necessary to set the oscillator frequency to at least twice the null frequency when adjusting the calibrate level. If the oscillator or equipment level varies greatly over this range, an external meter must be connected at the input point to insure the input level to the meter is the same for

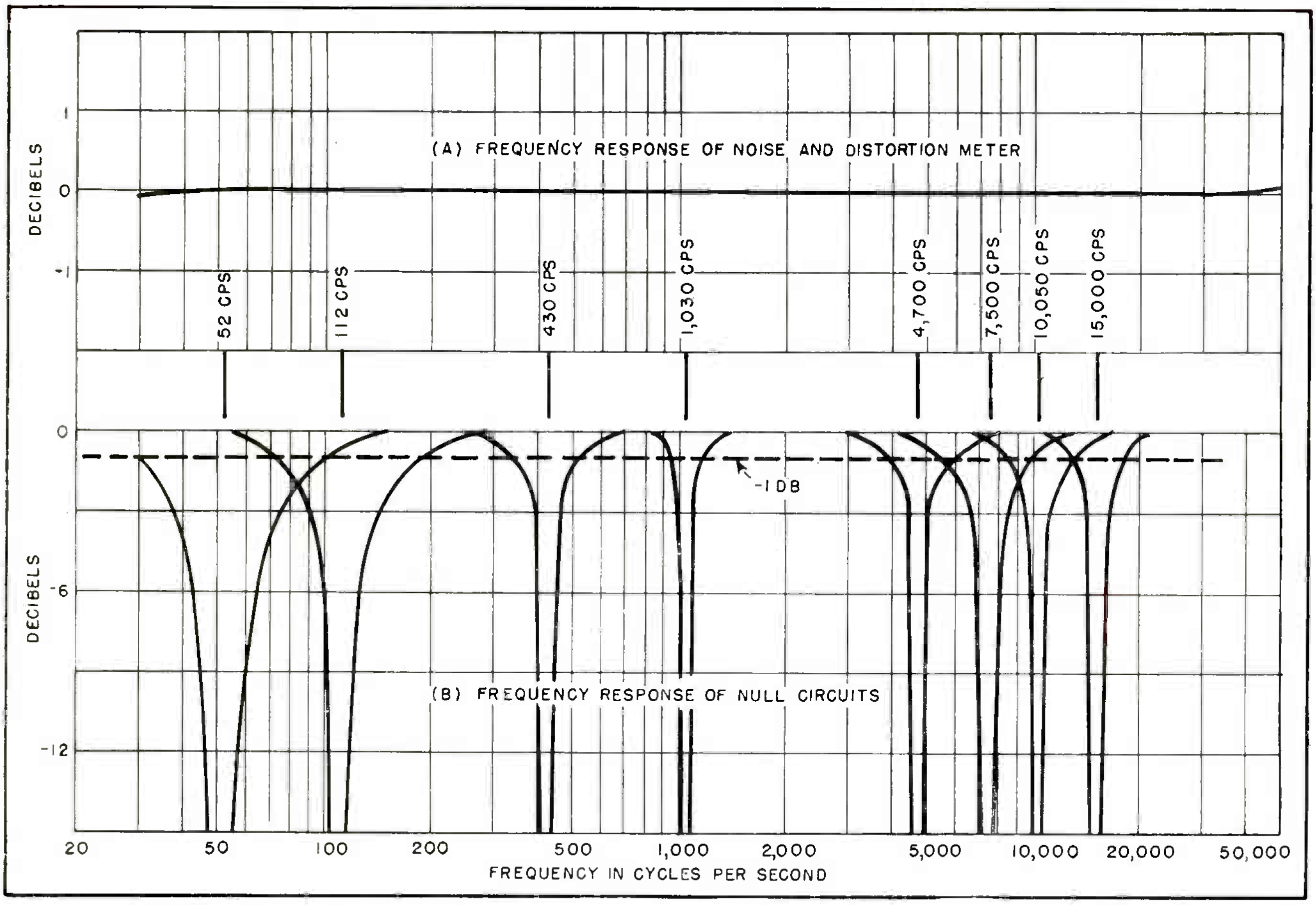


Fig. 3—(A) Frequency response of the meter, with the null bridge bypassed, is flat over the full audio spectrum. (B) The rejection of the null bridge is sufficiently sharp so that second harmonics are attenuated less than a decibel. Problem is to find large inductance with low loss for use at low frequencies

calibration and for the null frequency. After the level is correctly set, the oscillator frequency is reset to the null point and the attenuator adjusted until a reading can be obtained on the meter scale. The combination of the attenuator setting and meter reading indicates the total distortion.

Although the lowest calibrated reading for distortion is 0.3 percent on the 1-percent scale, a lower value can be read by setting the attenuator to the −50 db position. Full scale reading in the position corresponds to 0.316 percent which can be easily read on the 3-percent scale.

NOISE MEASUREMENTS are made by setting the frequency switch of the meter in the noise position and adjusting the meter for full scale reading. The signal is then removed from the equipment under test and the input properly terminated. The noise level present may then be read by decreasing the attenuator setting until an indication is obtained on the meter. Again, the combination of the meter reading and the attenuator setting gives the final result.

Distortion measurements taken with the meter indicate the rms total of all components of the input signal which fall within the limits of the frequency range, except the fundamental frequency component, which is rejected by the bridge. The reading of the meter will therefore include the following components: (1) harmonics, (2) modulation cross products between hum and fundamental, (3) modulation cross products between hum and harmonics, (4) hum components and (5) noise components. The noise and distortion meter sums all these quantities and indicates the ratio of the sum of all undesired components to the fundamental frequency component. If it is desired to determine the distortion due to the harmonic and cross product components alone, either of two methods may be used.

One method is to operate the equipment under test at a high output level. This results in making the hum and noise components small compared to the other components. The second method is to measure the distortion in the normal manner at the desired output level, then to measure the noise level in db, using the same output level as reference. The db noise level is then converted to percent and the values substituted in the equation

$$H = (D^2 - N^2)^{1/2}$$

where H is total harmonic and cross section distortion in percent, D is distortion in percent and N is noise in percent.

The noise and distortion meter described can be constructed for less than \$100.00. This is considerably less than the price of a similar instrument on the commercial market. The meter is capable of reading distortion as low as 0.1 percent and noise to below −60 db within the frequency range 30 to 50,000 cps.

RADIOISOTOPES for Industry

Examples of successful tagged-atom applications and suggestions for adapting the techniques to other measuring, controlling and tracing applications. Each new use means a new market for the required electronic radiation-detecting equipment

By A. P. SCHREIBER

Tracerlab, Inc.
Boston, Mass.

THE RECENT availability of radioisotopes has required an adjustment in the way of thinking of scientists and engineers. Many do not have a concept of the potentialities of radioactivity in industry, while others must overcome inertia to change on the part of industrial management before concrete work can be started in the direction of utilizing this new tool.

Some manufacturers are reluctant to pursue research on potential industrial applications because of the A.E.C. requirement that results of such work be freely available to others. The questions arising from potential health hazards both to plant workers and to the consumer are further deterrents to activity in the industrial field. There is also the ever-present threat of nuisance suits instigated by consumers against manufacturers who permit products to leave their plants containing small amounts of residual radioactivity. Even minute amounts of radioactivity in consumer products may, for a time, cause the manufacturer considerable embarrassment due to lack of understanding on the part of the consumer and to inadequate precedent in court rulings on damage suits involving low concentrations of radioactivity.

Lack of qualified personnel has been another serious deterrent to early development of industrial use of radioisotopes. This bottleneck to progress is slowly being alleviated by a few educational institutions. Notable among these is the Oak Ridge Institute of Nuclear Studies, which offers a four-week course to train research personnel in the use of radioisotopes. After participating in this course, technically qualified people have sufficient knowledge of radioactivity techniques to carry out original work involving radioactive tracers.

Literally tens of thousands of potential industrial uses of radioisotopes exist, since virtually every industry can profitably utilize the properties of one or more of the hundred odd radioisotopes whose half-lives and availability permit their consideration. To give some indication of the usefulness of radioisotopes, a number of problems will be outlined which might be solved with radioactivity and tracer techniques. In some of these problems radioactivity has already been used to give a practical solution. In some instances, radioisotopes are under serious consideration, while some examples of potential uses are merely speculative to illustrate what might be done.

BUGABOOS

Despite widespread speculation on possible industrial uses for radioisotopes, only 90 of the approximately 3,100 shipments from Oak Ridge to date were for industrial research and only 20 for metallurgical research.

This apparent disinterest on the part of industry arises from six major factors: (1) Unfamiliarity of scientists and engineers with potentialities; (2) inertia of industrial management; (3) opposition to A.E.C. requirement that research results be freely available to others; (4) potential health hazards; (5) threat of nuisance suits; (6) lack of qualified personnel for research

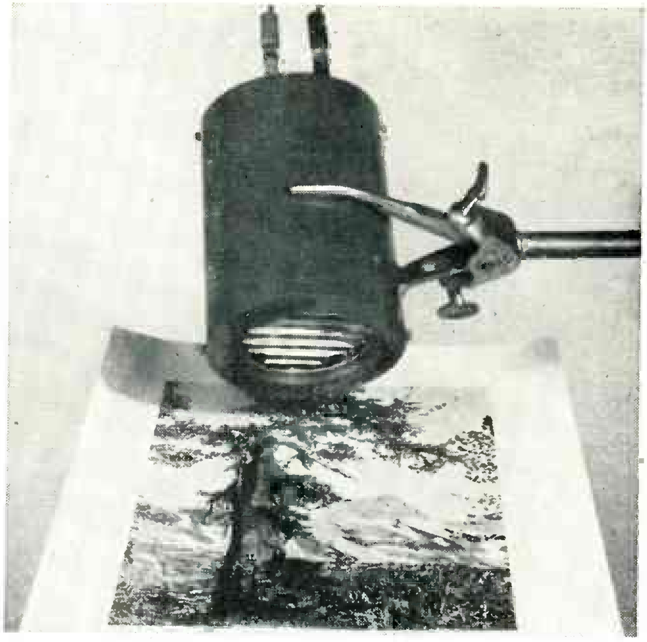
Rare Gas Separation

Let us first consider a company which is in the business of liquefying air and separating its components. In addition to recovering nitrogen and oxygen this company is interested in recovering the rare noble gases such as krypton and xenon since demand has recently outstripped the available supply. There is only one-tenth of a part per million of krypton and a hundredth of a part per million of xenon in air.

This particular manufacturer found that he was recovering only a small proportion of the total available krypton and xenon. He wanted to find out where these materials were concentrating in his process and how to make changes so that he could get better recovery.

Tracer techniques are admirably suited to the problem of tracing an infinitesimally small amount of an element dispersed in an enormous volume of a diluent such as air. Radioactive krypton and xenon, if

Heavy-industry installation made by Engineering Laboratories, Inc., Tulsa, Okla. for measuring, recording and controlling liquid level in oil-processing tank. Geiger counter in Gagetron unit outside tank receives weaker signal when oil rises over radioactive material inside because oil absorbs more radiation than air



Printing industry setup for measuring amount of ink on a sheet of paper. As developed by Sun Chemical Corp., New York City, this technique involves adsorbing a small amount of a radioisotope on the ink pigment and using a Geiger counter to measure amount of activity that is present

introduced in a fixed proportion with the incoming air prior to liquefaction, will permit analysis at any point in the process even down to a few parts per billion.

A Geiger counter for measuring the radioactivity content of the gas at various points in the process will indicate the amount of krypton or xenon present with an accuracy as good as one percent. This is made possible by the fact that the radioactive krypton or xenon introduced with the incoming air remains in a fixed proportion to the nonradioactive krypton or xenon which is naturally present in air. In other words, a radioactive isotope behaves chemically and physically exactly as a stable isotope of the element in question.

Physical Measurements

A paper mill has many technical problems in which radioactivity techniques might be used. For example, a mill manufacturing a laminated cardboard consisting of multiple layers of different kinds of pulp wants to improve its process control. The pulp comprising the outer layer is worth $200 per ton while that inside is worth only $15 a ton.

Using conventional methods, the thickness of the expensive pulp layer would vary as much as 20 percent. To achieve much closer process control with an attendant saving in pulp and increased uniformity of product, a radioisotope is used to tag the expensive pulp by adsorption on the pulp fibers. A Geiger counter is then placed in close proximity to the board just after it is formed. The amount of radioactivity detected will then be a quantitative indication of the thickness of the expensive pulp layer.

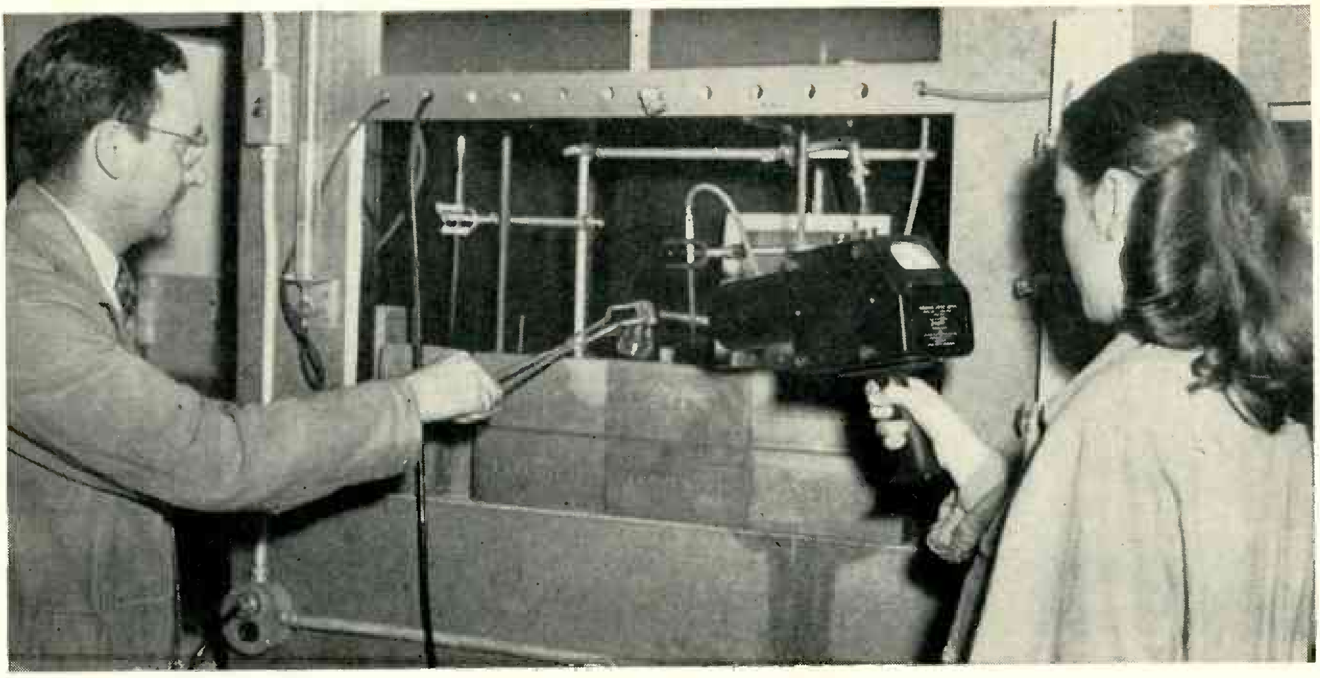
The output of the Geiger counter can be used to drive a pen recorder that continuously shows the thickness of this layer. Machine operators then know immediately the extent of thickness variations, and can make adjustments to keep the coating within predetermined limits. If desired, the Geiger counter output can be coupled to a servomechanism for automatically making machine adjustments.

A similar technique has been used by a printing-ink manufacturer to measure the amount of ink used on a page of printed matter and to determine the minimum amount of ink which will produce satisfactory results. This was done by adsorbing a small amount of a radioisotope on the ink pigment and measuring with a Geiger counter the amount of activity which was present on the printed page.

An analogous method has been proposed to measure thickness of metallic film deposited by an electroplating process where irregularly shaped objects are plated.

Another thickness measuring problem which is common to almost all plants manufacturing a continuous sheet of material such as paper, cellophane, steel sheet, rubber, or plastic is the continuous measurement of weight per unit area of the sheet just after it is formed. This measurement can easily and accurately be made by placing a source of radioactivity above the traveling sheet and a Geiger counter or ionization chamber radiation detector below it. A part of the radiation is absorbed by the sheet, in proportion to its weight per unit area. The detection instrument is calibrated to read directly in pounds per square foot or in other similar units.

Where thin, light sheets such as paper or cellophane are to be measured, a beta emitter such as strontium-90 and an ionization-chamber radiation detector can be used. This combination possesses several advantages over a gamma emitter and a Geiger-tube detector which may be required for thicker, denser ma-



Use of radiation survey meter for monitoring hot samples during preparation of radioisotopes for industrial uses. This provides a continuous check of the efficiency of techniques and materials used to protect personnel against excessive radiation exposure

terials such as sheet iron or steel.

A relatively strong source of beta activity can be used without danger of exposing operating personnel to excessive radiation dosage. Beta emitters are easily shielded by thin metal, glass or plastic, while a gamma source of reasonable strength requires heavy shielding of lead or other dense materials. An ionization chamber requires a stronger radiation flux than does a Geiger tube but it will not wear out, while the commonly used self-quenching Geiger tube has a finite life based on the amount of radiation it detects.

Another problem which is common to most plants having large motors and heavy equipment is concerned with lubrication. Frequently the bearings on a particular piece of equipment do not receive an adequate supply of oil due to a clogged oil line. Under ordinary operating procedures this will not be noticed until the bearing burns out. If a small amount of a gamma-emitting radioisotope were mixed with the oil it would be easy to make periodic checks of each bearing with a Geiger counter to find out whether it is receiving the proper amount of lubrication.

Textile Dyeing Control

It is generally conceded by those in the textile industry that dyeing process control is for the most part an art rather than a science because so many independent variables are present. Radioactivity can be of considerable assistance in controlling at least two of these variables, namely the concentration of the dye bath and the amount absorbed by the fabric.

The process in which fabric is passed through a dye vat in a continuous length is particularly adaptable to this type of control. If one or more radioactive atoms were incorporated into the dye molecule and tracer quantities of it were mixed with the normal dye, the concentration in either the cloth or the vat could be continuously and automatically determined by Geiger counters.

Electronically actuated controls can regulate the concentration in such a way that the weight of dye per unit area of cloth emerging from the dye bath will be a predetermined constant. Process controls such as these will eliminate substantial variations in shade between the beginning and the end of a dyeing run such as sometimes occurs with presently used methods of control.

For industrial research on dyes, radioactivity has many uses. Little is known of the reaction mechanism taking place in dyeing processes. It is sometimes difficult to determine just where the dye is absorbed and how much is absorbed. Chemical reactions in dyeing processes are not well understood. Much remains to be learned about the effect of washing upon dyes, soap retention of various types of fibers, and the mechanisms of fading. The answers to these and other questions confronting the textile chemist may be found through skillful application of radioisotope techniques.

Rayon Manufacturing

In the viscose process for making rayon, carbon disulfide is reacted with cellulose pulp and the resulting solution passed through tiny holes to form a continuous yarn filament. Sulfur is precipitated out on the fibers in the spinning process and is subsequently removed in a desulfurizing bath. It is quite important that complete removal of sulfur be attained since it affects both color and physical strength of the finished yarn. A simple means for controlling sulfur removal can be effected by tagging the source of the sulfur, namely the carbon disulfide, with sulfur-35.

Continuous routine check of sulfur removal can be made by placing a Geiger counter in close proximity to the rayon filament or the solutions through which it passes. Since the radioactive sulfur is a fixed proportion of total sulfur present, the total amount of sulfur removed in the coagulating bath can be quickly determined. Also, a check is easily made after the desulfurizing bath to determine whether complete removal of sulfur has resulted.

It is quite possible that automatic electronic controls could be devised to keep the desulfurizing bath within a predetermined concentration range by coupling the output of the Geiger tubes through a suitable servomechanism to valves on chemical solution tanks.

There are a number of processes in rayon manufacture in which the rayon is coated, such as the lubricant coating process which may utilize sodium oleate, polyvinyl alcohols, petroleum base oils or other lubricating compounds to facilitate winding and twisting operations. A uniform coating is required, otherwise inferior yarn may result. Radioactivity incorporated into the lubricant will permit precise measurement of the amount deposited on the filament. Recently considerable interest has been expressed in this method for research work on optimum coating thickness. Little is known regarding the amount of lubricant which should be deposited for best operation.

A further use of this technique is automatic regulation of lubricant-coating thickness in the industrial process. A Geiger counter in close proximity to the filament just after it has been coated with the radioactive lubricant will continuously indicate the film thickness. If the output of the Geiger counter were electronically coupled to the lubricant control valves by a suitable servomechanism, the amount of lubricant coated on the filament could be continuously and automatically controlled. Too little activity on the filament would open the valve, whereas too much would close it.

Later in the process, the lubricant is removed and replaced by various sizing compounds. These sizing compounds are frequently removed at a later point in the process. Radioactivity can be utilized for controlling the amount of sizing put on the fibers by methods similar to that described for the lubricant coating. Also it can control the removal process. As the fabric or filament passes through a washing bath it can be monitored by a Geiger counter to check for complete removal of coating compounds containing radioactive tracers.

In all of these industrial uses in which activity is introduced directly into the product, it is important that either the activity be removed before the finish of the processing operation or that only small amounts of radioisotopes be used which have sufficiently short half lives to insure that substantially no activity is present by the time the goods reach the consumer. In instances in which neither of these requirements can be fulfilled, tracer techniques can still prove of considerable value in obtaining information in pilot plant processes. Here it is possible to dispose of the contaminated product or hold it long enough to permit residual activity to decay.

Liquid Level Gage

A gage utilizing radioactivity to indicate liquid level in tanks has recently been developed. This gage is particularly useful where highly corrosive liquids are to be measured or where it is desired that the tank have no openings through which gas or vapor can leak. A float containing a long half-life gamma emitter and restrained to vertical movement is placed inside the tank. A Geiger counter, coupled to a counting-rate meter calibrated in liquid depth, is mounted directly above the float and outside of the tank.

As the distance between the radioactive float and the Geiger counter changes, there is a corresponding change in the detected counting rate and this is indicated on the calibrated meter. The output of the Geiger counter can be used to open a filling valve when the liquid falls below a predetermined level.

It is frequently helpful to know when the liquid level in a tank falls below a predetermined level. Two examples of instances where such measurements cannot be made by conventional means are in rubber latex tanks where high viscosity makes measuring difficult or in cupolas where molten steel is held prior to pouring into molds. A very simple indicating gage can be made by mounting a source of gamma radiation such as cobalt-60 outside the tank at the point where low level control is desired. Opposite the source of radiation, at the same level, a Geiger tube and amplifier circuit coupled to an alarm system are mounted on the outside of the tank. As long as the liquid level is above this point, only a small amount of radiation flux reaches the detector. When the level falls below that point, there is a substantial decrease in the radiation flux received by the detector. When this occurs, the output of the amplifier is used to actuate a relay coupled to an alarm light or bell.

Solving a Pollution Problem

Air and stream pollution from industrial wastes is an ever-present headache of the chemical industry. Again radioactivity can be of assistance. Let us consider a specific case. A chemical manufacturer was dumping large quantities of industrial waste into a river emptying into the ocean. Nearby was a bed of oysters, the quality of which had deteriorated during the past several years. The fishermen who owned these oyster beds believed that the chemical plant was at fault and filed a suit for damages. The management of the chemical plant was convinced that the wastes which they put into the river were not polluting the oyster beds.

Radioactivity can conclusively prove whether there is any basis to the fishermen's claims. All that is necessary is to mix a few millicuries of a radioisotope with the chemical waste, take samples of water in the oyster beds and make an assay of their radioactivity content. In that way it is possible to detect even a few parts per billion of the chemical waste water.

Petroleum Refining

In both plant and research problems of petroleum refining, a broad field exists for radioactivity techniques. In distillation processes it is possible to determine separation efficiency of a column by tagging one of the components of the mixture and analyzing the various frac-tions with a Geiger counter.

In catalyst studies, tagged chemicals may shed light on the mechanism of catalytic action in studies of catalyst promoters and poisons or in determining what happens to catalysts which are carried away with the reaction products, particularly when the catalyst is extremely valuable.

Relatively little is known about reaction mechanisms of hydrocarbons and other petroleum products. Tagged compounds will permit obtaining a great deal of information as to how polymerization and cracking take place.

In the field of lubrication the effect of additives on properties of oil can be studied with tracer techniques and the means by which the additives give various characteristics can be found. For example, several years ago an additive containing sulfur in a lubricant was tagged with radioactive sulfur-35 in an attempt to evaluate its effect upon different bearing alloys. It was then possible to evaluate quantitatively the amount of protective film which the sulfur formed on each of the various bearings.

By making bearing material radioactive, measurement of the rate of wear is easily determined and is detectable at a much earlier stage in a test run than by conventional methods.

Pipes carrying certain petroleum products become coated with sludge and paraffin, and it is necessary to clean them fairly frequently with a scraper which is pushed through the pipe by oil pressure. Occasionally one of these scrapers becomes stuck in the pipe and it is quite difficult to locate it. A small amount of a gamma-emitting radioisotope would permit detecting its location by a portable battery-operated Geiger counter carried near the pipe.

Sometimes different lots of oil with similar chemical and physical specifications are pumped through a pipeline and there is no simple means of detecting where one lot ends and the next one begins. If a slug of oil tagged with radioactivity were used to separate the two lots of oil, a Geiger counter could easily differentiate between them.

The field of radiation chemistry has vast potentialities. It is known that ionizing radiation such as is found in a pile or from radioactive isotopes will cause chemical changes. For instance, it is possible to polymerize certain compounds by subjecting them to a strong source of radiation. It is quite likely that new chemical reactions can be made to occur under the influence of radiation. It may be that cracking of petroleum products can be promoted by this means. Reactions induced in natural gas by intense radiation may produce many petroleum chemicals and plastics.

There has probably been more activity in applying radioactivity techniques to oil well problems than in any other industrial field. Oil-well radioactivity logging techniques are well known but there are many other potential uses which have evoked the interest of oil producers.

For example, with the prospects of eventual depletion of our oil reserves a great deal of consideration has been given to more efficient means of getting oil out of the ground. With conventional pumping techniques it is often not possible to recover more than fifty per cent of the oil in a field.

Improving Oil Well Recovery

Water flooding has been used to improve recovery. Large quantities of water are forced into one well in a particular field and in so doing the oil is displaced from the porous strata. Oil can then be pumped from the surrounding wells in a field which otherwise would be considered depleted. It is often possible to continue flooding a field for a number of years.

Sometimes the water pumped into the substrata breaks through into an operating well and is pumped to the surface with the oil. This is undesirable since the efficiency of the operation is greatly impeded. When a breakthrough such as this does occur, it is advisable to cement off that part of the well into which the water is being pumped.

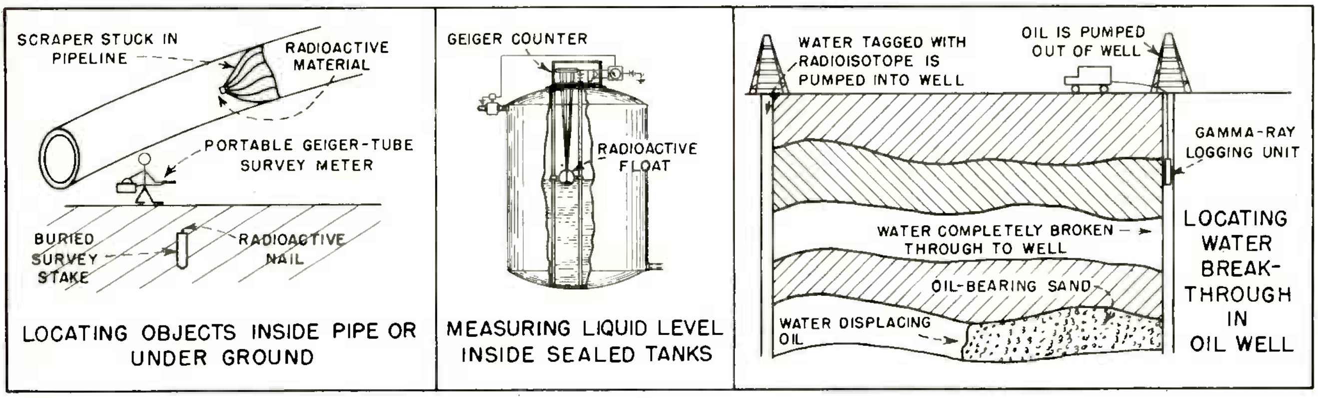
With conventional techniques it is extremely difficult to localize the area of breakthrough. The use of a tracer technique will greatly simplify this problem. Small amounts of a gamma-emitting radioisotope with a relatively long half-life, as for example cobalt-60, are continuously introduced into the oil field along with the flooding water. When a breakthrough is suspected the effluent of a well pumping oil is checked with a Geiger counter. More than a normal amount of activity indicates a water break-through. To locate its position, a gamma-ray log is made of the well by passing a Geiger tube throughout the length of the well and plotting variations of radioactivity as its location changes. The area of highest activity will mark the location of the breakthrough, which is then cemented off to permit continued efficient oil recovery.

Locating Survey Stakes

A simple and practical use for radioactivity has recently been considered by Government survey groups. It is frequently necessary to run surveys over large areas, often over land which is being farmed. Survey stakes are put into the ground at intervals of a few hundred feet. It is often necessary to bury these reference stakes approximately a foot underground to prevent interference with plowing and farming. Later, when it is desired to locate the stakes a new survey is necessary to locate the approximate spots where the stakes were placed and an area several feet in diameter must be dug to find them.

Serious consideration has been given to the use of a radioisotope to tag these stakes so that their location can be more easily determined. Several experiments carried out with tagged stakes indicate that a stake containing only ten microcuries of cobalt-60 can be detected with a portable Geiger tube survey instrument through a foot of earth. The cost of the radioactive material is only a few cents per stake and the necessary radioactivity survey instrument can be purchased with the labor savings of only a few days.

In the metals industries tracer techniques will perform jobs and yield data heretofore impossible to obtain with conventional techniques. For example, by the addi-



Representative examples of industrial radioisotope applications that can readily be adapted to a host of other uses for which existing methods are cumbersome, costly or unsuccessful

tion of tracer quantities of a radioisotope it is possible to determine the relative volatility of various components of alloys and to measure their rates of volatilization. This technique is particularly useful when small quantities of a relatively volatile constituent are present in an alloy. It also might be used for measuring the rate of volatilization of zinc in the metallurgy process for making brass.

Metallurgists are extremely interested in knowing more about how surface coatings on metals diffuse into the inner layers of a metallic mass as a result of heat treatment. A better understanding of this diffusion phenomenon will ultimately result in better heat-treating techniques.

Tracers in Metallurgy

A reasonable amount of work on this problem has been carried out by the use of tracer techniques. For example, self-diffusion can be easily studied by using the following technique. A thin layer of radioactive metal such as iron-59, copper-64, or cobalt-60 is deposited upon the solvent metal by a rolling or plating process. After heating the metal block in an annealing furnace, successive layers of the surface metal are removed with a milling machine and each layer is radioassayed with a Geiger counter. A plot of radioactivity concentration versus distance from the surface of the original sample will give a quantitative indication of the extent of diffusion of the metal coating.

It is frequently desired to know just how certain constituents of an alloy are dispersed. For example, a metallurgist may wish to know how a particular minor constituent of a welding rod alloy is dispersed within the metal after a weld is made. This is easily determined by the radioautograph technique, which consists of the following steps. A small amount of a radioactive isotope of the element it is desired to trace is introduced into the welding rod alloy while it is in a molten state prior to forming into rods. For example, it may be desired to trace titanium and in that case titanium-51, which emits 0.36 mev beta and 1.0 mev gamma radiations with a half-life of 72 rays, would be introduced into the melt.

The weld is made with the tagged welding rod in the conventional manner and a polished section of the weld is prepared and placed on a piece of photographic film. Those parts of the weld in which the titanium has segregated will darken the film due to radiation emitted from the radioisotope titanium-51. This selectively darkened film is superimposed over the polished weld section and both are examined under the microscope. This microscopic examination will locate the areas in which the titanium concentrated. It is possible to determine whether it concentrates within the crystalline structure of the metal or whether it remains outside the crystal boundary.

This technique has also been extensively used in biological and medical studies, as for example to determine just where iodine concentrates within the thyroid gland.

In all industrial applications of radioactivity, considerable care must be exercised in choosing the proper level of radioactivity concentration and the proper radioisotopes to use for eliminating the health hazards of excessive radiation exposure of plant personnel. Every effort should be made to use isotopes of fairly short half-lives and with as low an energy level as is consistent with desired sensitivity of the process-control instrumentation. In locations where radiation is unshielded from plant personnel it is quite important that only alpha or beta emitters be used, unless gamma emitters in low concentration can be satisfactorily utilized.

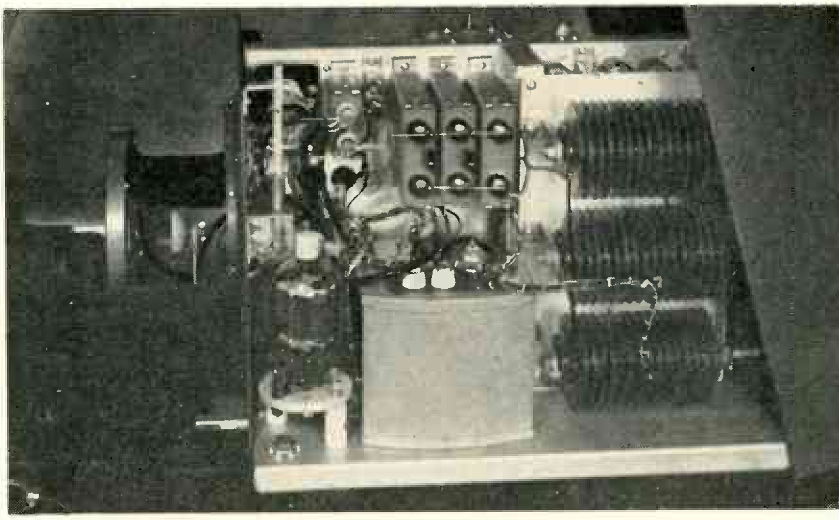
Residual Radioactivity

A further point of importance is the amount of activity remaining in the finished product. Wherever possible it is advisable to provide for removal of the radioactive material during the process. In instances where that is not possible, radioisotopes of short half-life should be used in sufficiently low concentrations as to constitute no health hazard to the ultimate user. The extent to which radioactivity can be used in processes where it is not removed from the finished product is limited by the number of radioisotopes which have both the requisite chemical properties and a short half-life.

At least 88 elements have one or more radioisotopes available from natural sources, pile irradiation or cyclotron bombardment, with half-lives sufficiently long to be considered for use in industrial processes. Consequently, there is little cause for concern over a lack of diversity of radio-elements.

Shutterless Television

Motion pictures on 16-mm film are converted from 24 to 30 frames per second. Electron tubes control speed and phase of projector driving motor, pulse and synchronize the light sources and provide the accompanying sound

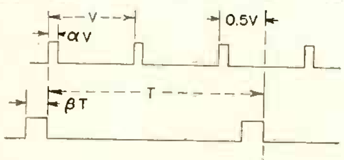


Internal view of Synchro-Lite chassis showing the high-voltage pulser and the selenium rectifiers

CONSIDERABLE work has recently been done toward improving 16-mm sound-motion-picture film and the associated projection equipment. Such film would provide economical television program material.

In most theater motion-picture projectors, the light source is a constant source (arc or incandescent lamp) and the film is illuminated intermittently by means of a mechanical shutter. For the projector selected this occurs 72 times per second. The film is transported past the aperture by an intermittent movement at the rate of 24 picture frames per second, resulting in each picture frame being illuminated three times. Assuming a 50-percent illumination time, and not allowing any time for phasing adjustments, the maximum allowable film pull-down time is 1/6 of 1/24 second or approximately 0.007 second.

In the television film cycle it is desirable to project 60 picture fields per second since the existing standards in this country require that the scanning of the target area in the television camera tube occur at this rate, interlaced to give 30 picture frames per second. This requires that the projector have a short film pull-down time if the



V = 1/60 second (vertical blanking interval)
αV = vertical blanking pulse width
= $0.05\,V$ to $0.08\,V$
T = 1/24 second = $2.5\,V$ (film frame interval)
βT = pull-down time (must be equal to or less than one-half V minus the vertical blanking pulse width)
$\beta T = 0.5\,V - \alpha V$
For α = 0.08 (maximum vertical blanking pulse width ratio)
βT = 0.007 second

FIG. 1—Film pull-down and vertical blanking periods

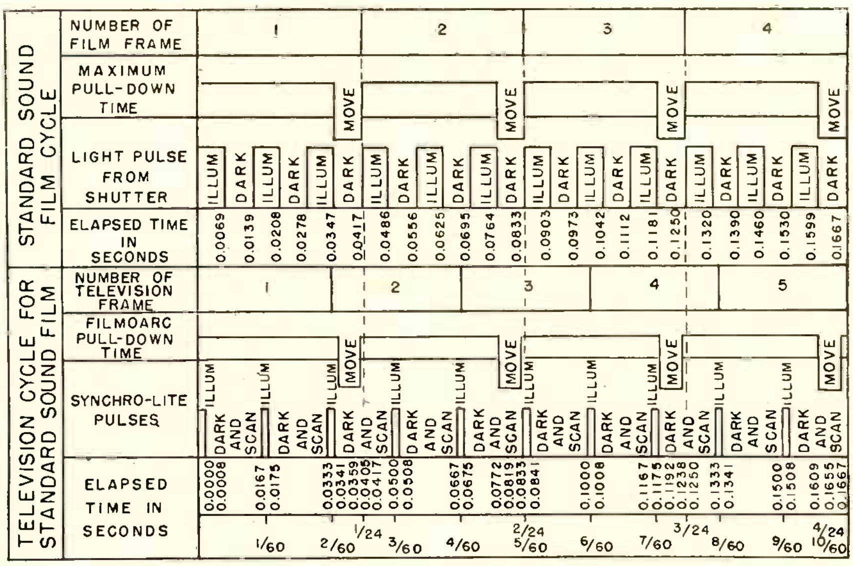


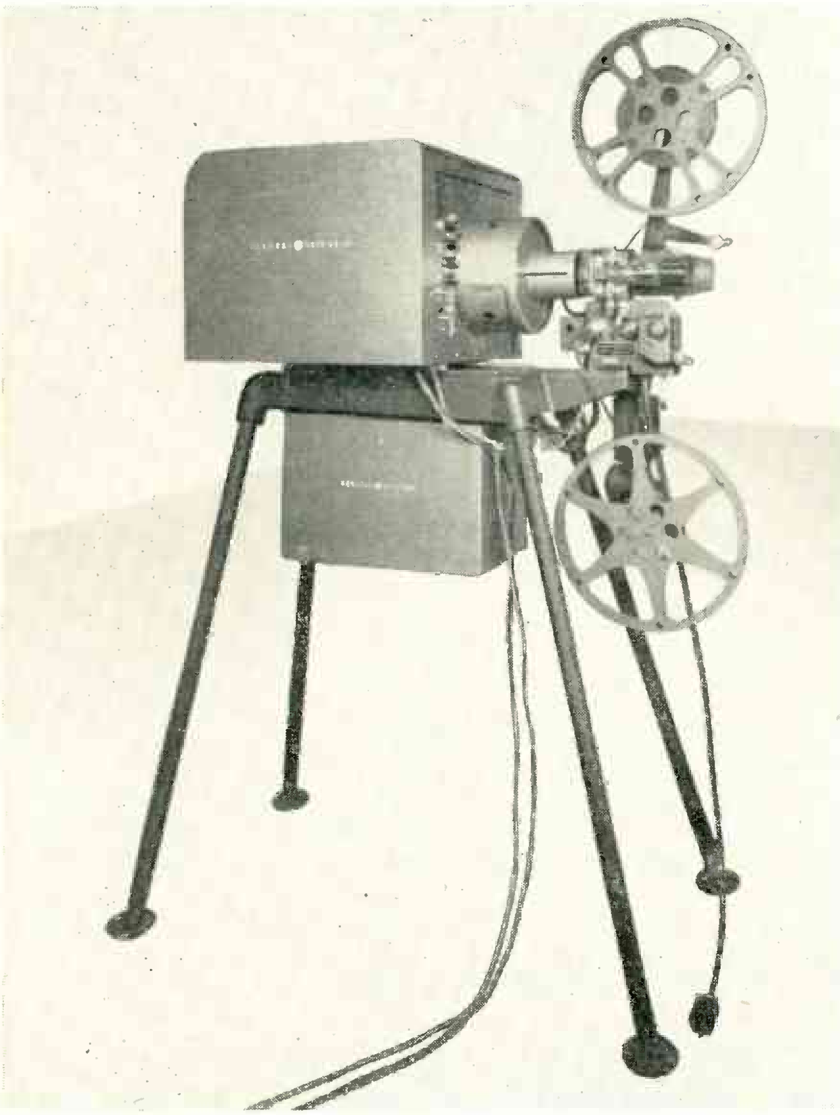
FIG. 2—Time cycles of 16-mm projector for theatre versus television use

Film Projector

By L. C. DOWNES

and J. F. WIGGIN

General Electric Company
Syracuse, New York



Complete television film projector. The speed-control amplifier is mounted in the suspended cabinet

conversion from 24 motion-picture frames per second to 30 television-picture frames per second is to be accomplished without modifying the intermittent mechanism internally.

The explanation of the need for a short fast pull-down time and the various factors involved are shown in Fig. 1.

Pull-Down Problem

The pull-down time for the projector selected for television must be less than 0.007 second. The Bell and Howell Filmoarc projector, which has a pull-down time of 0.0046 second, was chosen, thereby allowing a considerable margin of safety.

In the lower horizontal portion of Fig. 2 the time cycle of the occurrence of the illumination, dark and scan and move periods for the television cycle is shown. In comparison with the standard sound-film cycle, it is illustrated how four film frames are converted to five television frames by alternately illuminating one picture frame three times and the next frame twice, thus resulting in the conversion of 24 motion-picture frames per second to 30 television-picture frames per second.

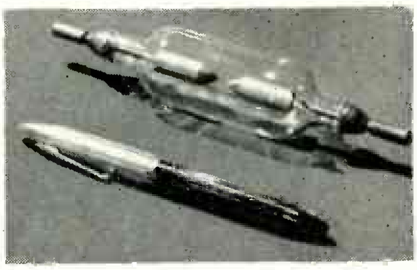
The positioning of the film in the aperture is accomplished by a speed and phase-control mechanism controlling the projector driving motor. A block diagram of the unit is shown in Fig. 3.

Phase Comparator

The vertical blanking pulse from the pulse generator is differentiated and applied to the grid of a buffer amplifier. The buffer amplifier triggers a 50-percent square-wave multivibrator at 60 times per second. The 50-percent square wave is fed into the phase-comparator circuit.

In the phase comparator, the 60-cycle square wave from the multivibrator is compared in phase with a signal from a tachometer generator which is geared to the projector driving motor. When the projector is running at exactly 24 frames per second, the output of the tachometer generator is a 60-cycle sine wave.

The output of the phase comparator is a d-c voltage which is zero



Krypton-filled flash lamp FT-230

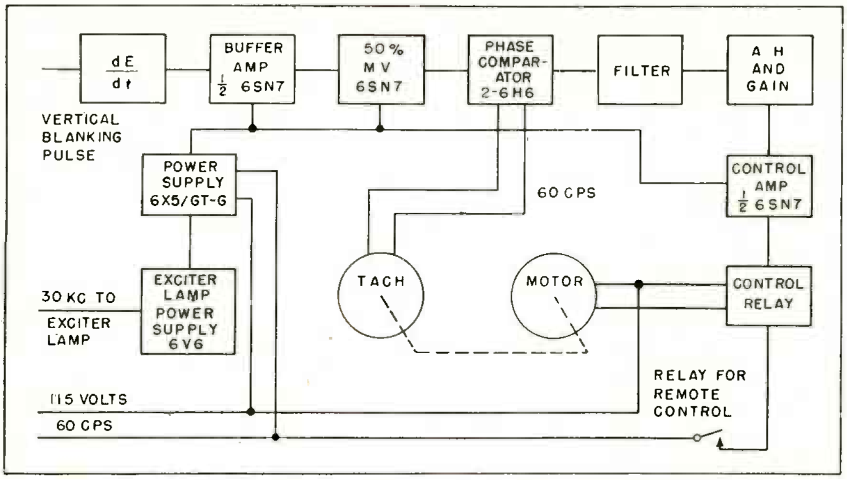


FIG. 3—Speed control amplifier for the projector

when the two input voltages are approximately 90 degrees out of phase and is plus or minus when the phase of one is advanced or retarded with respect to the other. The output of the phase comparator is filtered and fed through anti-hunt and gain-control circuits to the grid of the control amplifier tube.

A universal motor is used for the projector driving motor. It receives its power from the 60-cycle power line through a vibrating-contact mercury relay. The control-amplifier tube furnishes the direct current to bias the control coil of the relay. The relay has a vibrating contact arm which vibrates at 120 times per second and is driven by a 60-cycle voltage.

When there is no d-c in the control coil of the relay, the arm does not leave the front contact and the effective impedance between the front contact and the arm is zero. As the d-c in the control coil is increased, the arm spends less time in contact with the front contact and the effective impedance between the arm and the front contact is increased, thus reducing the current through the motor.

Control Principles

The control amplifier is biased so that approximately the correct plate current flows through the control relay to cause the motor to run at the correct speed. When the speed of the projector driving motor varies, the phase of the two voltages in the phase comparator changes. If the phase of the two voltages in the phase comparator changes so as to cause a positive increase on the grid of the control amplifier tube, the current in the control coil of the relay increases and moves the vibrating arm away from the front contact, increasing the effective impedance in series with the projector driving motor, thereby causing the motor to slow down and correct the phase between the two voltages.

If the two voltages are out of phase in the other direction, a negative change will appear on the grid of the control amplifier and the relay will act so as to speed the motor up to correct the phase. This circuit will keep the pull-down of the film in very accurate synchronism with the vertical blanking signal and does not require that the pulse generator of the television system be synchronized with the local power frequency.

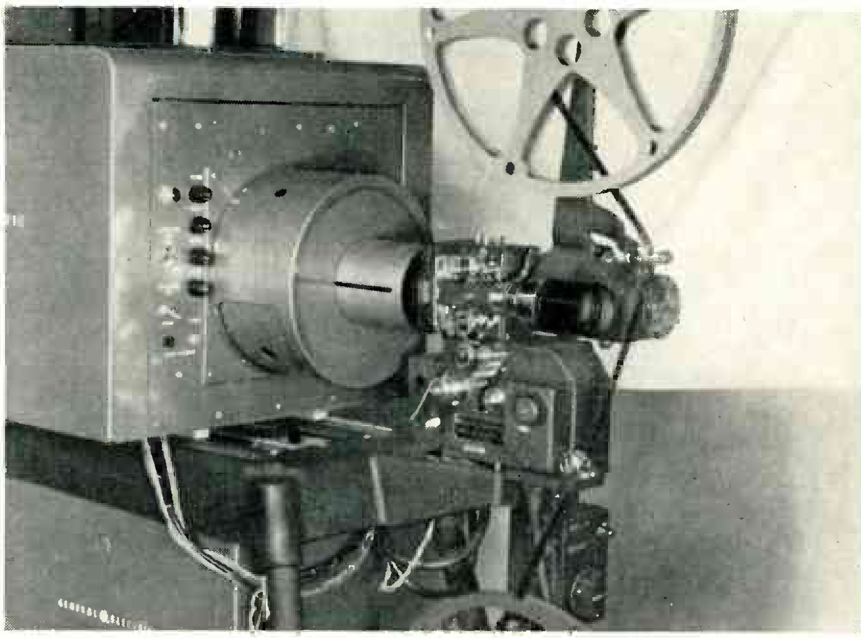
The speed control amplifier unit also contains a relay for remote starting and an oscillator for energizing the exciter lamp in the projector sound head.

Film Illumination

The illumination of the film in an intermittent-motion film projector adapted to television work takes place during the vertical blanking period. New proposed standards for the vertical blanking period impose increasingly stringent requirements on the lamp and projector phasing. The proposed standards for the vertical blanking period limit pulse width to 5 to 8 percent of 1/60 second. Old standards were 7.5 ± 1/2 percent.

If at all possible, it is desirable to keep the illumination time equal to or less than the lower limit of the vertical blanking period. Considerable difficulty was foreseen in trying to obtain sufficient illumination of the film by use of an incandescent lamp or other continuous source of light interrupted by a mechanical shutter.

As the percentage of illumination is reduced, the intensity of the



Close-up of control panel and optical and mechanical arrangements of the projector light source must be increased to maintain a satisfactory average intensity of the projected image. When shutters are used to form the intermittent light pulses, the opening and closing times become an appreciable portion of the total time. Considerable care must be taken in designing a shutter system which functions properly in consideration of the short illumination period available.

Projectors designed for use with a continuous light source and mechanical shutters are often noisy, slow in starting, and susceptible to excessive vibration. They require large driving motors and powerful light sources, each of which has its inherent inconveniences.

Pulsed Light Source

For the pulsed light source system described here several types of flash lamps filled with inert gas were tried. Xenon-filled and krypton-filled lamps gave the most promising results. For economic reasons it was finally decided to make use of the krypton-filled FT-230. In this lamp, the arc strikes between the points of two tungsten-alloy electrodes. The glass envelope is filled with krypton gas to a pressure of about two atmospheres. In physical size the lamp is about 6⅝ inches long and the maximum diameter of the envelope is about one and one-quarter in.

The task of operating the FT-230 in this particular application resolves itself into three problems; the gas between the electrodes of the lamp must be broken down or ionized, energy for the flash must be supplied to the lamp, and the light pulse must be cut off at the proper time.

Pulsed Light Circuit

The Synchro-Lite Unit* block diagram is shown in Fig. 4. The vertical blanking pulse from the pulse generator is applied to the grid of the blocking oscillator and triggers the 6SN7 tube of this circuit at 60 times per second. The pulse formed by the blocking oscillator is used to drive the 715B high-voltage pulser tube. The output of the high-voltage pulser is an oscillatory voltage having a peak-to-peak value of about 15,000 volts. This voltage appears across the gap lamp electrodes and ionizes the gas between the electrodes. Once the gas has been ionized sufficiently, a much lower voltage will sustain the arc.

The energy for sustaining the arc or light pulse is provided by a three-phase selenium rectifier supply which is designed to operate from a 230, 208, or 115-volt, three-phase, 50 to 60-cycle source. The output of the selenium rectifiers is about 130 volts. A rheostat R is

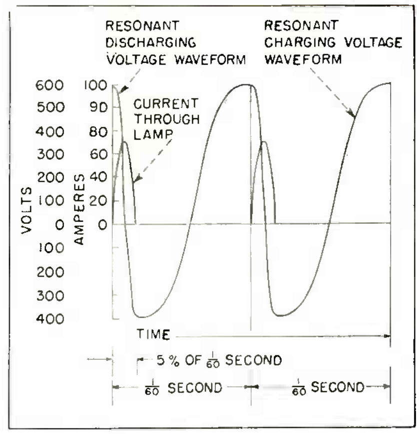


FIG. 5—Waveform of voltage across capacitor C of Fig. 4 and current through the lamp. The scale is distorted for illustration purposes

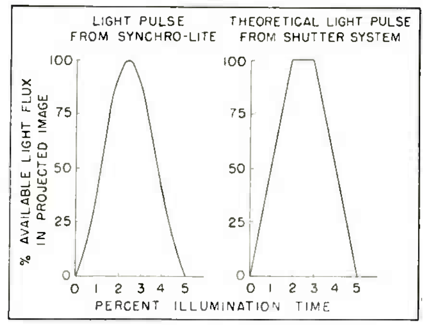


FIG. 6—Comparison of light pulse from Synchro-Lite with theoretical light pulse from shutter system having 2-percent opening and closing times

connected in series with the output of the rectifier for controlling the current through the lamp and thus controlling the light output.

Selenium rectifiers were used because of the relatively low direct voltage required. A three-phase rectifier circuit was used to eliminate expensive filtering and to improve operation of the unit independently of the local power frequency. If the lamp were operated independently of the local power line and the d-c were not adequately filtered, modulation of the light would occur due to the variations in the output of the d-c supply.

Normal current for the lamp is about 1.5 to 2.0 amperes average, depending upon the setting of the rheostat R. The voltage measured at the input to L_1 is about 100 volts for normal operation.

Inductor L_1 and capacitor C constitute a resonant charging circuit

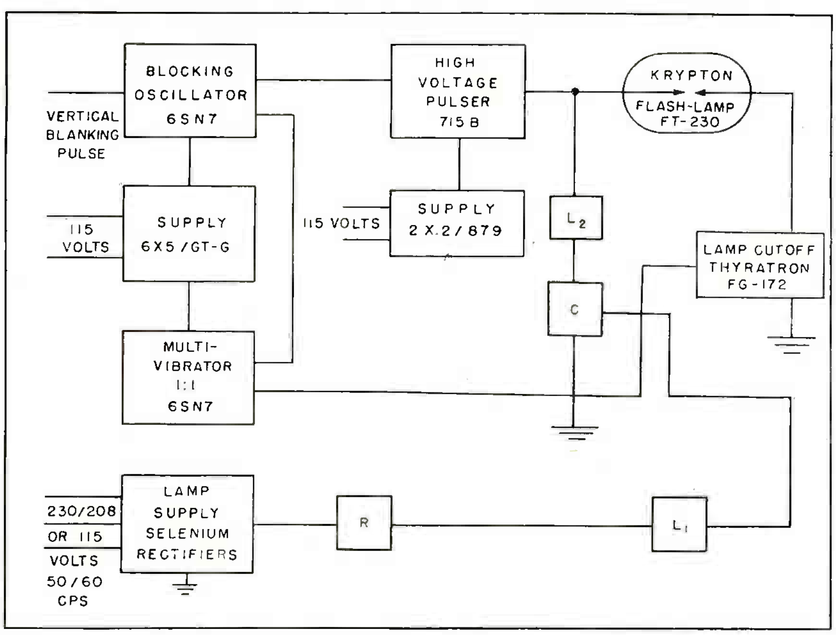
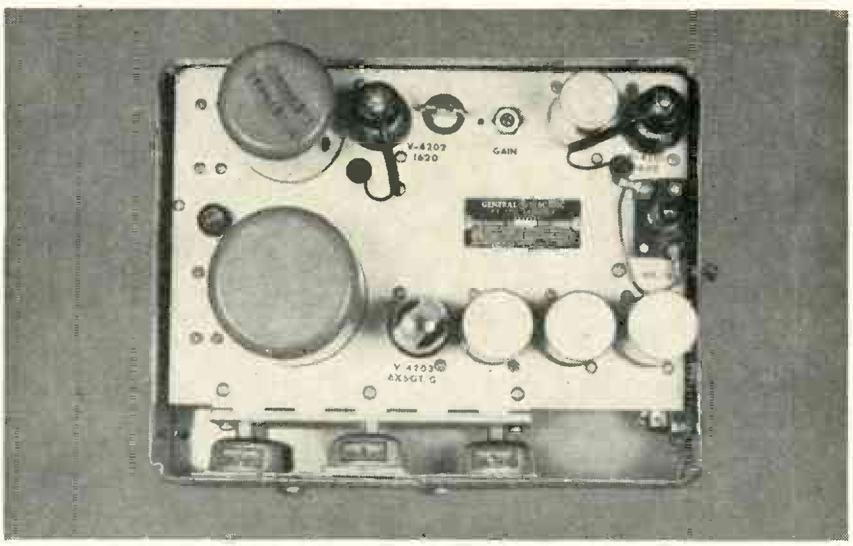
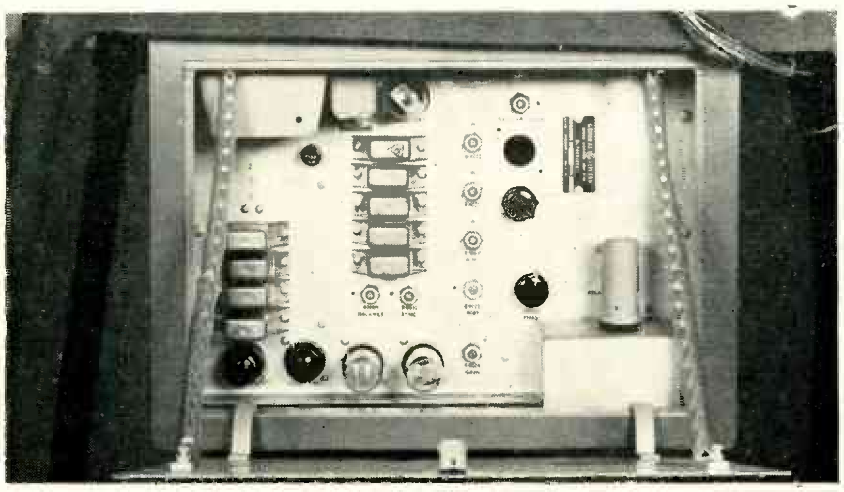


FIG. 4—Synchro-Lite block diagram

*Registered in U. S. Patent Office



Sound amplifier for the projector



Tube and adjustment side of the speed-control amplifier

which charges capacitor C to a voltage of about 600 volts just before the high voltage is applied to the negative terminal of the lamp. A voltage transformation of about 6 to 1 is obtained by using this resonant charging circuit in conjunction with the resonant discharging circuit, L_2 and C.

The duration of the flash and the shape of the light pulse is controlled by the resonant discharging circuit L_2 and C and the thyratron.

Values of L_2 and C are selected so that the first half-cycle of the resonant discharge wave will produce a light pulse of $4\frac{1}{2}$ to 5 percent of 1/60 second in duration. Thus, the light pulse will be equal to or less than the lower limit of the vertical blanking period.

The thyratron carries the full lamp current and is used to prevent the negative current swing of the resonant discharge cycle, thus insuring that only one light pulse will occur. The peak current through this part of the circuit will vary from 40 to 70 amperes, depending upon the setting of rheostat R. A 6SN7 multivibrator triggered from the cathode of the blocking oscillator is used to drive the grid of the thyratron. This pulse occurs at almost the same instant that the high-voltage pulse occurs.

The voltage across capacitor C and the current through the lamp are not in phase but have a phase difference somewhat as shown in Fig. 5.

The light pulse obtained by this circuit approximates the current wave through the lamp, which is a half sine wave. This light pulse is shown in Fig. 6 in comparison with the theoretical light pulse obtained by the carefully designed shutter system previously mentioned. It has been found that a light pulse of this type minimizes transient effects in the camera pickup tube as opposed to a light pulse which has infinitely steep sides or, in other words, a rectangularly shaped light pulse.

Conclusions

This projector design possesses a number of operational advantages:

A powerful continuous light source is no longer required. Mechanical noise, vibration, and projector driving power are decreased.

Power requirements are low. The power requirement for the Synchro-Lite is about 400 watts, for the speed control unit, projector driving motor and take-up-rewind motor about 210 watts. The entire projector consumes less power than is usually required for the conventional light source.

Danger from fire is greatly reduced, because the temperature at the film gate is low. This feature permits making camera adjustments with film in the aperture and the light on at full brilliance. It also permits using the projector for televising 16-mm strip film.

Electronic synchronization of the light source and projector driving motor with the camera synchronizing signal greatly decreases projector phasing problems.

For future work in televising when programming acquires a complexity comparable to present day radio-network programming, split-second timing of programs will be a must. To facilitate network operations it will be desirable to operate the pulse generators of the television stations independently of the local power frequency. This projector has been so designed that it readily lends itself to that mode of operation.

A sound amplifier has been designed for the projector that will accommodate fully the sound reproducing abilities of 16-mm film.

Acknowledgment

The writers wish to acknowledge the pioneer work of D. E. Norgaard on a mercury capillary version of the Synchro-Lite, and the work of J. B. Kilmer on the speed control device.

Pickup of timer (upper left) which scans printing easel (bottom) can be mounted on enlarger

DARKROOM TIMER

Multiplier phototube, scanning the easel of an enlarger, times exposure in accordance with negative density, lens aperture and lamp brightness. Novel neon regulator stabilizes dynode voltages for phototube

By A. STUART MACKAY
Dept. of Electrical Engineering

and RICHARD R. SOULE
University of California
Berkeley, California

PHOTOGRAPHIC darkroom workers, faced with the necessity of spending much time and money making test strips to determine proper exposure for enlargements, have devised various photoelectric timing circuits.

Ideally, such a timer should be adaptable to any enlarger and so constituted that a single pushbutton turns on the enlarger and starts the timer, which will in turn automatically turn off the enlarger at the end of the proper exposure. It should also operate efficiently regardless of line voltage, degree of enlargement, aperture and negative density.

This article describes such a timer that is small, simple and can be permanently attached to any enlarger.

Most timing circuits that have been described are modifications of the basic resistance-capacitance circuit. The charging or discharging of a capacitor is controlled by the internal resistance of a phototube that is exposed to the same light as the enlarging paper. When the voltage across the capacitor reaches a preassigned value, a relay trips, turning off the enlarger. Because the phototube current integrates the light intensity continuously during each exposure, the circuit responds not only to the gross phenomena of negative density, degree of enlargement and lens opening, but also to smaller variables such as lamp brightness, variations with line voltage, and bulb blackening with age.

Modifications have suffered from low sensitivity and leakage currents. Because of some timers' low sensitivity to light, the enlarger must often be rebuilt to include an optical beam splitter that delivers an appreciable portion of the light directly to the photocell or phototube in order that there be adequate light to activate the device. Furthermore, leakage currents, which may be comparable to the phototube current, make timing erratic.

Both of these limitations are overcome by using a multiplier phototube. In such a tube the current produced by the incident light is repeatedly amplified by secondary emission from the arrangement of dynodes. This amplification, taking place within the phototube, raises the output current to the order of a milliampere before leakage currents can affect it. The sensitivity of photomultiplier tubes is so great that they can give a direct indication of the intensity of light that is so weak that it would take two hours' exposure to affect the best photographic emulsions. If such a tube is used to control the charge on a capacitor of good quality, leakage currents are negligible.

Regulated High-Voltage Supply

Although using a photomultiplier tube eliminates the sources of error commonly encountered in self-adjusting timers, one slight complication is introduced: the photomultiplier tube requires a high voltage that must be regulated. Even if a conventional regulated supply is used, tube operation may be unsatisfactory because of the redistribution of potential along the divider for the chain of dynodes when their currents vary by amounts comparable to the divider current. A lower-impedance divider could be used, but it is better to regulate each dynode potential individually.

Quarter-watt neon lamps are ideal for regulating the dynode potentials of a multiplier phototube because of the low current drawn by the tube. If several such lamps are connected in series and this string placed in series with a dropping resistor, the voltage across the string is fairly independent of the applied voltage. A difference of about 55 volts appears across each lamp. The measured a-c resistance of the lamps operating in this current range is about 1,500 ohms, which, in conjunction with a fairly high dropping resistance, gives adequate regulation for most photographic purposes. Because the d-c resistance of the lamps is much higher, the divider current is small.

Satisfactory operation can usually be obtained from photomultiplier tubes operated in autorectifier circuits; that is, with alternating voltage applied to the voltage divider, the tube passing current only when its anode is positive. The fact that the tube is operative less than the full time is equivalent to a reduction in amplification, which can be regained by increasing the voltage on one dynode. However, because the neon string is being repeatedly fired (twice each power cycle), the voltage across each lamp rises to its ignition potential of about 70 volts, or about a third higher than the operating voltage. Thus, at the start of each half cycle the voltage across the string of lamps will momentarily rise too high by several hundred volts if all the lamps light simultaneously. During this period of high voltage the current amplification of the photomultiplier will be much greater than during the remainder of its cycle. An appreciable portion of the total capacitor current will flow during this ignition interval, making the timing sensitive to line voltage variations.

The spike can be minimized by making the lamps ignite in sequence, starting with the first dynode. The small spikes that result are unimportant because so many occur at low voltages, where the amplification is down. The firing sequence can be controlled by attaching a graded-capacitor voltage divider across the string of lamps, the largest capacitor being across the last lamp to fire. In this way the final spike is only 20 volts. This arrangement eliminates possible variations in the time at which the lamps light and the duration of the action. In choosing the sizes of the capacitors, the lower limit is set by stray capacitances and the upper limit by the necessity for the largest capacitance to have a small reactance compared to the resistance of the dropping resistor so excessive phase shift will not be produced. The intermediate values of capacitance are convenient ones approximately evenly spaced. Several lamps can be allowed to ignite together in the early part of the cycle when the voltage is low, thus reducing the number of capacitors. By placing two lamps between some dynodes the amplification can be increased. With the circuit shown, the current amplification is about 80,000.

Darkroom timer is built in two parts: chassis (left) housing relays, gas triode, transformer and timing capacitor, and (right) phototube scanning head

The lamps, their associated capacitors and the phototube are housed in a pickup head so that a long multiconductor cable, whose capacitance might interfere with the divider action, need not be used.

Charging the Capacitor

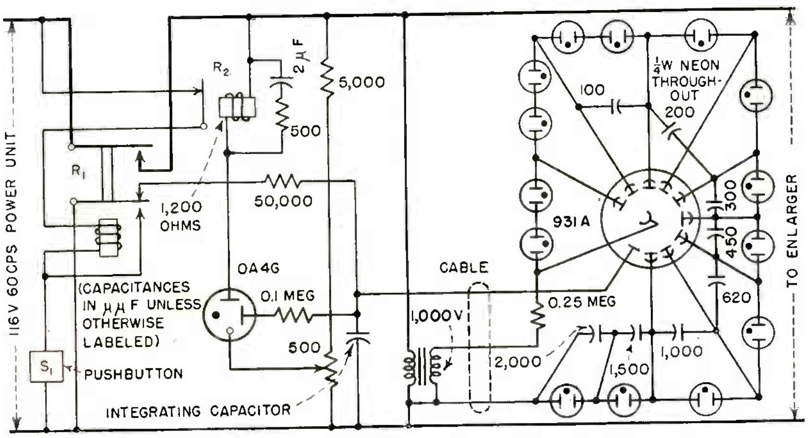
Two neon lamps are used between the last dynode and the anode of the photomultiplier tube to assure a constant (fairly saturated) high signal current and to provide enough voltage so that the firing voltage of the thyratron, which terminates the timing period, can be chosen at a value for which the derivative of the capacitor charging curve is still large. The integrating capacitor should have low leakage. Electrolytic capacitors, which have high leakage and change capacitance, cannot be used.

Different contrasts, grades and surfaces of paper will require different exposures. With the dynode voltages fixed, the exposure interval can be changed by switching capacitors or changing apertures in front of the phototube. Capacitances of the order of magnitude of one microfarad were found proper.

Timers of this sort can be of two types. In the more common type, an initially discharged capacitor is abruptly charged at the beginning of the timing cycle and then allowed to discharge slowly until the capacitor voltage falls to a predetermined value and activates the circuit. In the other type, the capacitor is momentarily shorted and then charged slowly until its voltage rises to the assigned value. This latter arrangement is preferable because the average voltage across the capacitor during the timing cycle is lower than in the first arrangement and hence the leakage current is smaller. In the first type circuit, leakage tends to make the interval too short; in the second, it tends to make it too long, but the error is less.

Timing Operations

The foregoing considerations form the basis for the complete circuit shown in the diagram. To understand the functions of the components, let us follow a timing cycle. Depressing pushbutton S_1 causes relay R_1 to close and, because one set of its contacts is across S_1, to remain closed even after S_1 is released. Another set of contacts on R_1 turn on the enlarger and supply power to the photomultiplier transformer. The integrating capacitor charges slowly from the current passed by the phototube, making the control element of the OA4G tube increasingly negative with respect to its cathode. When the potential difference between these two electrodes becomes high enough, a pilot discharge takes place that partially ionizes the tube. On the next half cycle, the anode of the OA4G becomes positive, the



Circuit of timer shows parts built on chassis to left of cable and, at right, multiplier phototube and its neon-bulb regulator built in pickup head

tube breaks down, and relay R_2 is energized, thus releasing R_1. In dropping back, R_1 turns off the enlarger and the power to the phototube and also connects a 50,000-ohm resistor across the integrating capacitor, thus discharging it in preparation for another cycle. Between timing cycles the equipment draws no power and thus can be left permanently connected. It has no warmup delay, so to operate it for the next cycle all that is necessary is to push the button again.

The type OA4G tube was chosen not only for its heaterless construction, but for other advantages. Before the control electrode breaks down there is very little leakage through the tube because the cathode is cold. Also, because of the construction of this tube, the voltage at which the control electrode fires is a very slowly varying function of the anode potential. No regulation of the anode supply is necessary. In the circuit shown the cathode of the OA4G is returned through a voltage divider so that a variable positive bias can be introduced as a fine control for the timing interval. This bias controls the integrating capacitor voltage at which the tube fires.

Because the cathode bias is an alternating voltage, it tends to fire the tube only during a positive half cycle. However, the control electrode might break down during a negative half cycle and discharge the integrating capacitor to the extinction voltage before the positive half cycle arrives. Hence a 0.1-megohm resistor is used to limit the discharge current to a value that will still ignite the anode circuit but will not discharge the integrating capacitor too rapidly. This resistor also protects the tube by limiting the discharge current.

By using a 110-volt a-c lockin relay for R_1, its size and capacity are not limited by the ability of a tube to pass large currents, as in some timers. The lockin action also makes the timing interval independent of the way in which the button is pushed. Even at short intervals, the action of the two relays of this circuit is quite regular.

The phototube used has an S4 blue-sensitive surface (response peaked at 4,200 Angstroms) and thus should not see light coming through a reasonably good safelight filter. (The dark current to the integrating capacitor is below 0.1 microampere.) However, if spurious currents flow due to the safelight, a relay can be arranged that will turn the safelight off when the enlarger goes on.

Photomultiplier Pickup Head

The phototube is mounted in a light-tight housing with an aperture aimed down at a small angle toward the enlarger easel. However, the angle from the vertical should not be less than about 10 degrees because specular reflections from the paper might then give erratic results as the enlarger head is moved. The housing is mounted on the enlarger head and adjusted so that the phototube sees a suitable portion of the print. As the enlarger head is raised or lowered the phototube will see a larger or smaller portion of the easel but will be further from or closer to it so the light reaching the phototube will be independent of its height. The timing is thus independent of the degree of enlargement.

With usual subjects, the pickup head can be set to scan the middle of the print. However, for certain subjects, such as a portrait against a black background or another against a white background, the field of view of the pickup should be limited only to the region of primary interest. A small lamp could be installed in the pickup head to project a beam of light onto the field of view to facilitate aiming the pickup.

Although the field of view of the pickup head can be controlled solely by stops or diaphragms, the same result can be obtained with much better light-gathering power by using a lens to cast an image of the working area of the easel onto a diaphragm in front of the phototube. This lens need not be of good quality as a sharp image is undesirable, but it should have a short focal length. The diaphragm in front of the phototube can be a ground glass masked to accept the desired field of view. The image should not be formed directly on the photocathode because it may be nonuniform.

To test the reliability of this timer, prints were made with the enlarger lens at f4.5 and at f16 and with the line voltage at 115 and at 105 volts. The four prints were processed identically thereafter and compared. They were indistinguishable from each other. However, because of the change in color of the enlarger light with line voltage, some enlargers may not give compensation to this degree. The magnitude of the effect will be determined by how well the photocell color characteristic curve matches that of the paper being used. Because of its cascade action, and consequent extreme voltage sensitivity, this timer may be inadequate for exacting color work unless the line voltage is stabilized. A constant-voltage transformer is a simple solution to such a problem.

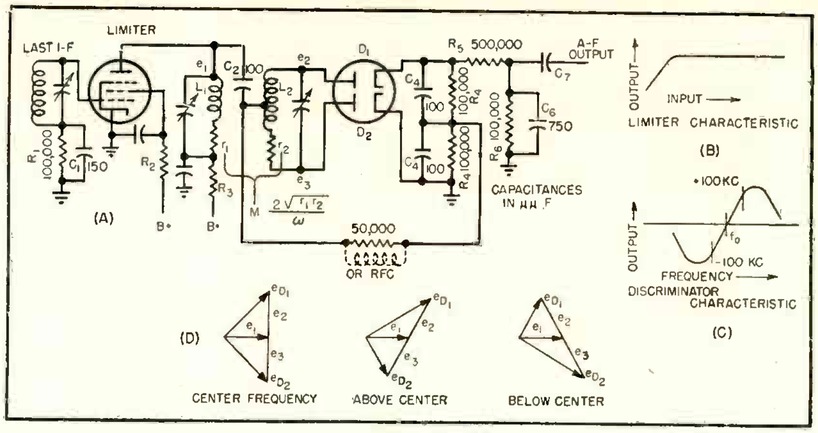


FIG. 1—Limiter-discriminator f-m detector circuit. The graphs show operational characteristics; the vector diagrams explain instantaneous effects

F-M Receiver

A survey of design and production techniques, including an evaluation of limiter-discriminator, ratio, and synchronized-oscillator detectors. Hum reduction and the tracing and elimination of regenerative effects in i-f and r-f stages, particularly for a-c/d-c receivers, are described

By E. C. FREELAND

Engineering Department
Philco Corp.
Philadelphia, Pa.

A NUMBER of problems arise in the design of f-m receivers as compared with those for a-m only. Because the f-m system is capable of handling greater dynamic range, the power output of the audio amplifier must usually be about twice that for a-m, and the extended frequency range requires up to 15,000 cycles frequency response.

Distortion must be held to less than 5 percent and efforts must be made to eliminate high-order distortion. A de-emphasis circuit must be switched in for f-m to compensate for the predistortion introduced at the transmitter to improve the high-frequency signal-to-noise ratio. The de-emphasis element takes the form of an R-C low-pass filter with a 75-microsecond time constant for the requisite 6-db-per-octave audio attenuation.

Audio and modulation hum may arise in the filament circuit. Heater-to-cathode leakage in detectors employing balanced discriminators or ratio detectors may cause hum problems in production because one of the cathodes is above ground for audio frequencies. Insofar as a-c/d-c receivers are concerned, the detector must be placed at the low end of the filament string.

Filament-to-grid emission in the converter and local oscillator tubes of a-c/d-c receivers has been found to be a possible cause of frequency-modulation hum in the local oscillator. The use of a low value of grid leak in the order of 15,000 ohms has been found quite helpful. The converter tube should be located next to the second detector in the filament string in order to minimize the a-c filament-to-grid potential. The presence of frequency modulation in the local oscillator is readily detected by applying to the converter grid first an unmodulated i-f signal and then an unmodulated r-f signal and noting the increase in audible hum.

Detector Systems

There are three types of f-m detectors generally used in commercial receivers. They are: the balanced discriminator which is usually preceded by a limiter; the ratio detector which uses a balanced discriminator in a circuit arrangement which accomplishes noise reduction without the use of a limiter; and the synchronized-oscillator type of frequency detector, the commercial form of which is known as the Bradley detector, giving noise reduction without a limiter.

Figure 1A shows a schematic for the limiter and balanced discriminator form of detector. Amplitude-modulation limiter action is obtained by the use of a low time constant circuit of the order of 15 microseconds in the grid of the limiter tube and by the proper adjustment of plate and screen voltages to obtain a flat saturation characteristic, as shown in Fig. 1B. The opposing noise voltage appears across the low time constant circuit R_1C_1, with the result that the a-m noise modulation is materially reduced. Resistors R_2 and R_3 are chosen to give screen and plate voltages in the order of 5 to 40 volts to obtain the desired limiter characteristic.

The desired discriminator characteristic shown in Fig. 1C is obtainable with approximate transformer constants such that L_1 equals L_2, M is twice that for critical coupling, and Q is 50 for an i-f frequency of 10 mc. The magnitude of L_1 and L_2 determines the voltage output and is about 5 to 10 mh in commercial design.

The vector diagrams in Fig. 1D show how the voltage output is developed as the signal goes through its frequency modulation cycle. Voltages e_2 and e_3 are added at 90 degrees to the primary voltage e_1 through C_2 when at the center frequency. As we move off resonance, the phase of the secondary voltage shifts with respect to that of the primary, a difference in diode voltage is obtained and an incremental

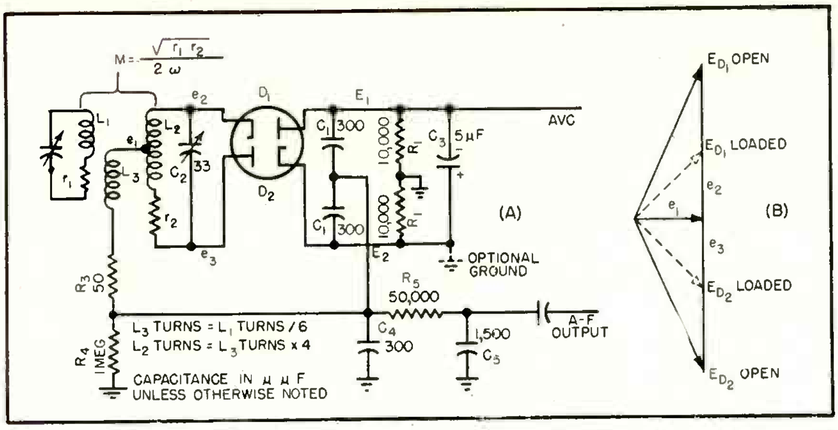


FIG. 2—Ratio detector for f-m. Transformer turns ratios are given and the vector diagram indicates optimum transformer performance

Design Problems

d-c voltage is produced across resistors R_4. Circuit R_6C_6 in conjunction with R_5 serves as an attenuator and de-emphasis network. The values given are approximately as required for the average audio amplifier of a radio receiver.

Ratio Detector

Figure 2A shows the schematic diagram for the ratio detector. Here, a-m rejection is obtained by a double diode circuit in conjunction with a balanced discriminator transformer which has special electrical constants. The addition of a capacitor C_3 for storage of stabilizing voltage and the reversal of the diode D_1 are the most significant circuit changes over that of the ordinary balanced discriminator. In addition, the diode conductance should be high and the diode load resistors low so as to load the secondary windings L_2 to a point where the secondary Q is approximately one-fourth the unloaded Q.

The open circuit voltage across L_2 is made large compared to that across L_3. The application of the diode load should then reduce the voltage across L_2 such that it is equal to about 75 percent of the voltage across L_3. This effect is illustrated in the vector diagram in Fig. 2B, which also gives the approximate turns relation required to simulate the conditions of this vector relation. Coil L_1 is made large in comparison to L_3 so as to match more nearly the plate resistance of the i-f amplifier and to minimize the effect of the diode load on the primary Q. The value of M is made less than critical so that E_2, within limits, will be a direct function of the diode load.

The application of a carrier signal to the primary of the discriminator transformer will now charge C_3 to a d-c voltage equal to $E_{D1} + E_{D2}$ and this charge will follow low rates of change in carrier level. However, suppose that the carrier level is suddenly increased as by a burst of noise. Capacitor C_3 will essentially act as a short-circuit, consequently the diodes will impose a heavy load on L_2 and the voltages E_{D1} and E_{D2} will increase only by a small fraction of the carrier increase caused by the noise. Conversely, if the carrier level is modulated downward by the noise, C_3 remains charged and reduces the diode current, which results in an increase in E_{D1} and E_{D2}. If the downward modulation drives the diode current to zero, then L_2 is open-circuited and no increase in opposition noise voltage is possible.

The lower the value of R_1 and the greater the Q of L_2 the more downward modulation the detector can handle. However, the lower the value of R_1 the less sensitive is the detector and the greater is the possibility of distortion due to incorrect phase relations in the transformer. A good compromise design using approximately the constants shown will handle up to 60 percent of downward modulation.

The audio voltage appears across R_4 which, so far as operation is concerned, may be an open circuit and is shown only as a means of clarifying the functioning of the circuit. When the carrier frequency is at its center value the voltages E_{D1} and E_{D2} are equal, and since the two diode currents are in opposition, no voltage will be developed across R_4.

Now as modulation moves the carrier off center frequency such that E_{D1} decreases and E_{D2} increases, the current through R_4 due to E_{D1} is decreased. This is equivalent to an increase being caused by a voltage in opposition to that due to E_{D1}. Since E_{D2} represents such an opposition voltage, the two changes in diode currents produce a resultant change in voltage across R_4 equivalent to connecting the two diode voltage increments in parallel, while a balanced discriminator adds these voltages. Thus the output of the ratio detector is given as one-half E_{D2} minus E_{D1}.

Since no audio voltage can appear across the stabilizing capacitor, the ground can be shifted to the optional location and thus permit the use of a cathode common to that of the first audio tube. However, this arrangement does not permit the effective use of balancing resistors between the diode and the junction of the stabilizing capacitor and load resistor which are sometimes required for the best results insofar as noise rejection is concerned. These balancing resistors are of the order of 1,000 ohms.

Equivalent Circuit of Ratio Detector

Figure 3 may help further to clarify the operation of the ratio type of detector. Figure 3A shows the equivalent circuit under center-frequency conditions, with batteries substituted for rectified and applied voltages. Resistors are substituted for the various impedances. The values shown are only relative for the purpose of illustration and bear no absolute relation to the actual detector circuit. Batteries B_1 and B_2 are fictitious voltages which replace the i-f plate current of the driver stage. The diode load has also been relocated so as to represent the load across the transformer and a one-megohm resistor occupies its conventional location so as to simulate as nearly as possible the actual detector.

The diagram shows the detector under a stabilized condition, wherein B_3 may be removed without changing the circuit conditions. Now if, with B_3 connected, B_1 plus B_2 is increased or decreased the change in current will flow through B_3 plus R_{D1} and R_{D2} and the change in E_{D1} and E_{D2} will be 1/100th of that which would occur if the stabilizing voltage B_3 were not present. It is seen that a-m has little effect on E_{D1} and E_{D2}.

Figure 3B shows the relations at off center frequency for a change in diode voltages of one volt, Fig. 3D shows voltages in parallel.

Figure 3C shows the equivalent of a circuit used with a grounded cathode. Since the ground has effectively moved from zero to plus four volts with respect to point a and the voltage from a to d is proportional to the carrier strength, point a delivers an avc voltage equal to half the charge on the stabilizing capacitor.

The importance of electrical balance of the secondary of the discriminator transformer cannot be overstressed. The transformer parameters, particularly the impedance of the secondary and its coupling to the primary, are also deserving of careful consideration for the best possible a-m rejection.

A signal generator capable of delivering a signal with simultaneous amplitude and frequency modulation will be of great help. The frequency modulation should be of the order of 100 cycles at ±75-kc deviation and the a-m of the order of 1,000 cycles at 50-percent modulation so that it is possible, by the use of a high-pass filter, to measure the a-m component of the audio output voltage in the presence of the output due to frequency modulation. This filter should have sufficient attenuation to reduce the reading on the output meter, due to f-m, to a negligible value compared to that due to a-m.

This check for attenuation can be made by switching off the amplitude modulation and reading the output through the filter when frequency modulation is applied. A synchronized scope pattern of the discriminator characteristic will also show the presence of a-m by giving a wide line. The proper interpretation of this pattern will be of value in determining the f-m/a-m ratio. A ratio of 30 to 1 in voltage, which is about 30 db, is considered satisfactory for field performance. The ratio should be checked at various levels of input.

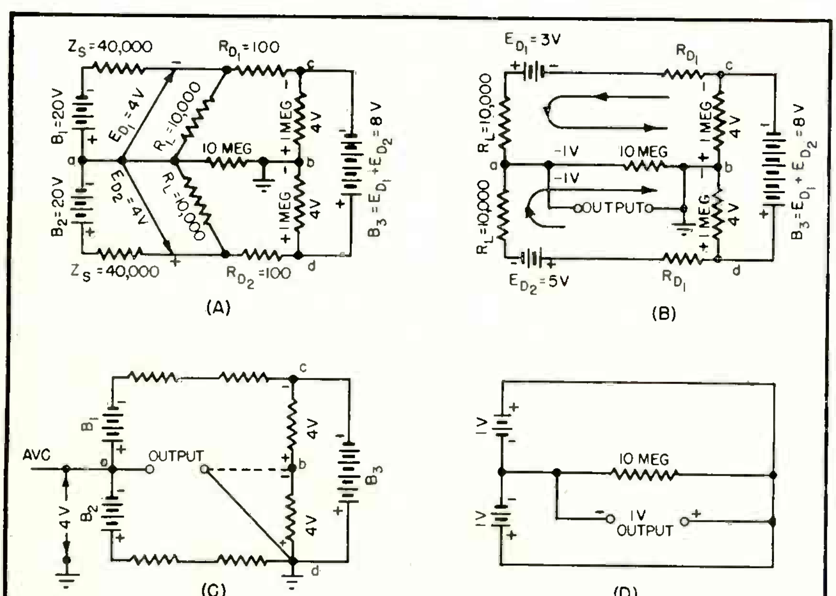


FIG. 3—Simplified diagrams of the ratio detector, with batteries representing voltages and resistances representing impedances

Figure 4 shows a circuit arrangement which is applicable to the Bradley synchronized-oscillator type of detector. The oscillator circuit may be of the Colpitts or Hartley type, the particular requirement being that it run under class C conditions. The tube is a pentagrid type with the element structure of such design as to give the special characteristics required for best operation as a synchronized-oscillator type of detector and noise rejection.

Frequency modulation as required to maintain lock-in is obtained from a 90-degree component of the oscillator signal injected across L_1 by L_2. The magnitude is controlled by the change in oscillator plate current I_p. The control of magnitude of the 90-degree component is accomplished by changing the total effective bias of E_{G3} plus E_{G1}. This 90-degree component will appear as a capacitance or an inductance across L_1C_1, dependent upon the polarity of L_2. Therefore the reversal of L_2 reverses the phase of the audio output in reference to the carrier modulation.

In most cases the capacitive polarity for L_2 gives the best results and is determined by observing the oscillator frequency when changing the bias E_{G3}. If the phasing is correct, the oscillator frequency will increase with more negative bias.

Load resistance R_L damps L_2 such that its Q is approximately 10. This damping prevents changes in phase of the 90-degree component during the application of frequency modulation to the oscillator under lock-in conditions. When the circuit parameters are properly adjusted, a straight line is obtained between the break-out points and the output is independent of the input.

Figure 4B illustrates the method by which the effective bias of $E_{G3}+E_{G1}$ is made to vary with modulation. This method produces an audio component of plate current through R_3C_3, the amplitude of which is a direct function of the carrier deviation. It is to be noted that the time constant of R_3C_3 is 75 microseconds, as required to supply the proper de-emphasis correction to the audio response curve.

When the signal voltage is at 90 degrees to the oscillator grid pulse

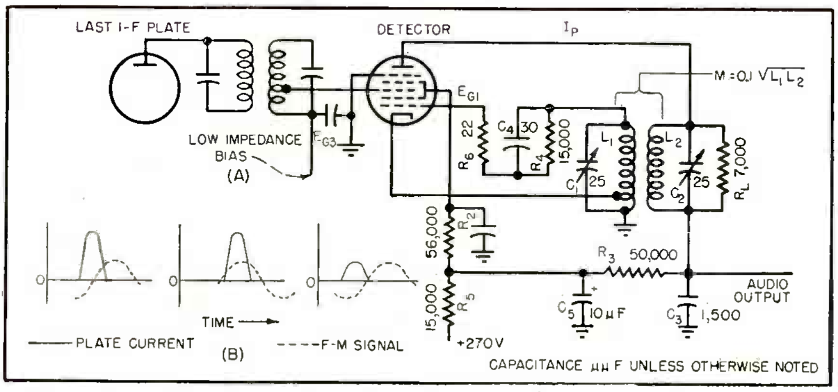


FIG. 4—Typical synchronized-oscillator f-m detector. Plate-current and signal relations are shown at B

no change in plate current will take place. It should be remembered, however, that a fictitious capacitance or inductance is present across L_1C_1 under this steady-state condition. The oscillator frequency is in part determined by this 90-degree component as well as L_1C_1 and the padding of C_1 must be such as to compensate properly.

Now let us apply modulation to the carrier such that its frequency is shifted by a small incremental change, and such that the phase shifts in such a direction as to approach the in-phase condition. A small increase in plate current takes place, resulting in a corresponding increase in the 90-degree component of oscillator current across L_1C_1. This change in turn produces enough change in oscillator frequency to satisfy the conditions around the loop.

The converse takes place when the modulation is such as to move the frequency in the opposite direction, as indicated by the out-of-phase condition shown in Fig. 4B. When the change in plate current caused by this phase shift is not sufficient to provide the magnitude of 90-degree component required to deviate the oscillator so that it is in step with the carrier, break-out occurs and the audio output goes through a point of discontinuity which will be observed as a ragged type of distortion. When break-out occurs, either the phase shift has gone through 90 degrees or the tube has reached saturation.

While the lock-in sensitivity of this type of detector is as low as 0.3 volt, full advantage of this sensitivity cannot be realized because of the fact that it is necessary to drive G_3 from a source impedance of a few thousand ohms in order to reduce stray oscillator voltage on G_3 due to capacitance coupling in the tube. Experience has shown that excessive oscillator voltage on G_3 introduces objectionable distortion. A more complete description appeared in the October 1946 issue of ELECTRONICS, p 88.

It is seen from Table I that the choice of the f-m detector has a direct bearing on the requirements of the i-f amplifier, particularly so far as gain is concerned. Whether or not an r-f stage is used also affects the gain requirements and overall stability of the i-f system.

The antenna sensitivity may vary between two and 75 microvolts, depending on the price class and performance requirements. It is possible to realize a gain of 2 in the antenna stage, and for the r-f stage a gain of 10. Although the theoretical maximum is considerably higher, it is difficult to realize, because of tube loading and other circuit losses that are difficult to control. Keeping these factors in mind, we can estimate the gain requirements and the number of stages to be used in the i-f system.

Figure 5 shows a typical double-channel i-f stage capable of handling either f-m or a-m signals. The a-m trimmers C_5, C_6, C_7 and C_8 act as bypasses for the 10.7-mc f-m signal, while L_1, L_2, L_3 and L_4 are of negligible impedance at the a-m i-f.

The stage gain at optimum coupling is given by

$$A = E_{G2}/E_{G1} = \frac{G_M (Z_3 Z_4)^{1/2}}{2 + (Z_3/R_p)} \qquad (1)$$

when Z is ωLQ, L_3L_4 is in the order of 8 to 12 microhenrys and Q is about 50 for the average receiver. In most cases the term Z_3/R_p can be neglected. The attenuation at plus and minus 100 kc in a stage employing a transformer with a Q of 50 and adjusted for critical or optimum coupling is 1.2 to 1. It is desirable, from the standpoint of facilitating production padding and field operation in any one of the previously discussed detector systems, to maintain the coupling at slightly less than the critical value.

Regeneration

In many cases the chief problem pertaining to the i-f amplifier is that of regeneration. The cause of regeneration is difficult to locate because in many cases no analytical method seems to be available by which its source can be located.

It is helpful to consider a regenerative or degenerative amplifier as one having a portion of the output signal coupled back to the input in some particular phase relation to the original. Rather than feed the original signal in at the first stage of the amplifier, let it be applied to the last stage in such a manner that the regenerative as well as the original signal will be amplified. This effect is accomplished as shown in Fig. 5 by applying the so-called original signal from the generator through a small capacitor about 3 μμf to the terminal of L_3, C_3 being adjusted to compensate for

Table I—Approximate Performance Data for ±22-KC Deviation

Type of F-M Detector	Location of Measurement	Sensitivity in μV	Output Voltage
Ratio	Driver Grid	100,000	0.3
Bradley	Driver Grid	75,000*	2.0
Limiter and Balanced Discriminator	Limiter Grid	10×10^6	5.0

* Lock-in sensitivity for ± 75 kc

the additional capacitance across L_3. The front end of the amplifier has previously been tuned and the detector converted to an a-m type by opening one diode or stopping the oscillator. When the diode is removed, an equivalent capacitance should be substituted in its place to maintain correct tuning. With an amplitude-modulated signal, it is now possible for the audio amplifier to indicate relative signal amplitudes. The feedback signal, if present, is readily removed by shorting L_2 with a 0.01-μf capacitor. The presence of feedback will be indicated by a change in amplitude of the detected audio output.

When the amplifier circuits are tuned exactly to the frequency of the applied signal, the phase angle between the feedback signal voltage and that of the applied signal is usually some multiple of 90 degrees. If under these conditions the feedback is not in phase with the applied signal, the tuned circuits will seek a new frequency such that the several small phase shifts in each circuit will add up to bring the feedback voltage almost in phase with the applied signal. Under this condition the apparent maximum gain is not at the true resonant frequency of the tuned circuits and the selectivity curve becomes unsymmetrical, or if the feedback is of sufficient magnitude the amplifier will oscillate at some frequency, usually within $(1 \pm 2/Q)$ times the resonant frequency of the tuned circuits. If the feedback is small, and at 90 degrees to the applied signal, it may only change the symmetry of the selectivity curve, and it will then be necessary to check for the presence of feedback at frequencies slightly off resonance. The check is still made by observing the change in output due to shorting L_2 with a 0.01-μf capacitor.

The application of this method to the solution of a regenerative problem is relatively straightforward. Since there is no longer dependence upon the front end of the amplifier to provide a source of signal, it is possible to disconnect or short-circuit any point ahead of L_3 without affecting anything other than the regeneration.

To locate the source of feedback, start at the first stage and, with a 0.01-μf capacitor, bypass successively the grids and plates of each stage until a change in output signal level is noted. Such a point is a source of feedback, but not necessarily the only one.

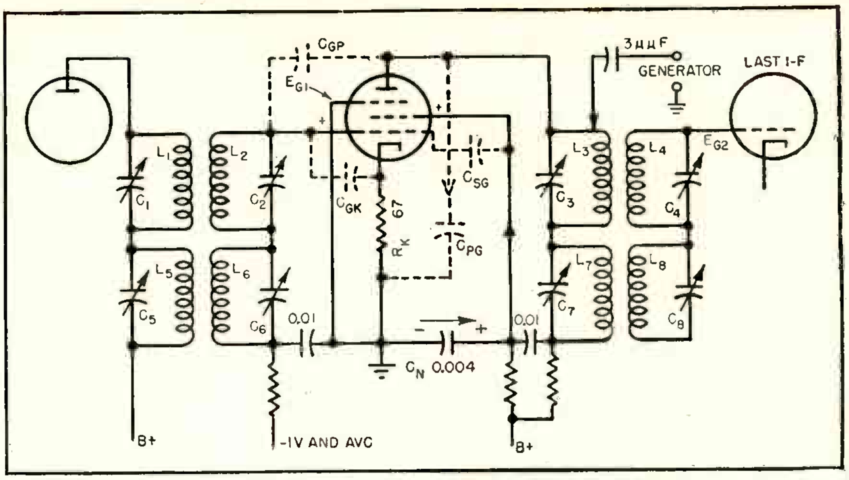


FIG. 5—Representative a-m and f-m intermediate-frequency stage with notations for discussion of regenerative effects

If the amplifier is oscillating it will be necessary to proceed down the line until a point is reached where the bypass kills the oscillation. Having located the point at which regeneration occurs, it then becomes only a matter of inserting the necessary filtering, providing the feedback is in the low-potential end of the circuit. If it is in the high-potential end, other methods of correction must be applied.

The most familiar type of regeneration, which occurs in the high-potential end of i-f amplifier impedances, is that resulting from grid-to-plate capacitance. The advent of the screen grid tube eliminated, for a time, this type of regeneration, but as better i-f transformers were developed and the individual stage performance improved, it again became the limiting factor so far as stage gain is concerned. This style of feedback can be found in most low-cost broadcast receivers and manifests itself as an unsymmetrical selectivity curve.

An indication of the magnitude of feedback due to the grid-to-plate capacitance (C_{GP}) is given by

$$\frac{A_f}{A} = \frac{1}{1 - (C_{GP}\, Q_2\, A/C_2)} \qquad (2)$$

when A_f is gain with feedback owing to C_{GP}. It is approximate because it does not include the phase

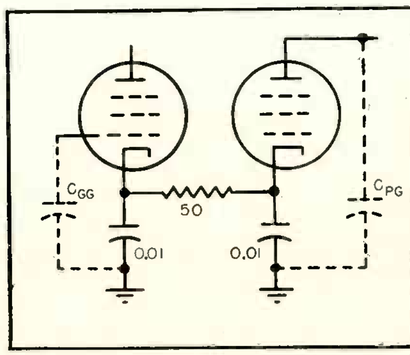


FIG. 6—B-minus decoupling circuit

angles which vary with the degree of feedback and approach 90 degrees as the magnitude of the feedback is reduced.

Consider a possible example where C_{GP} is 0.004 μμf, Q_2 is 50, C_2 is 24 and A is 60. By substitution it is found that the amplification with feedback present is twice that without feedback, while good design practice calls for this ratio to be less than about 1.3 to 1. If the overall design is such as to require the maximum possible i-f stage gain, the use of neutralization is a means of reducing the feedback due to grid-to-plate capacitance.

Neutralization

A convenient means of neutralizing the grid-to-plate capacitance involves obtaining an out-of-phase voltage on the screen with respect to that of the plate. The screen-to-control-grid capacitance C_{SG} then sets up a voltage across L_2 in opposition to that of the feedback voltage caused by the grid-to-plate capacitance. The polarity signs in Fig. 5 indicate the conditions of in-

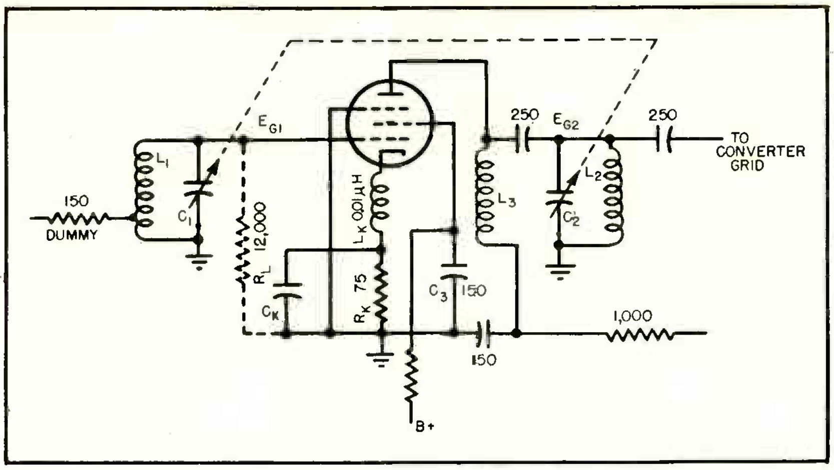


FIG. 7.—R-f stage for a-m and f-m receiver, arranged for discussion of regenerative effects

stantaneous polarity as required for conditions of neutralization.

The out-of-phase voltage to be applied to the screen is best obtained by making the screen bypass C_N common to the plate bypass. Now C_N, in combination with the plate-to-ground capacitance C_{PG}, forms a voltage divider across L_3 and the current is in such direction as to obtain the necessary phase reversal across C_N. For purposes of clarity, C_{SG} is assumed small in comparison to C_2 and hence shows only the approximate relation required for balance

$$C_N = C_{PG}\ C_{SG}/C_{GP} \qquad (3)$$

Since C_{PG} is not readily determined and the lead inductance of C_N is also a factor, the conditions for balance are more exactly determined by experimental methods than by calculation from the theoretical equation. Because the 3-μμf coupling capacitor adds to the plate-to-ground capacitance, a more accurate balance will be obtained if this capacitor is reduced to about 1 μμf and its leads dressed down towards the chassis to keep the grid-to-plate capacitance at a minimum. It will then be necessary to readjust C_3 for maximum output to compensate for the change in coupling capacitance. Now with L_1 shorted, observe the effect of C_2 on the output. If C_N is too large the circuit will be under-neutralized and the output will be observed to increase and then decrease as the phase of the feedback is changed by tuning C_2 through resonance from the high-frequency side. The converse is true if the circuit is in the underneutralized condition.

When the correct value of C_N is inserted no change in output will be observed as C_2 is tuned through resonance. The value of C_N may vary from minus 25 to plus 50 percent without increasing the feedback ratio beyond about 1.3 to 1 providing the ratio without neutralization does not exceed 2 to 1, but since allowance must be made for other variables, a tolerance on C_N of minus 10 to plus 25 percent is preferred.

Feedback in F-M Sets

The common type of overall regeneration due to common coupling in the B-plus circuits is familiar to most engineers and need not be discussed here. There is, however, a new problem in the B-minus circuits which will be encountered when designing an f-m receiver incorporating the familiar a-c/d-c circuit in which the chassis is isolated from the power circuits. Figure 6 shows the circuit elements involved in this type of feedback and a filter for eliminating it. The plate-to-ground capacitance C_{PG} sets up a voltage across the 0.01-μf capacitor connected between ground and cathode of this stage. In the absence of the 50-ohm filter resistor, this voltage would be applied between the grid and cathode of the previous stage through its grid-to-ground capacitance C_{GG}.

Experience would lead one to think that the value of the capacitor between cathode and ground in Fig. 6 should be increased, but a little further investigation will show that a 0.01-μf capacitor will resonate with half-inch leads at about 10 mc. The choice of this particular value of capacitor for most of the bypass requirements in the i-f amplifier of f-m receivers is then apparent. It is necessary to depart from conventional a-m technique so far as the B-minus circuit is concerned, by adding filter sections between the cathodes of successive amplifier stages.

Filament Feedback

Similar problems to that of the B-minus circuit also exist in the series filament string of a-c/d-c receivers, the feedback being due to the capacitance between the filament and cathode and the filament and grid. In the solution of this problem, series chokes are used and the bypasses are returned to the cathode rather than ground in order to avoid modulation hum due to a-c potential on the floating chassis. Filters of this type are also often required in a-c receivers to reduce feedback currents carried by the parallel filament circuits.

The combination of the low capacitance used in the tuned circuits of the i-f amplifier and the construction used in high G_m tubes increases to a marked degree the effect of the change in input capacitance when avc is applied to the grid. The proper choice of cathode resistor R_K will introduce an apparent negative capacitance designated as ΔC in the expression

$$R_K = \Delta\ C/C_{GK}\ G_M \quad (4)$$

This negative capacitance diminishes with G_m at approximately the same absolute rate as that of the positive input capacitance. The value shown in Fig. 5 is approximately that required for correction of input capacitance change of the average i-f stage employing a high G_m tube.

The choice of a converter is somewhat dependent upon overall design considerations. The triode is known to have a much lower equivalent noise resistance than a pentagrid type and therefore will be the most likely choice if no r-f stage is contemplated for one or both bands. If an r-f stage is included as part of the design, a pentagrid converter may give slightly better performance in f-m gain and r-f input resistance.

The chief regeneration problems associated with the converter are the so-called hot spots which are identified as highly regenerative portions of the band. They apparently arise from the oscillator coupling to the i-f through the filament or B-plus leads to produce an antenna frequency, which in turn is coupled back to the antenna or r-f circuits. Bypassing of the hot filament or B-plus leads to chassis through a small self-resonant capacitor of about 100 $\mu\mu$f has been found to be effective in removing this type of regeneration.

R-F Amplification

If an r-f stage is used, degenerative as well as regenerative problems will be encountered. Because the phase relations cannot be maintained so that the two effects cancel, it is necessary to treat each as an individual problem and apply independent solutions.

The acorn tube makes the most reliable type of diode voltmeter, but still imposes a loss across the tuned circuit. A small series capacitor will reduce the loss, but at the same time reduces the voltmeter sensitivity. Keep leads short.

The gain of the r-f stage shown in Fig. 7 is given by

$$A = G_M \omega L_2 Q_2 \qquad (5)$$

Special design precautions must be taken even to approach this theoretical value. An amplifier tube working at these frequencies has a low input resistance caused by transit time and the voltage across the cathode-lead inductance L_K. The grid-to-cathode capacitance C_{GK} couples this cathode voltage to the grid circuit in degenerative relation to the applied signal. If the cathode lead is assumed to be one inch long with a diameter of 0.05 inch, the relation

$$L_K = 0.005\, l \left[2.3 \log_{10}\left(\frac{4l}{d} + \frac{d}{4l} - 1\right)\right] \qquad (6)$$

shows it to have an inductance of 0.01 microhenry. Inserting this value in the equation

$$R_L = 1/\omega^2 G_M L_K C_{GK} \qquad (7)$$

and assuming that the grid-to-cathode capacitance of the tube is 5 $\mu\mu$f, while the G_m is assumed to be 4,000 micromhos, gives an apparent load resistance of 12,000 ohms. The shunt impedance of L_1C_1 is found to be about 10,000 ohms and hence R_L has the effect of reducing the Q of the tuned circuit by a factor of approximately two to one.

The effect of the input admittance on the circuit Q of L_1C_1 is readily verified by observing the voltage change across L_1 as the tube is turned on with the signal generator loosely coupled to L_1C_1 through a 2-$\mu\mu$f capacitor. If the loading is of the magnitude indicated by the previous calculations, the voltage will drop about two to one with the r-f tube hot as compared to that with the tube cold. Part of this loading depends upon the transit time of the electrons between the grid and cathode.

The net effect of the tube on the Q of the input circuit can be largely compensated by inserting, in series with the cathode, a small resistor R_K. If C_K is very small and R_K large in comparison to L_K, the phase angle of the feedback will be shifted such that R_L is replaced by a negative capacitance which affects only the value of C_1. If the impedance between cathode and ground has a capacitive phase angle, R_L will be negative, and if sufficiently so, the circuit will oscillate. When a proper adjustment of the cathode impedance is made, the generator voltage across L_1C_1 will not be affected by turning the heater of the r-f tube on or off.

The importance of short leads and low inductance in common circuit paths is important in r-f stages that employ the conventional type of f-m tuning capacitor. The circuit elements involved are arranged in Fig. 8, where L_{M1} is the mutual inductance to be considered as replacing the coupling in the capacitor owing to common currents through the rotor shaft and frame of the tuning capacitor. The inductance of a ground lead represented by L_{M2} indicates how coupling exists due to the stray ground capacitances of the grid and plate circuits. While this inductance, for the same degree of feedback, can be about five times that of L_{M1}, it will be shown that it is important to use the best possible grounding on the rotor shaft and frame of the tuning capacitor.

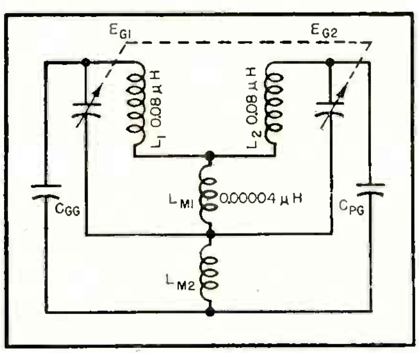


FIG. 8—Circuit to indicate capacitor-shaft coupling

Suppose that L_{M1} is physically represented by a copper rod 1/32 inch in diameter and 1/64 inch long. While Eq. 6 cannot be rigorously applied to such small dimensions, we find by substitution that the inductance of L_{M1} is approximately 0.00004 microhenry. Using the relation

$$A_f/A = 1/[1 - (L_M Q_1 A/L_2)] \qquad (8)$$

if the stage gain A is assumed to be 20 and Q_1 is 100, it is found that the right-hand denominator becomes zero and a condition of oscillation exists. This analysis, like that of the previous problem relative to i-f regeneration, is only approximate because it does not include the phase angle of the feedback which varies with the degree of feedback and approaches 90 degrees as the feedback approaches zero.

This type of regeneration might be analyzed by a similar procedure to that described for feedback in the i-f amplifier stage. The signal from the generator is applied across L_2 through a small capacitor and its amplitude observed on a high-frequency diode voltmeter connected directly across L_2. If regeneration is present the deflection of the diode voltmeter will change with the tuning of a trimmer across C_1 while C_2 is adjusted for resonance. Regeneration may be due to mutual coupling between the coils, capacitance coupling between the circuits, or mutual coupling owing to common currents in the tuning capacitor. Correction of these various conditions is straightforward. To eliminate the coupling in the tuning capacitor entirely, it may be necessary either to use insulated rotor sections in the gang capacitor or replace it with permeability tuned coils.

R-F BRAZING of Radio Components

By R. A. NIELSON

Engineering and Service Division
Westinghouse Electric Corporation
Los Angeles, California

This simple jig positions and aligns stainless-steel parts for brazing. Heating time required with the 4-turn coil is about one-half minute

The one-turn loop encircling the joint heats parts to brazing temperature. Here the operator adds additional alloy by hand to complete the brazing job

Parts for f-m dummy-antenna assembly. Silver-plated copper spinnings are simultaneously brazed to the brass support ring by induction heating

INDUCTION HEATING has found many uses in industry because of its speed and effectiveness, and frequently it is adopted of necessity because no other system is suitable for a particular operation. Such was the case with the assembly of a certain type of f-m dummy-antenna at the Hoffman Radio Corporation in Los Angeles, California.

These antennas were to be formed from the pieces shown in the large photograph. Two 0.03-in. thick silver-plated copper spinnings were to be simultaneously brazed to the $\frac{1}{4}$ x $\frac{1}{2}$-in. brass mounting ring.

Since the initial order was for only 185 units, gas torches were first tried for brazing the assembly. Twenty minutes of heating was needed to complete the braze and, at the end of that time, not only was the silver plating demolished, but the assembly had become so distorted that a straightening operation was necessary.

Improved Method

The gas-torch method, proving to be generally unsatisfactory, was discarded in favor of a 5-kw, 450-kc Westinghouse generator and current transformer. A single-turn coil, encircling the joint, delivers 3 kw of r-f power to the brass mounting ring. As the ring heats, the brazing alloy (Easy Flo No. 45), preplaced on each side of the joint, melts and wets to the ring. As heating continues, the heat from the ring brings the spinnings to brazing temperature, the alloy wets to the spinnings and flows into the joints, and the braze is finished.

Using this induction system, the silver plate remains intact, and there is no distortion of the assembly. Three to four minutes of heating is required for the operation. This relatively slow heating rate is necessary since, if the ring is heated much faster, it will expand away from the spinnings and an unsatisfactory braze will result.

Prior to heating, both spinnings are liberally coated with flux to protect them from oxidation or discoloration. The brazing alloy is applied, in the form of a ring, to both sides of the joint. In practice, it is sometimes necessary to hand-feed small additional amounts of alloy to make a perfect braze.

The same piece of equipment, fitted with a different coil and jig, is used to join stainless-steel parts for the arms of a particular type of radio-range antenna. These arms are made from lengths of 2-in. tubing with caps silver-brazed on each end. A 4-turn coil induces the heat in the area of the proposed joint, and the brazing process requires about 30 seconds of heating time. Here too, a protective flux coating is applied prior to heating. The brazed arms are finished by sandblasting, after a warm-water wash which has removed the flux material.

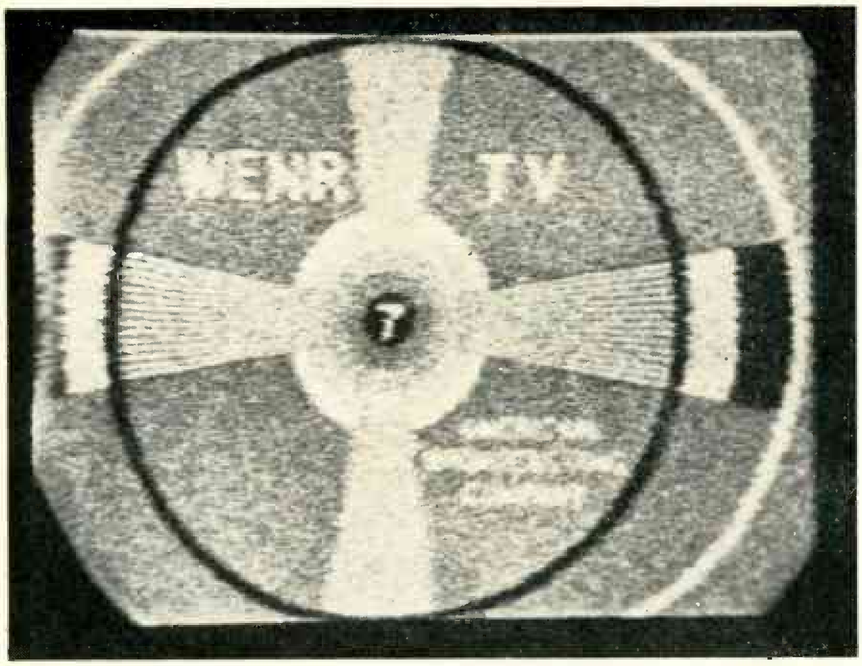


FIG. 1—Test pattern obtained for triggered synchronization with weak noisy signal

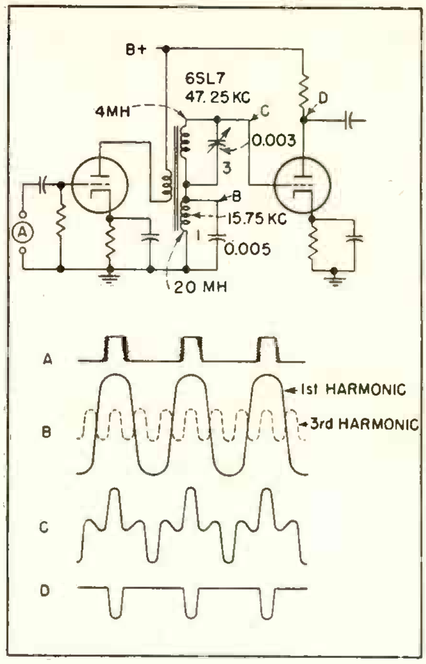


FIG. 2—Harmonic resonator circuit

Locked Oscillator for

Synchronization of horizontal sweep is accomplished by two types of flywheel circuits, a resonator and a locked oscillator. Both types introduce selectivity between the noisy signal and the sweep circuit, thereby contributing to noise protection and picture improvement

By KURT SCHLESINGER
Motorola Inc.
Chicago, Illinois

PRACTICAL EXPERIENCE with television reception has shown that the early method of triggered synchronization of each line individually, as illustrated in Fig. 1, is inadequate under conditions of noise and weak signals.

Considerable improvement was obtained when the method of automatic phase control was introduced. This method employs an oscillator at line frequency in combination with a phase detector. The phase detector produces a d-c bias whenever the oscillator tries to drift away from phase coincidence with the synchronizing signal.

The ability of automatic phase control to suppress noise resides basically in two factors: the element of selectivity offered by the oscillator system and the long time constant of the phase detector. The effects of individual noise pulses are reduced by averaging action.

The existence of a very successful solution, such as automatic phase control, has mitigated against the investigation of other methods that might achieve the same goal with simpler means, such as the flywheel circuits covered here.

Flywheel circuits for television receiver synchronization do not contain a separate phase detector. They employ a tuned circuit of medium or high quality which may be either passive in the form of a resonator, or active as part of an oscillator. In any case, the circuit is directly exposed to the synchronizing signal by which it is either shock-excited, as in a resonator, or locked in, as in the oscillator.

In a resonator, the phase is adjusted, once and for all, by tuning. In the locked oscillator, there is a natural tendency of the signal to pull the circuit oscillation into phase with itself. Both resonating and oscillating flywheels introduce selectivity between the noisy signal and the television sweep and must therefore contribute to noise pro-

From a paper presented at the 1948 National Electronics Conference in Chicago.

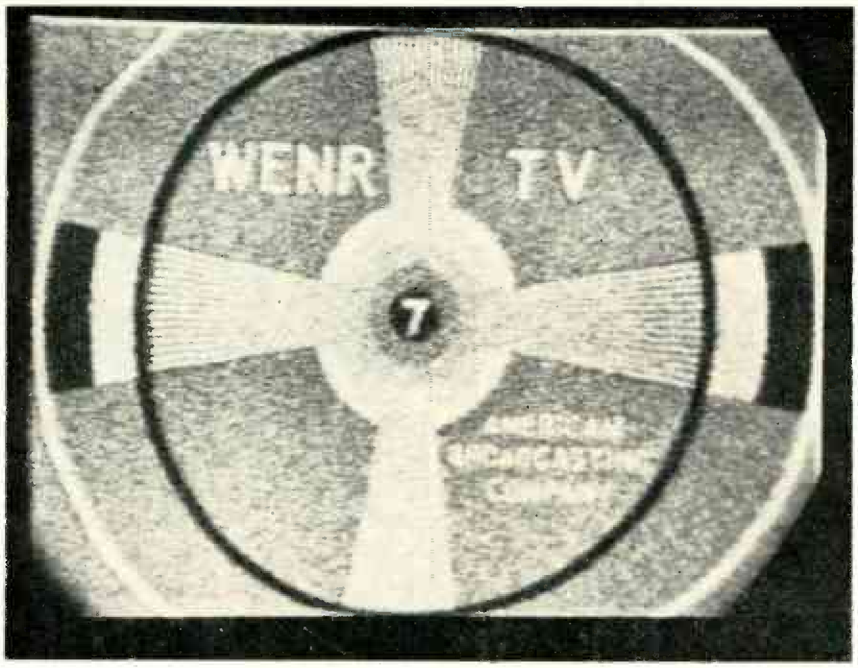


FIG. 3—Test pattern obtained for harmonic resonator with weak noisy signal

Television Synchronization

tection with a resulting picture improvement comparable to that obtained with afc.

Flywheel circuits without separate phase control seem to be entirely practical. They are particularly simple and efficient in the form of the locked-oscillator type, but their future in commercial television will depend to a large extent on the degree to which transmissions adhere to the existing standards on stability of synchronizing signal generators.

Passive Resonating Flywheel Circuits

Consider a tuned circuit in resonance with the line frequency $f_H = 1/H$. If such a resonator has a figure of merit Q, it will act as a stabilizer for both amplitude and frequency. Both functions may be conveniently expressed in terms of a characteristic time constant:

$$T = (Q/\pi)\, H \text{ seconds} \qquad (1)$$

Equation 1 indicates that it takes more than Q/π lines for the resonator to reach steady state. On the other hand, the system may be expected to carry on over Q/π lines, if pulses fail. Hence it effectively locks Q/π lines together.

For the noise spectrum, the same resonator will act like a bandpass filter and will reject all noise frequencies that are not contained within a narrow frequency range of

$$b = 1/\pi T \text{ cps} \qquad (2)$$

centered around the scanning frequency. In view of Eq. 1 and 2, the tuned circuit has been likened appropriately to a flywheel stabilizer for synchronizing pulses affected by noise.

One inherent drawback of the flywheel is also immediately apparent. The expression for its phase delay,

$$\frac{d\phi}{d\omega} = T \qquad (3)$$

indicates, together with Eq. 2, that the phase shift per unit of frequency variation increases with improving noise rejection. However, phase shift in the flywheel means a horizontal shift of the television picture. This condition precludes, at the present state of the art, the use of circuits with more than $Q=30$. The locked oscillator permits going somewhat further.

The specific problem of the television application resides in the fact that the input to, as well as the output from, the flywheel consists of pulses, not sine waves. The tuned circuit will therefore appear as part of a more complex system, including nonlinear elements such as rectifiers or clippers.

The noisy pulse input has to be transformed into a sine wave and the latter back into a pulse. The first step may be accomplished by shock excitation, the second by clipping from either the crest or the zero passage of the sine wave.

By suitable phasing of the sine wave, the pulse output may be slightly advanced ahead of the sync pulse. This procedure often results in improved noise rejection, since the blocking oscillator is triggered in the absence of noise and has become immune to it when the noisy signal arrives.

Harmonic Resonator

Figure 2 shows a harmonic resonator circuit which has an effective Q of 30. Both high-mu triode sections are operated beyond cutoff most of the time, except during the pulses. In this manner, losses due to shunt damping are avoided.

The noisy plate current pulse of the first triode section shock-excites two high-Q circuits, tuned to the first and third harmonic of the line frequency respectively, or 15.75 kc and 47.25 kc. Odd-order cosines are chosen, because their addition yields a complex waveform with polarity inversion between pulses. In this manner, noise and undesired trigger action in the midline region are safely avoided. The L/C ratios are so designed that the amplitude of the harmonic is about one-third that of the fundamental. At the grid of the second triode a wave is produced as shown at C, which may be considered as a somewhat crude synthesis of a pulse train out of two of its Fourier coefficients.

Clipping the positive crest off this wave without grid current loading yields at plate D a pulse output which is sufficiently sharp for all practical purposes and may be advanced with respect to the signal pulse A by slight detuning of the third harmonic resonator circuit 3. The time constant in the cathode arm of the second triode equals that of the resonator.

To show the effect of this harmonic resonator on the picture, a photograph of the screen was taken for the same receiver used in Fig. 1. The improvement in Fig. 3 is considerable, in spite of the relatively low Q of the circuits used. Small lettering begins to be readable. However, close inspection shows that the system is unable to keep vertical edges straight over more than about 10 consecutive lines.

Phase-Shift Limitation

For further improvement, the natural step seems to be to multiply the Q of the ringing circuits. If it were desired to lock one whole field together, or at least 100 lines, a Q anywhere from 300 to 800 would be required. With electrical circuits, such high values may be obtained only by carefully controlled regeneration.

At the IRE convention in New York, 1948, H. E. Harris[2] presented a circuit called a Q multiplier, by which he obtained values of more than 10,000 at 100 kc, and without undue tendency to break into oscillation.

Another way would be to replace the electrical resonators by certain piezoelectric crystals or magnetostrictive devices with which such high values of equivalent Q are quite commonly available. There is one fundamental objection, however, to such high selectivities: In a single tuned circuit the percentage phase shift is Q/π times the percentage frequency variation.

Since any change of phase delay manifests itself as a sideward shift of the whole picture, we are faced with an ever increasing instability of horizontal centering. The standards of good engineering practice for frequency stability of sync generators require that the percentage of average frequency variation be limited to less than 0.5 percent, and that the rate of change of this percentage be held within 0.15 percent per second[3]. The latter condition limits the degree of hunting of the scanning frequency.

From the first standard it follows that the percentage of off-centering due to changes of the average line

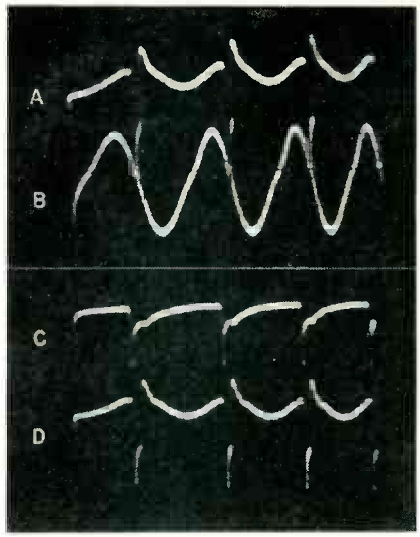


FIG. 5—Pulse transmission through the locked oscillator. Waveform A is the pulse input and oscillator voltage drop across the input resistor, showing i_{osc} in phase with the pulses. Waveform B is grid voltage lagging 90 degrees behind the pulse fundamental. Waveform C is the output from the discharge tube and D the signal input, showing that the discharge is ahead of the sync pulse thereby saving time for retrace

frequency may be as much as 5, 15 and even 45 percent of the picture width, if the Q of the resonator is increased from 30 through 90 to 300. The first figure, $Q = 30$, is quite acceptable, being less than $\frac{1}{2}$ inch on a 10-inch screen. The use of flywheels with a Q of 90 and more seems quite problematic, at least until transmitter time-bases are available which are considerably better stabilized than they are today.

Similar conclusions are drawn from a consideration of time bases whose scanning frequency is constant on the average, but is temporarily subject to rapid hunting. This may occur if the power line is used for frequency comparison. These phase-sensitive resonators are quite sensitive monitors of the transmitter scanning rate, as are also the locked-oscillator circuits to be described. Using them, the viewer soon finds out what type of time base is in use at the transmitter. Fortunately more and more stations are switching over to free-running master oscillators, with or without crystal control. This in turn will make it possible to use higher selectivity in flywheel circuits of this kind.

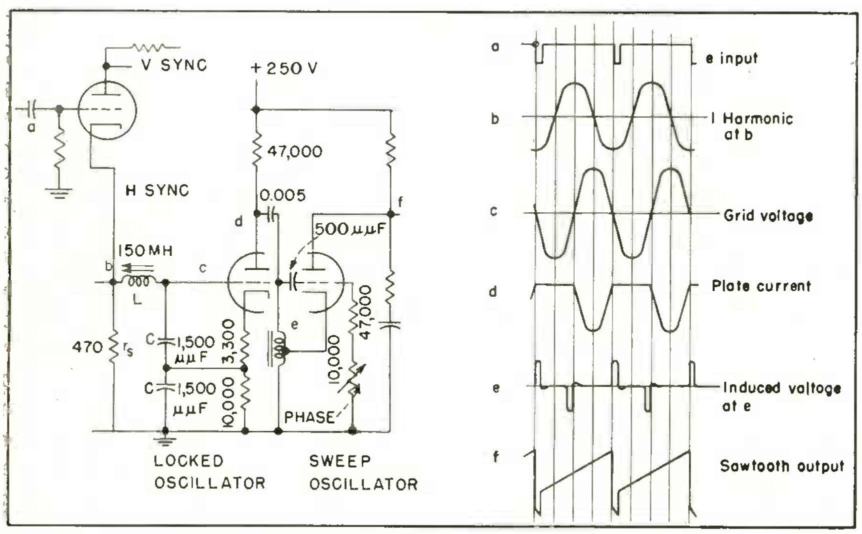


FIG. 4—Circuit and waveforms of locked oscillator

It seems most desirable to have, as a line lock, a somewhat flexible device which has only a moderate filter factor for strong signals, but high noise protection for weak signals, including those which are no longer able to saturate the clipper. Fortunately a system of that kind exists in the form of the locked oscillator.

Active Oscillating Flywheel Circuits

Figure 4 shows a locked oscillator for television synchronization. The oscillator uses a high-μ triode that operates beyond cutoff for each half cycle. As a result, pulses are obtained in the plate circuit in line with each zero passage of the plate current. The small plate transformer which differentiates the plate current wave may actually form a part of the horizontal blocking oscillator.

Positive line sync pulses are injected across a low impedance, r_s. Since the locked oscillator keeps in phase with the locking voltage, if in tune with its free running frequency, the pulse output would tend to lead almost 90 degrees ahead of the fundamental cosine wave associated with the pulse input. It becomes necessary, therefore, to retard that cosine wave 90 degrees before it reaches the oscillator grid. This is accomplished, along with a beneficial step-up of the lock-in voltage, by including the sync injection resistor r_s in a tuned circuit with series inductance L and shunt capacitance C. This circuit is then made to oscillate by tapping the cathode halfway down on the capacitance (Colpitts oscillator). With the values shown, the tank circuit has a Q between 10 and 30 if the resistance r_s is varied from 1,500 to 500 ohms. High values of r_s yield better phase stability and poorer noise protection, and vice versa.

A slight phase lag, about 10 degrees, exists between the pulse output from, and the pulse input to, the locked oscillator, as shown in Fig. 4 at *a* and *d*. This may be readily corrected by detuning the oscillator slightly. For this purpose a grounded resistor is provided in series with a high impedance.

The double-trace oscillogram of Fig. 5 shows the phase relation between input and output and also the oscillator grid voltage with 90-degree lag. It proves that the output may be advanced ahead of the signal. This leaves more time for the line retrace and thus makes it possible to design more efficient horizontal sweep circuits by trading flyback speed for deflection sensitivity.

Figure 6 shows the noise-reducing properties of the locked oscillator. The picture was taken with an intermediate value of coupling resistor (1,500 ohms), and by no means represents the limit of noise protection, but rather a practical compromise with good stability of picture centering. Note the absence of sync jitter and the readability of the small lettering. The smoothness of vertical lines under severe noise is markedly improved over the resonator case, shown in Fig. 3.

Design for Minimum Drift

In spite of these very encouraging results, the locked oscillator

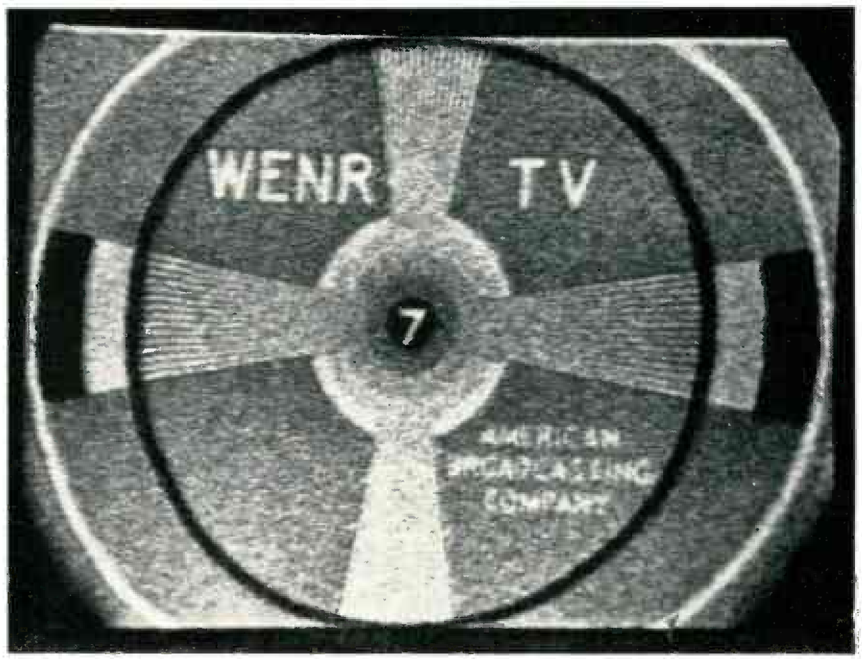


FIG. 6—Test pattern obtained for locked oscillator with weak noisy signal

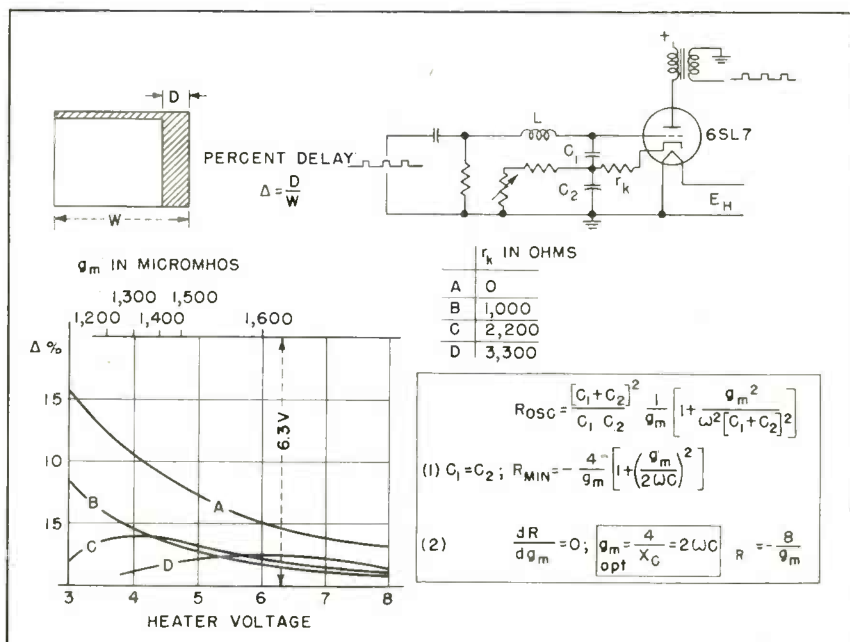


FIG. 7—Circuit design to minimize influence of g_m variations

would not be practical if it showed any marked tendency for horizontal drift. Apart from the influence of instabilities in the video signal, any frequency drift in the locked oscillator itself is bound to cause off-centering of the picture. Even if such drift is too small to cause actual loss of synchronization, it may over a period of time result in a shift of the picture position, requiring manual correction by retuning. It is therefore of great practical importance that the oscillator be designed for minimum frequency drift.

In a low-frequency oscillator of this type, most of the slow frequency drift is caused by variations in cathode temperature, with resulting changes in the tube transconductance. In comparison, the plate voltage could be varied from 100 to 300 volts without harmful influence on the picture position provided that high-μ triodes are used. Fortunately, the Colpitts type of oscillator used here lends itself to a quantitative analysis[4,6] which indicates that there is a design which reduces the effect of g_m variations to a minimum.

Figure 7 shows theoretical and experimental data regarding the influence of heater temperature on the phasing of the picture. In box, Eq. 4 for the negative resistance component of the input impedance of the Colpitts oscillator is taken from an earlier paper of the author. It indicates that the negative input conductance reaches a maximum of $-g_m/8$ if the two circuit capacitances are equal and that the influence of g_m disappears if the effective transconductance of the tube becomes four times the susceptance of the tank circuit.

Thus, there is an optimum tube for each circuit at a given frequency. The second condition is easily met as long as the circuit reactance is high. It calls for the insertion of a critical resistance r_k in series with the cathode to reduce the tube transconductance to the value required by the theory. This value is 3,100 ohms for a triode with 1,600 micromhos in connection with the above circuit.

In Fig. 7 the sync phase is shown for various values of r_k and over a very wide range of heater voltages, using a type 6SL7 triode. With a cathode resistor of approximately 3,000 ohms, the heater influence is almost zero over a range from 5 to 7 volts.

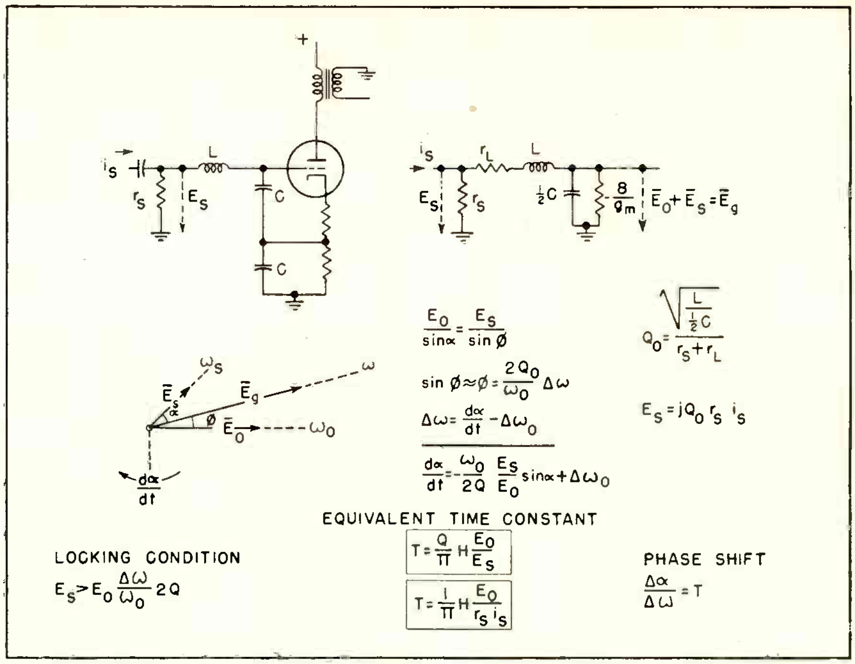


FIG. 8—Derivation of transient response of locked oscillator

Theory of Locking

An excellent analysis of the principles of operation of locked oscillators[6] can be applied to the present circuit.

Figure 8 shows the line lock oscillator and its equivalent circuit, with the tube replaced by a negative conductance of $-g_m/8$. If there is no sync injection, the tank circuit oscillates at its natural frequency ω_o, and the amplitude E_o increases until g_m decreases, by biasing and time division, to a value sufficient to balance the losses in the circuit. The automatic grid bias tends to keep this amplitude constant.

The synchronizing voltage E_s at frequency ω_s is stepped up by near-resonance from the first harmonic of the pulse train; all higher harmonics are rejected. The actual grid voltage is the vector sum of E_s and E_o: E_s has to supply the balance of reactive power to make the oscillator run at the frequency ω_s which differs from the natural frequency ω_o.

The phase diagram leads directly to Adler's differential equation for the pull-in process. For small phase angles between sync pulse and response, which is the only case of interest for television, the oscillator behaves like a flywheel with the time constant:

$$T = \frac{Q}{\pi} H \frac{E_o}{E_s} \qquad (5)$$

If we compare this with Eq. 1, which gives the corresponding figure of merit for a resonator with the same Q, we find that the locked oscillator is better by the factor E_o/E_s, the ratio of the oscillator and synchronizing amplitudes measured at the grid. Hence the noise protection increases with decreasing signal voltage.

The upper limit for this voltage factor is the locking condition

$$E_s > E_o \frac{\Delta\omega}{\omega_o} 2Q \qquad (6)$$

which indicates that the Q of the tank circuit should not be made too high.

Equation 5a is an alternate expression for the time constant of the locked oscillator where the source of synchronizing pulses is a constant-current device and where I_s is the amplitude of the first harmonic of the pulses which it supplies:

$$T = \frac{1}{\pi} H \frac{E_o}{i_s r_s} \qquad (5a)$$

This form shows that the noise protection increases in inverse proportion to the value of the coupling re-

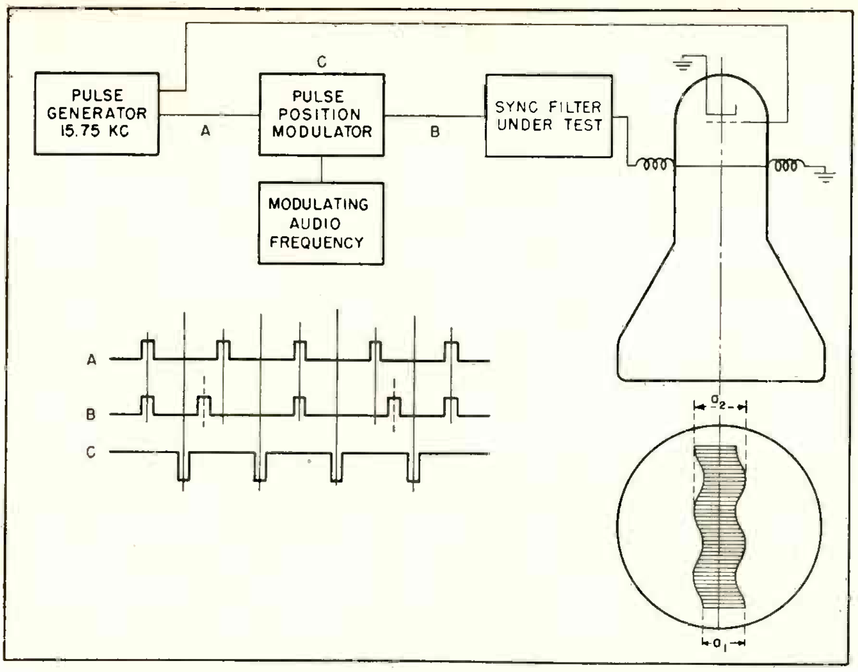


FIG. 9—Test equipment for sync filters using pulse position modulation

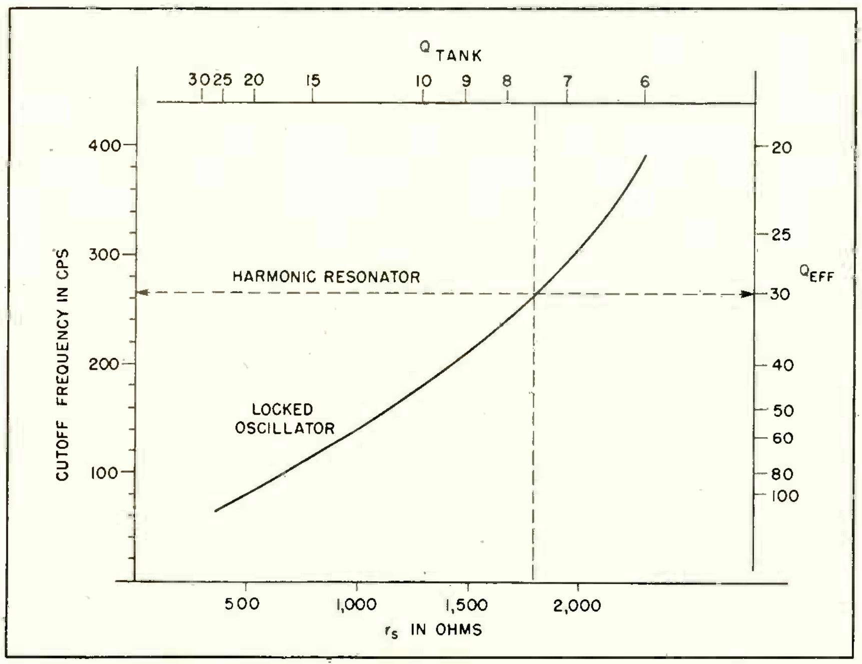


FIG. 10—Comparative measurements of oscillator and resonator performance

sistor r_s, while the actual Q cancels. The sync injection resistance r_s is thus confirmed as the appropriate circuit element for adjustment of the flywheel efficiency.

A formula for the phase stability is also given:

$$\Delta\alpha/\Delta\omega = T \qquad (7)$$

Unfortunately, the phase delay equals the actual time constant, and not the much smaller one of the tank circuit. Hence, the limitations discussed for high-Q resonators apply also for the locked oscillator, and even more so, since there are more local causes for frequency drift than in passive circuits.

To check the efficiency of this and other types of flywheel circuits a special test gear has been built. Shown in general outline in Fig. 9, it consists of a pulse generator which develops equally spaced pulses at line frequency, as shown at A. This output is fed into a pulse position modulator which turns out a signal shown at B. The rate of change of pulse position is controlled by a modulating audio signal generator.

These phase-modulated pulses are then passed through the synchronizing unit under test, be it a locked oscillator, resonator, afc circuit or the like. The filtered signal then goes to the standard sweep generator. A suitable unmodulated marker is also derived from the master pulse generator and fed to the kinescope grid. The resulting display on the screen shows an undulating vertical bar with strong horizontal excursions for low modulating frequencies, whereas for higher modulating frequencies the bar straightens out.

From this test an upper cut-off frequency β may be read for each type of filter, and from it there follows the figure of merit of the device:

$$\frac{Q}{T} = \frac{f_H}{2\pi\beta} = \frac{2{,}500}{\beta} \qquad (8)$$

where f_H is the line frequency, 15.75 kc. This has been done for both the resonator and the locked oscillator. Figure 10 shows the results of the test. The oscillator was tested with various values of sync-injection resistance r_s. The preceding tube supplied a pulse current of 1 ma at a duty cycle of 8 percent. Both systems are about equivalent for a Q_o of 10, but the oscillator takes the lead for lower values of r_s, and in inverse proportion to the injection resistance.

The developments described above were made possible under the leadership of D. E. Noble, director of research at Motorola Inc. The author is also indebted to Robert Adler for interesting discussions on the general theory of the locked oscillator, and to V. Graziano, who designed and built the test equipment.

References

(1) K. R. Wendt and G. L. Fredendall, Automatic Frequency and Phase Control of Synchronization in Television Receivers, *Proc. IRE*, p 7-15, Jan. 1943.
(2) H. E. Harris, A Simplified Negative Resistance Type Q-Multiplier, *IRE* Spring Convention, New York, 1948.
(3) FCC Standards of Good Engineering Practice for Television Broadcast Stations, Apr. 30, 1941, par. 16 and 17.
(4) K. Schlesinger, Cathode Follower Circuits, *Proc. IRE* p 843, Dec. 1945.
(5) Joseph M. Diamond, Circle Diagrams for Cathode Followers, *Proc. IRE*, p 416, March 1948.
(6) Robert Adler, A Study of Locking Phenomena in Oscillators, *Proc. IRE*, p 351, June 1946.

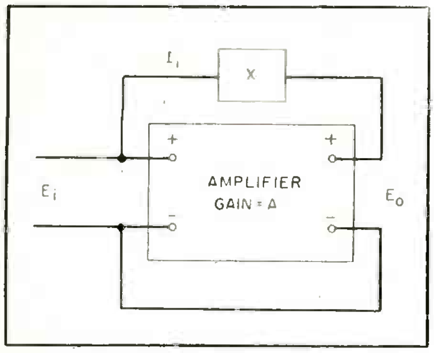


FIG. 1—Functional diagram of variable reactance

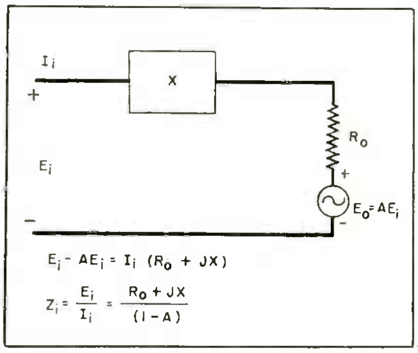


FIG. 2—Equivalent circuit of Fig. 1 for analysis

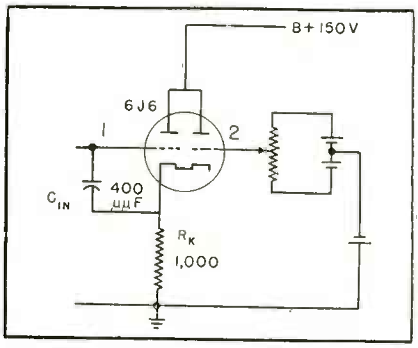


FIG. 3—Cathode-follower reactance-tube circuit

High-Q Variable Reactance

A cathode-coupled dual triode provides wide reactance variation, wide frequency deviation and higher Q when combined with a tuned circuit than a conventional reactance tube. Circuits of a frequency-modulated oscillator operating at one megacycle and an f-m audio-frequency oscillator are given

REACTANCE-TUBE circuits have found an increasingly large field of use in recent years with the advent of frequency modulation and automatic frequency control, and with the expansion in use of industrial electronic equipment and instrumentation. Unfortunately these circuits do not have a very high Q and the range of linear variation of reactance is limited. The basic principle of the variable reactance to be discussed has been described in the literature previously[1,2]. However, the practical methods used to obtain improved results are believed to be new.

The electronic reactance to be described has certain advantages over the conventional reactance tube. These advantages are a higher Q, coupled with a wide range of reactance variation, and simplicity. The circuit has been found quite useful in frequency-modulated oscillators operating both at audio and radio frequencies and in variable-frequency RC type filters. In addition to the variable-reactance circuits, two frequency-modulated oscillators are described, one operating at radio-frequency using the basic circuit and one operating at audio frequencies using the new circuit.

Principle

The basic circuit [1,2] consists of a feedback amplifier with a reactance connected in the feedback loop from output terminals to input terminals as shown in Fig. 1. The input impedance is a function of the feedback reactance and the gain and output impedance of the amplifier.

In the equivalent circuit of Fig. 2, it is assumed that the input impedance of the amplifier is very high. The amplifier is replaced by an equivalent generator having an open-circuit voltage AE_i and an output resistance R_o equal to the output impedance of the amplifier.

The current flowing into the input terminal is:

$$I_i = \frac{E_i - AE_i}{R_o + jX} = \frac{E_i(1 - A)}{R_o + jX} \quad (1)$$

where A is the open-circuit gain (gain with X equal to infinity) of the amplifier. The impedance presented at the input terminals is therefore

$$Z_i = \frac{E_i}{I_i} = \frac{R_o + jX}{(1 - A)} \quad (2)$$

This equation shows that the in-

By J. N. VAN SCOYOC

and J. L. MURPHY

Armour Research Foundation
Illinois Institute of Technology
Chicago, Illinois

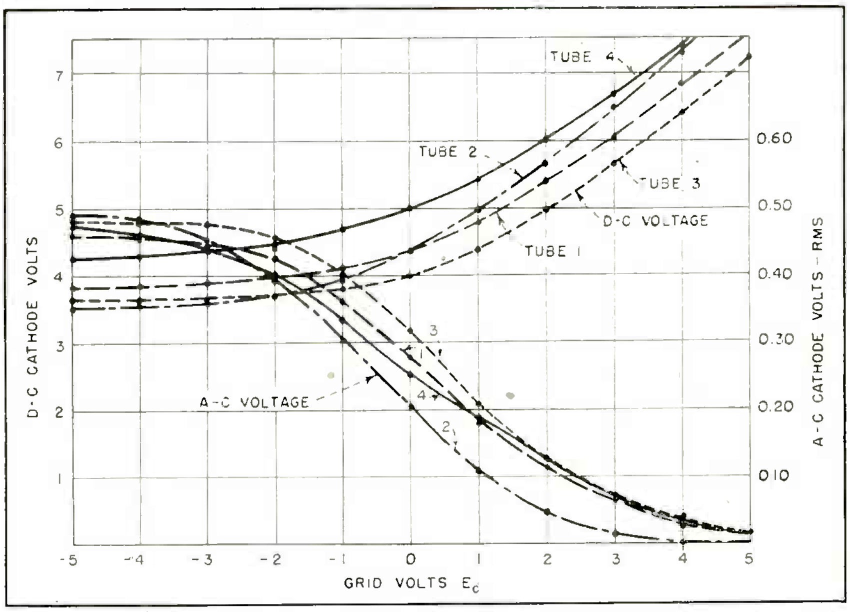


FIG. 5—Cathode voltages when a peak signal of one volt is applied to the grid of the input triode. The applied plate voltage is 150 volts and the cathode resistor is 1,000 ohms

put impedance is a function of the loop impedance including the output resistance, and the factor (1 −A) where A represents the gain of the amplifier without feedback.

Examination of Eq. 2 shows that for positive values of A (even number of stages or a cathode follower) the impedance Z_i has the same sign as $R_o + jX$ if the gain is less than unity, and the opposite sign if the gain is greater than unity. For negative values of A (odd number of conventional amplifier stages) the sign of Z_i is the same as that of $R_o + jX$ for values of A either greater or less than unity. A negative resistance can, of course, produce oscillation and this circuit is used in RC-tuned oscillators.

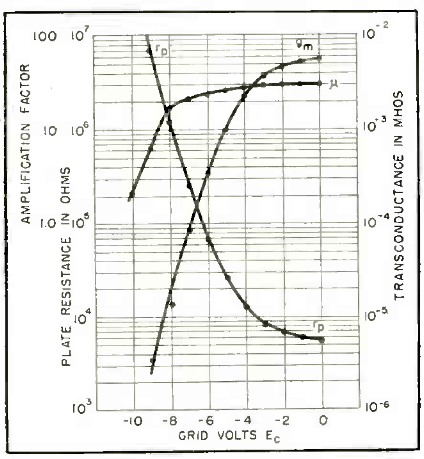


FIG. 4—Characteristics of a single section of a 6J6 tube vary considerably with change in grid voltage

The reversal of sign of the reactance results, in the case of an inductor, in a reactance that varies directly with frequency (as for a positive inductor) but one in which the current leads the voltage instead of lagging it. Similarly, for a capacitor, a reactance which varies inversely with frequency, as in the case of the positive capacitor, is obtained but the current lags the voltage.

The effective Q of the circuit, X/R_o is independent of A as may be seen from Eq. 2. However, if R_o is a function of amplifier gain, as in the case of a variable load resistance amplifier, the Q will vary with the gain. A high Q may be obtained by making the amplifier output impedance small in comparison to the feedback reactance.

To obtain a variable reactance as a function of a control signal, this control signal may be used to change the gain of the amplifier in some way. For static use, a potentiometer gain control could be used, or some other means such as changing tube transconductance could be used to vary the gain of a stage or several stages of the amplifier.

The load resistance of one or more stages may be used to control the gain. The load-resistance and transconductance variation could be accomplished either statically or dynamically. A combination of load variation and amplifier-transconductance variation is used in the cathode-follower circuit described here.

Dual-Triode Cathode Follower

Figure 3 shows the schematic diagram of a dual-triode variable reactance circuit; one section of the tube functions as a cathode-follower amplifier, and the other as a cathode follower used as a variable load resistance for the first. The only circuit elements required in addition to the tube are a cathode resistor, a feedback reactor and the necessary grid returns.

Triode 1 with the feedback loop consisting of C is the cathode-follower amplifier which will be called the input section. Triode 2 is the variable or control tube used to vary the gain of triode 1. The cathode-to-ground impedance of triode 2 functions as a variable load resistance for triode 1, and this resistance is controllable by the voltage applied to the grid of triode 2. This variable load resistance appears in parallel with the common cathode resistor used to carry the plate current and provide bias for the two sections.

Due to the direct coupling between the two sections, an increase in the control-section grid voltage produces a decrease in the input-section bias, thus changing the transconductance of triode 1 simultaneously with the load change. The resulting change in the input-section transconductance augments the gain variation due to the change of load resistance.

The parameters of one section of a 6J6 tube are shown in Fig. 4 as a function of grid voltage. The curves were measured on a standard vacuum-tube bridge. As may be seen, the transconductance and plate resistance vary widely over the useful range of grid voltage. These characteristics, which resemble those of a remote-cutoff pentode, make the 6J6 a good choice for this circuit. The transconductance and plate resistance of other tubes such as the 6SN7 remain relatively constant over most of the useful range of grid voltage, and change more rapidly in the cutoff region.

Method of Analysis

Since complete analysis of the circuit would require a complicated study of the variation of the tube parameters with the voltage applied to the control section, a complete analytical solution has not been attempted. Instead, the gain and cathode voltage were measured as a function of control-section grid voltage. Both the d-c cathode voltage and the a-c cathode voltage due to a signal of 1.0 volt peak applied to the input section grid were measured on four sample tubes and the results are shown in Fig. 5.

As the control section grid becomes more positive relative to ground, the negative bias on that section is reduced. Simultaneously, the negative bias on the input section is increased. The control section output resistance, which is roughly equal to $1/G_m$, is reduced since the transconductance is increased. The increase in negative bias on the input section reduces the transconductance of that section, and consequently reduces the gain. Thus the gain is reduced by two means.

At negative values of control-section voltage, that section presents a high resistance as a load to the input section, increasing the gain. This gain is also increased as a result of maximum transconductance of the input section at small values of negative bias. This effect

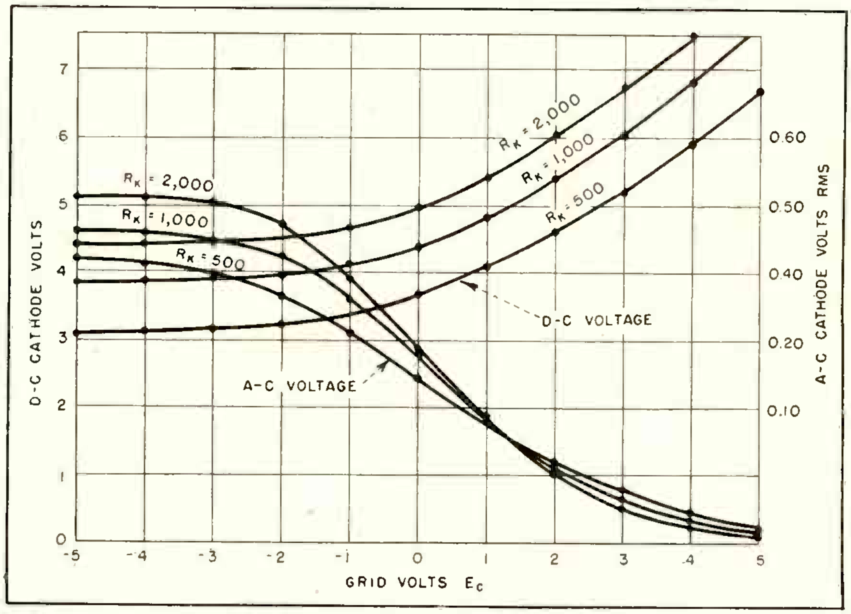


FIG. 7—Increasing the values of cathode resistor provides higher gain

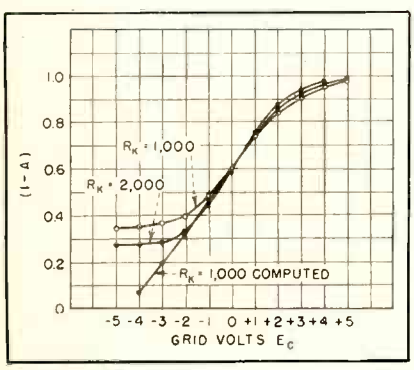


FIG. 6—Values of (1—*A*) for dual triode

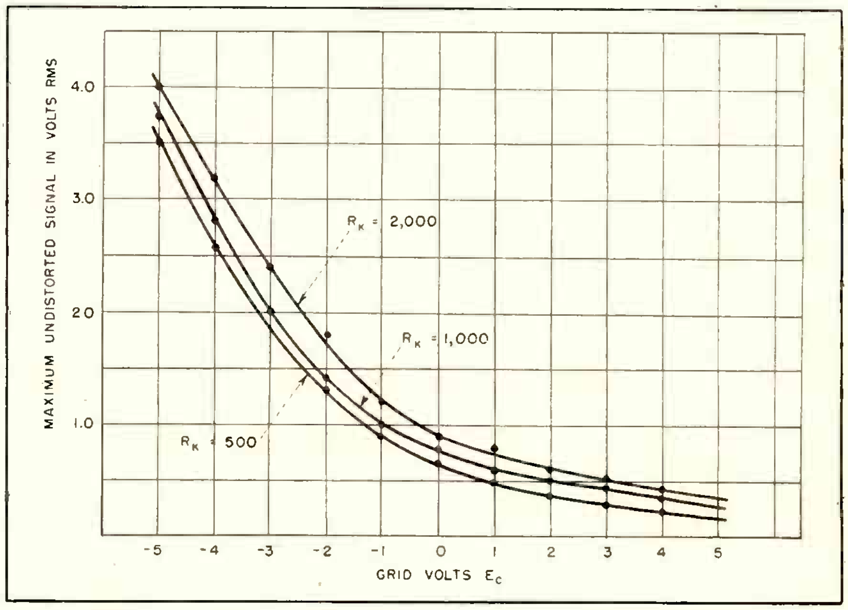


FIG. 8—Distortion level for the three values of cathode resistors

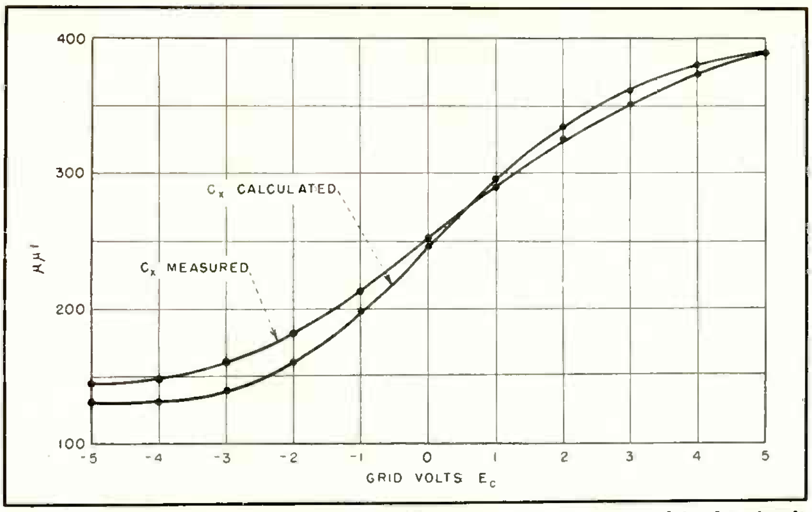


FIG. 9—Input capacitance of tube 1 at 1,000 cycles when connected in the circuit of Fig. 3

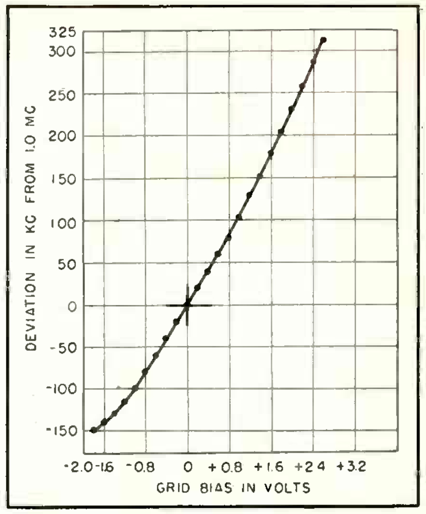


FIG. 11—Frequency deviation of the one-megacycle oscillator

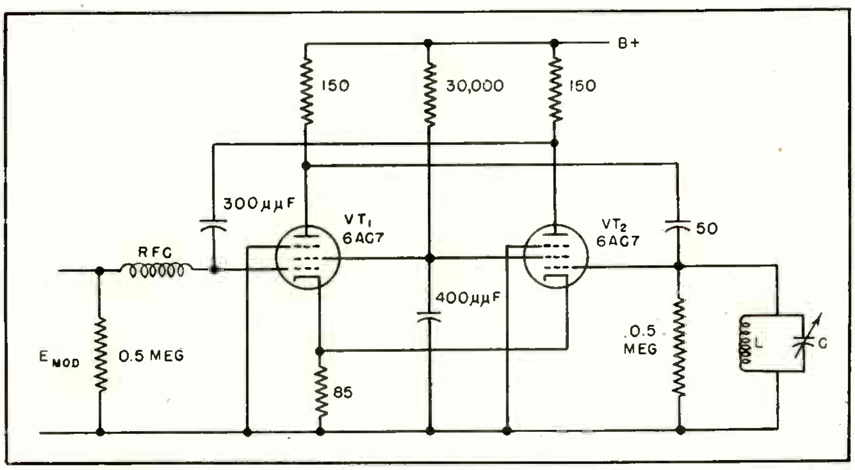


FIG. 10—One-megacycle f-m oscillator using a two-stage amplifier as a variable reactance

is shown by the family of curves of the a-c voltage at the cathode. The four tubes varied rather widely in their static and dynamic characteristics. These families of curves were taken with a common cathode-resistance of 1,000 ohms.

The factor $(1 - A)$ as a function of grid voltage applied to the control tube is shown in Fig. 6. The two S-shaped curves were measured with two values of cathode resistance, while the third curve was computed from measured tube parameters. The calculated curve was obtained by calculating the gain for each value using the correct tube constants as obtained from Fig. 4. These curves show a total variation of the factor of the order of three to one. The curves show good agreement except near the end, where the control tube grid is cut off.

Figure 7 shows curves of d-c and a-c cathode voltage for 500, 1,000 and 2,000-ohm cathode resistors. Otherwise, the conditions were the same as those of the previous curves. The higher values of cathode resistance gave higher figures of gain since the effect of the fixed resistor was reduced.

Linearity

Figure 8 shows the maximum signal which can be applied to the amplifier grid (triode 1) without producing perceptible distortion of the cathode voltage waveform. At extremely high values of positive voltage on the control section, the allowable input voltage is small. This is because the input section is operating near cutoff with a small effective load resistance, and the tube parameters vary throughout a cycle of applied voltage.

No trouble is experienced with negative voltages on the control section, since the effective load resistance is nearly equal to the resistance used in the cathodes. In applications of this circuit, several volts have been applied to the input grid without observing any ill effects due to the harmonic currents drawn. This is, of course, primarily a function of the circuit to which the reactance is connected and its impedance at the frequency of the harmonics.

To verify the theory, values of capacitance were calculated and measured for the circuit of Fig. 3. The measurements were made on a standard capacitance bridge at a frequency of one kilocycle. The capacitance was calculated by using some of the data previously shown of cathode voltage as a function of control voltage. When this was known, the parameters of each section were determined from the curve. These values were then substituted into the equation for input capacitance. There was a fair agreement between the calculated and measured values, as shown in Fig. 9.

The deviation between the calculated and measured values was greatest at the two extremes of grid voltage where the plate resistance and transconductance vary most rapidly. An input capacitance was obtained that was linear over ± 10 percent for a change of control-section grid voltage of ± 0.5 volt. A total variation of 3 to 1 was obtained. The Q was measured with a Q meter and was found to vary from 30 to 50 in the frequency range of 50 to 75 kilocycles.

R-F Oscillator

Figure 10 shows a radio-frequency frequency-modulated oscillator using a two-stage amplifier as a variable reactance. This circuit operates at a carrier frequency of one megacycle. Amplifier gain, and hence, amplifier input reactance, is controlled by changing the transconductance of VT_1 by impressing the modulating voltage on the grid of this tube. A 50-$\mu\mu$f capacitor is used for the feedback reactance.

The plate load and common cathode resistor values are proportioned to produce a gain of approximately unity with no modulating voltage. From Eq. 2 it may be seen that the reactance is infinite for no modulation, a negative capacitive reactance for positive swings of modulating voltage (gain greater than unity), and a positive capacitive reactance for negative swings of modulating voltage (gain less than unity).

The frequency deviation from one megacycle as shown in Fig. 11 was linear to approximately 80 kc on either side of the center frequency, while the maximum frequency was 1,310 kc and the minimum 850 kc. Thus a frequency range of 1.54 to 1 was obtained. The linear variation was obtained with a grid-voltage variation of ±0.8 volt, and the total variation was obtained by varying the voltage applied to the grid from −1.8 to +2.6.

Audio F-M Oscillator

Figure 12 shows the application of the circuit of Fig. 3 to an audio-frequency f-m oscillator. This circuit has been used to produce linear

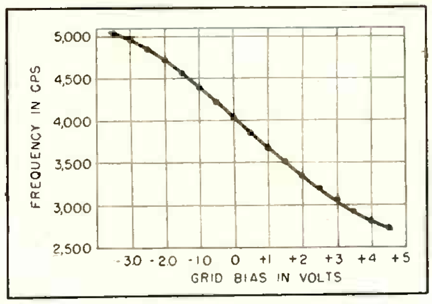


FIG. 14—Frequency deviation of the audio oscillator is linear for about 10 percent each side of the center frequency

frequency deviations of ±17 percent when operated at center frequencies varying from 3 to 7 kilocycles.

The circuit is illustrated functionally in Fig. 13 and consists of three low-gain amplifier stages connected in a ring and separated by phase-shifting networks. Three tubes were used instead of a single tube as in the usual phase-shift oscillator in order to operate all reactances at an equal voltage level. The carrier voltage at the grids of the reactances was approximately two volts.

The frequency variation of one of these oscillators is shown as a function of grid voltage in Fig. 14. The output frequency was linear over a region of ±10 percent of the center frequency which was four kilocycles in this particular case. The total variation obtained was approximately 2,320 cycles. The deviation from linearity was only 0.5 percent at extremes of ±17 percent of the center frequency, and tests with square-wave modulating signals showed the transient response to be good.

Other applications of the dual-triode reactance circuit include remote tuning (1.6 to 1 range), tuning of RC frequency-selective circuits and filters, production of phase modulation and for self-balancing bridges.

Acknowledgement is gratefully made to E. H. Schulz for suggestions during the course of the work and assistance in preparation of this paper.

REFERENCES

(1) H. J. Reich, The Use of Vacuum Tubes as Variable Impedance Elements, *Proc. IRE*, 30, p 288, June 1942.

(2) H. J. Reich, "Theory and Application of Electron Tubes," McGraw-Hill Book Company, Inc., New York. 1944, p 214.

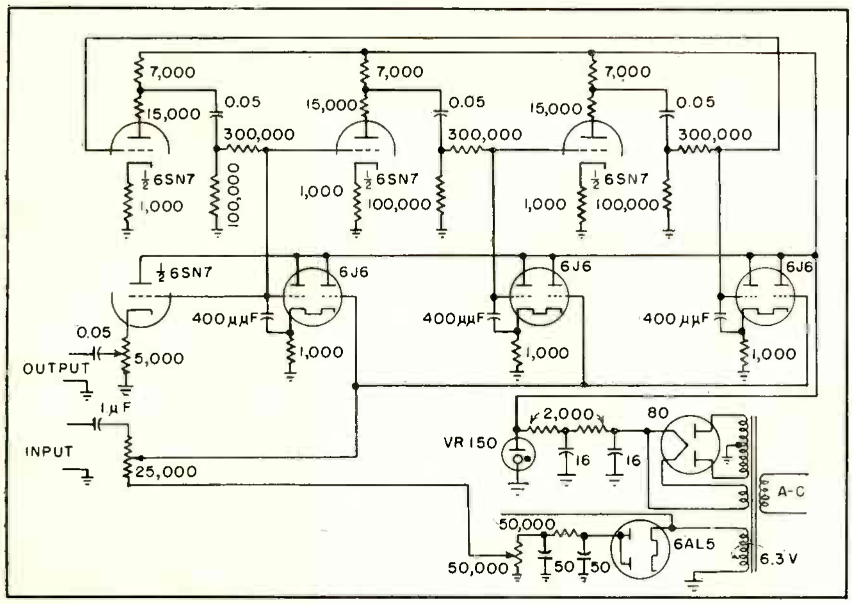


FIG. 12—Circuit of frequency-modulated audio oscillator

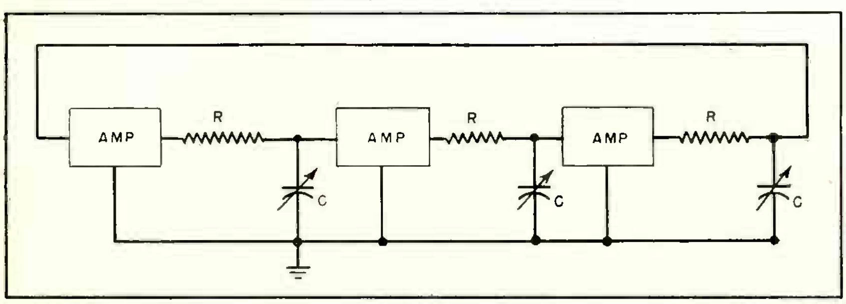


FIG. 13—Block diagram of f-m audio oscillator

NEW GRIP PIN TYPE CONTACT NOW IN

NOVAL LAMINATED SOCKETS

PATENT PENDING

Saddle type, molded with .093 mtg. hole, 1-1/8" mtg. center
53F 12617 — Mica
53F 12641 — Black
53F 13505 — Ceramic

Attached base with .093 mtg. hole, 1-1/8" mtg. center, molded button top casting
53F 12625 — Mica
53F 12826 — Black
53F 13503 — Ceramic

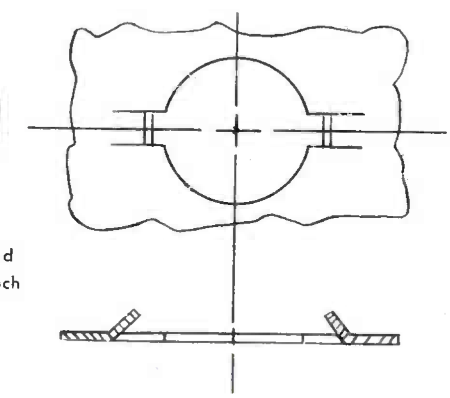
16G 12626 — Shield, 1-1/2"
16G 12627 — Shield, 1-15/16"
16G 12628 — Shield, 2-3/8"

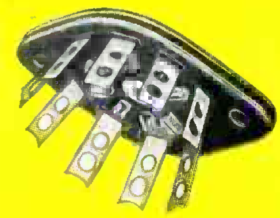
Only in Cinch is the Noval line so complete; Molded and laminated sockets. Pictured on this page are the various types now available. And only in Cinch will the user get that long sought locking type contact, grip pin, that provides high extraction pull out . . . supplying maximum tube retentivity.

Write for samples and further details.

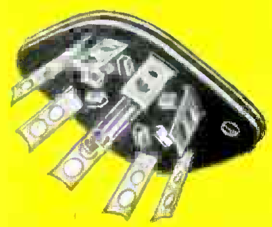
NOVAL SOCKETS
ARE NOW AVAILABLE IN CHASSIS CLINCH TYPE

Miniature Molded Noval chassis clinch No. 53G 13301

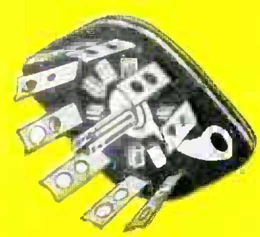




Laminated Noval (plain) with grip pin type contact, 1-1/8" mtg. center
No. 56E 13481



Laminated Noval (with center shield)
No. 56E 13383



Laminated Noval (with center shield and grounding strap)
No. 56E 13483

CINCH MANUFACTURING CORPORATION
2335 W. VAN BUREN ST. CHICAGO 12, ILLINOIS
Subsidiary of United-Carr Fastener Corporation
Cambridge 42, Massachusetts

AVAILABLE AT LEADING ELECTRONIC JOBBERS . . . . . . *everywhere*

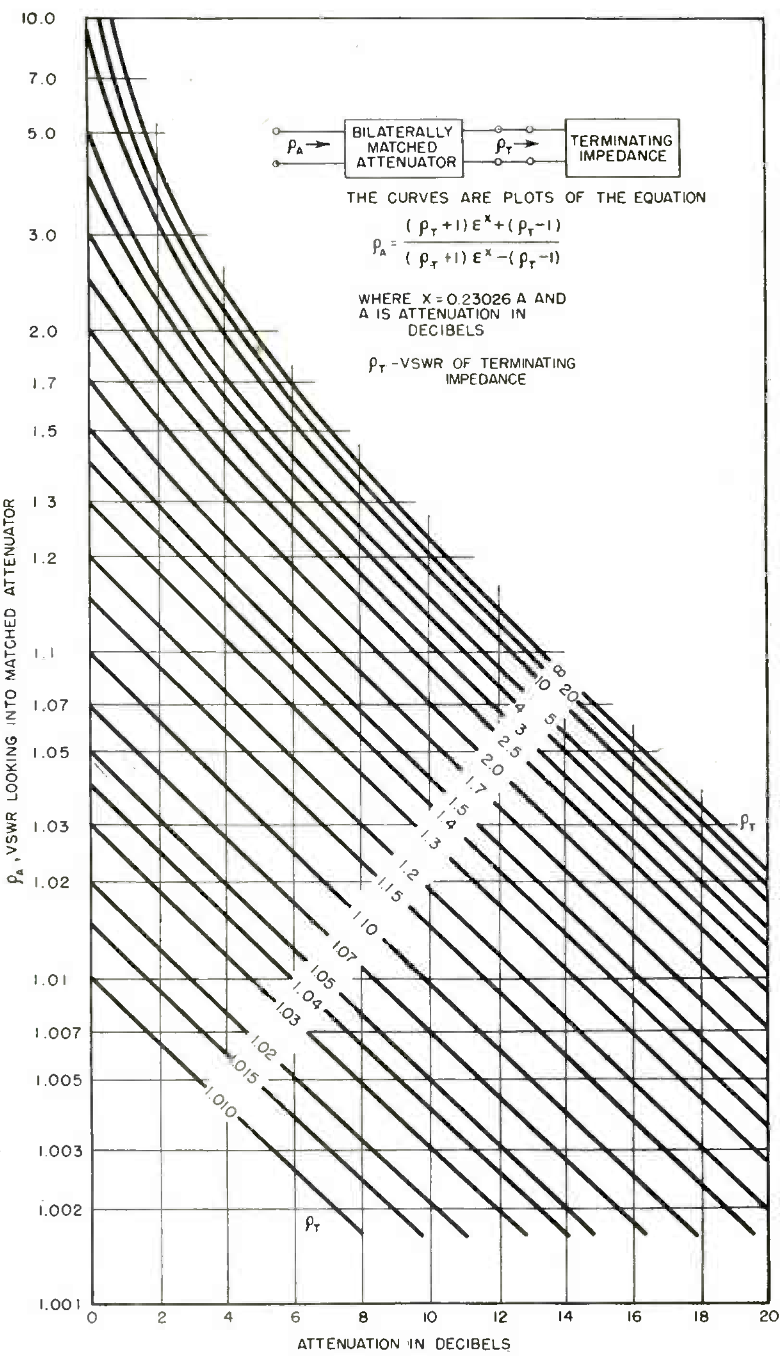
CINCH SOCKETS ARE STANDARD

Reducing Standing Waves

Bilaterally matched attenuator, interposed between load and generator, reduces vsw ratio seen by generator. Chart shows what attenuation gives the required reduction

By R. E. GRANTHAM

Microwave Standards Section, National Bureau of Standards Central Radio Propagation Laboratory, Washington, D. C.



ATTENUATORS are often used in circuits to isolate changes of impedance from impedance-sensitive devices such as klystron oscillators. Also, attenuators are occasionally used in transmission lines to reduce the voltage standing-wave ratio.

For application at ultrahigh frequencies and above, the accompanying graph provides a convenient means of calculating isolation effected by a given amount of attenuation. A condition for the application of the graph is that the attenuator must be bilaterally matched. That is, the vswr must be 1.00 looking into either pair of attenuator terminals if the opposite pair is connected to an impedance having a vswr of 1.00. The attenuator, then, might be one of the bilaterally matched metallized-glass units which are commercially available in both waveguide and coaxial transmission-line types or a suitable length of lossy coaxial transmission line such as the Army-Navy type RG-21/U.

The accompanying graph presents a plot of the vswr looking into a bilaterally matched attenuator ρ_A as a function of both the vswr of the attenuator terminating impedance ρ_T and the attenuation A, expressed in decibels, of the attenuator.

Assume it is necessary to buffer an oscillator from its load impedance so that frequency changes due to changes in the load impedance are minimized. Assume also that the maximum vswr variation to be tolerated by the oscillator is from 1.00 to 1.16 and that the load vswr variation is from 1.00 to 10.0. Entering the graph with ρ_T = 10.0 and ρ_A = 1.16, it is found that 10.5 decibels of attenuation is required.

FP FOR TV

TELEVISION DEMANDS *PERFECTION*

There can be no compromise with quality — in television. New standards are essential for long life, dependability and trouble-free operation.

Mallory FP Capacitors are accustomed to severe service—have been operating at 85° C. for years. Even though this extreme temperature may not be apparent in your particular model, it's good to know that Mallory gives you an extra margin of safety.

The fact that no human hand* touches any vital part during processing and assembly shows the extreme care taken to insure the long life so characteristic of this remarkable Mallory product.

**The chlorides present in perspiration cause destructive corrosion and shorten the capacitor's life in the field.*

FP is the type designation of the Mallory developed electrolytic capacitor having the characteristic design pictured. Adopted as standard by RMA, it is famous for dependable performance.

P. R. MALLORY & CO., Inc.

MALLORY

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

SERVING INDUSTRY WITH

Capacitors
Contacts
Controls
Rectifiers
Switches
Vibrators
Power Supplies
Resistance Welding Materials

TUBES AT WORK

Including INDUSTRIAL CONTROL

Edited by VIN ZELUFF

New Instruments for Textile Measurements 126
Power from Photocells 148
Microwaves for Railroad Control 150
Television Crosshatch Generator 154
Electronic Control for Milk Pasteurization 158
Wire Recorder Techniques 160

New Instruments for Textile Measurements

A DEFINITE trend toward utilization of electronic circuits for obtaining increased accuracy in measuring fiber and yarn diameter, moisture content, tensile strength, and modulus of elasticity was apparent in the commercial exhibits at the annual meeting of Textile Research Institute, held in New York City Nov. 18 and 19. Well over half the booths contained at least one electronic unit.

Pulse Propagation Meter

The velocity of propagation of compressional sound waves in fibers and other materials is measured nondestructively with a new pulse propagation meter developed by The Magnetic Amplifier Corp. of Waltham, Mass. The square of the velocity multiplied by the known density of the material gives the instantaneous modulus of elasticity, an important characteristic of textile fibers, fabrics, plastics, rubber, leather, paper, metals, rock, ceramics, crystals, concrete and many other materials. A single reading of the instrument gives the desired result (Young's modulus), whereas previous techniques for engineering materials required measurement of the slope of a stress-strain curve.

Other applications include detection of internal stresses in cakes of soap molded under pressure; here, monitoring of the elastic modulus of the output of the molding machine provides instantaneous product quality control by revealing misadjustments that cause internal stresses and minute ruptures. Aging, stiffening and crazing of plastics and plastic-coated or impregnated fabric used in airplane control surface coverings are also revealed.

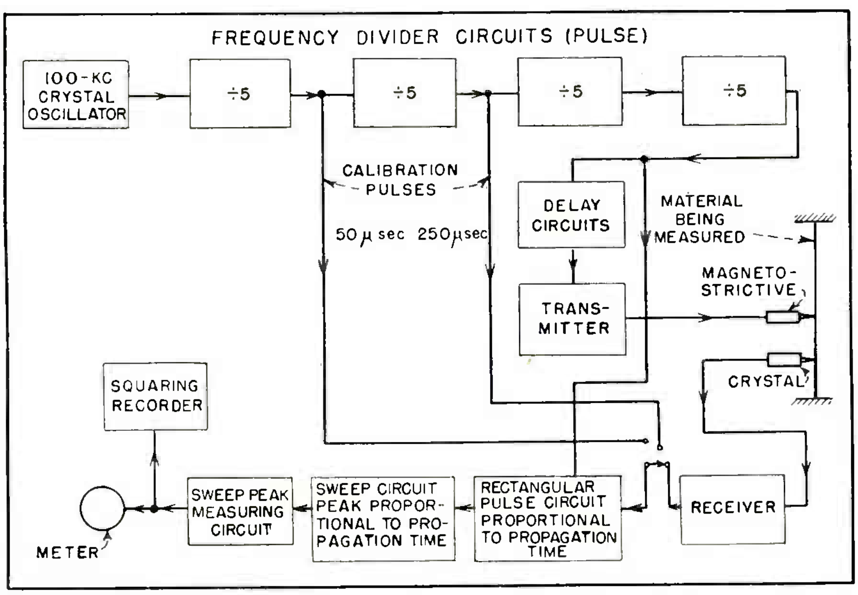


FIG. 1—Block diagram of pulse propagation meter for quality control of a variety of materials ranging from textiles to metals, plastics, concrete and even soap

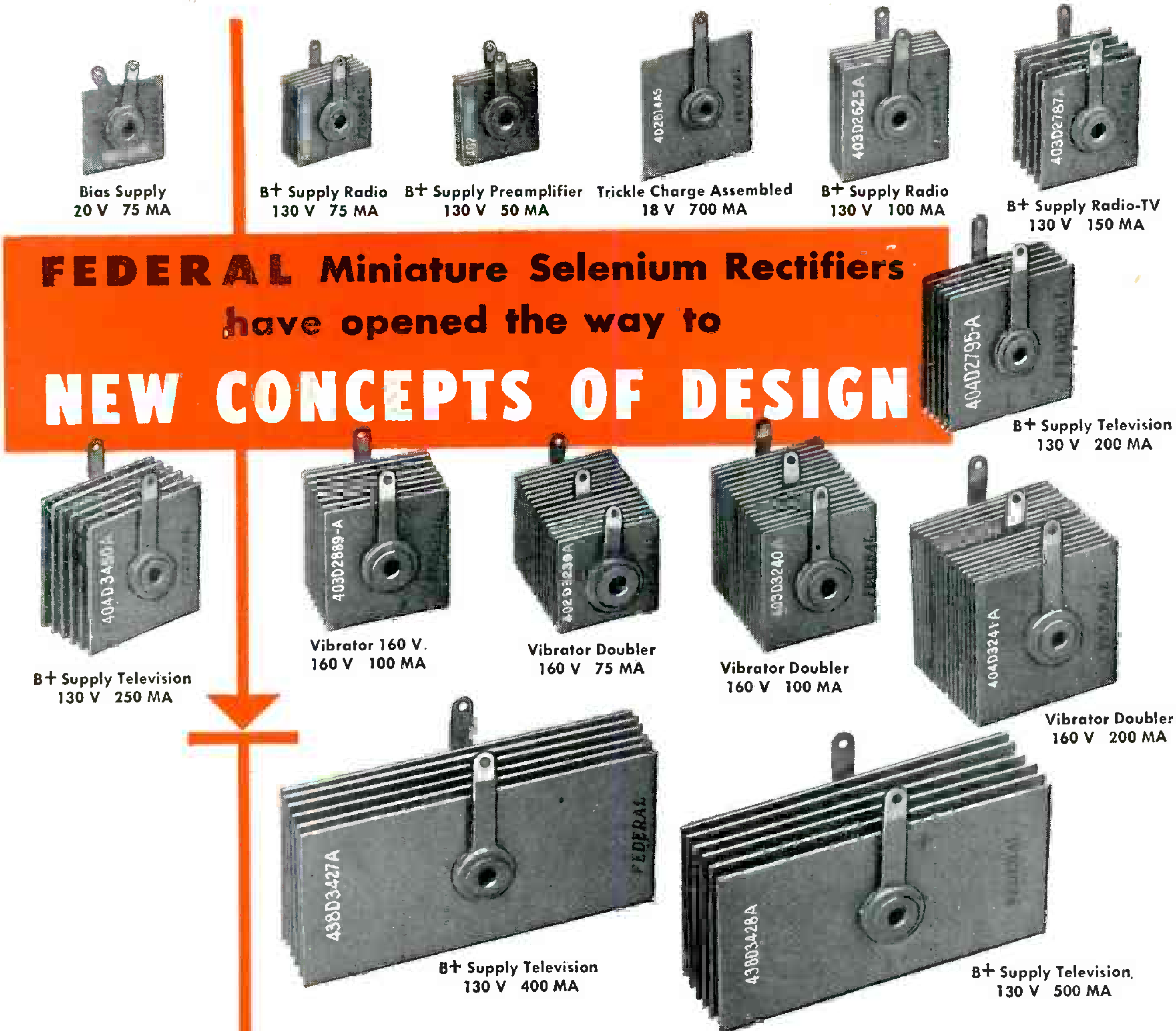
The instrument uses a magnetostrictive transmitting transducer and crystal receiving transducer mounted from ½ to 20 inches apart with their active edges resting on the material under test. An electronically generated pulse applied to the magnetostrictive transducer sends a short acoustic pulse through the material to the crystal pickup. The time of travel between the two points is measured electronically and indicated on a meter reading in microseconds. Since distance is known, velocity is readily determined from the time reading.

A block diagram of the complete equipment appears in Fig. 1. The associated recorder responds to the square of time, and hence provides a continuous record of the reciprocal of the modulus of elasticity as required for showing variations in the modulus during desired programs of loading, aging, humidity and temperature variations.

Referring to the block diagram, a 100-kc crystal oscillator is used as a source of calibration signals and to develop the transmitted pulses. This oscillator synchronizes a pulse generator that generates pulses having 0.5-μsec duration, 10 μsec apart. Four scale-of-five dividers spread the pulses to 50, 250, 1,250 and 6,250 μsec apart respectively, with the last group being used to trigger the power pulse of the transmitter after an adjustable small delay. The receiving crystal feeds a receiver-amplifier having automatic gain control to insure maximum precision of measurement.

The first computer stage has two stable equilibrium states. The output pulse of the divider strip places this stage in its first equilibrium condition, and the first received pulse reverses this state. All subsequent received energy due to reflections is ignored, and the second state is maintained until reversed by the next outgoing pulse. This stage thus generates a negative rectangular pulse whose duration is equal to the time of propagation plus initial intentional delay that is later calibrated out. The delay insures that all circuits act linearly even for propagation times as short as one microsecond.

The rectangular pulse allows a



The Federal Miniature Selenium Rectifier has firmly established its position as a versatile new source of DC power in electrical and electronic design.

From a "Federal First" in 1946—when the nation's leading radio set manufacturers were quick to adopt it as a rectifier tube replacement—the field of application of Federal's Miniature Selenium Rectifier has expanded to a point where radio rectifier tube replacement is but one of an almost limitless variety of uses.

Today there are millions of Federal "Miniatures" in use not only in radio sets but in television, electric shavers, electronic musical instruments, intercommunication systems, mobile radio and many special applications.

Now Federal offers a line of 18 different "Miniatures"—and still more are in development. It is our policy to work directly with you in specifying the right Federal Miniature Selenium Rectifier to meet your requirements. If there's not a Federal "Miniature" to handle your particular job, there can be. For information, write to Department F-413

FTR
An IT&T Associate

KEEPING FEDERAL YEARS AHEAD... is IT&T's world-wide research and engineering organization, of which the Federal Telecommunication Laboratories, Nutley, N. J., is a unit.

Federal Telephone and Radio Corporation

SELENIUM and INTELIN DIVISION, 900 Passaic Ave., East Newark, New Jersey

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

THE FRONT COVER

A TYPICAL setup of the Navy's teaching-by-television studio (described in Nov. 1948 ELECTRONICS, p 134) is the colorful subject of this month's cover. Referring to the black-and-white reproduction below, instructor John Leonard, Lt., USNR, is lecturing about the cutaway 4,000-lb J-31 jet engine behind him, used in the Ryan Fireball jet fighter. Other instructional props in the background include a futuristic red plastic rocket model, a relief map of Long Island terrain, and a tactical board for setting up problems involving aircraft and ships.

The two cameras on the floor, the four-unit monitoring panel and the control panel are General Electric units, while the two portable television line monitors at the right are DuMont units.

The picture going out of the studio at the moment is on the lefthand monitor, showing a full-face view of the instructor as picked up by the lefthand camera. The next monitor has a monoscope pattern, but more often is connected to show the output of a GE film camera located under the control room. This camera is arranged for three-way operation from a 16-mm sound film projector and two 35-mm slide-strip film projectors.

The third monitor shows the output of the lefthand camera and hence has the same picture as the first. The fourth monitor serves the other camera, here aimed at the jet motor in readiness for the next scene. Squatting on the floor is assistant producer Nat Marshall, who along with camera and mike boom operators receives instructions over headphones from director Peter L. Barker at left foreground. The audio engineer at the control panel rides gain on the sound portion of the program just as in broadcast studios.

Early in January, weekly schedules of lectures will be telecast four miles over a Philco 6,000-mc microwave link (described on p 80 of this issue) to television receivers at the Merchant Marine Academy, Kings Point, N. Y., under conditions permitting comparison of television and conventional teaching techniques. Western Union engineers are supervising the installation of the microwave equipment and the 125 and 140-ft towers which will be used. Some of the Navy's most successful classroom instructors are being specially trained for most efficient utilization of television as a teaching medium.

linear sweep circuit to charge a capacitor to a peak potential exactly proportional to pulse duration. A peak rectifier and meter are used to measure the resulting direct current that is proportional to propagation time. Calibration pulses are taken from the divider strip at 50 and 250 μsec after the transmitted pulse, to serve for midscale calibration of the 0–100 and 0–500 μsec scales of the meter.

Moisture Meters

Moisture content of yarn moving through a slasher is sensed by the two large circular electrodes in Fig. 2 and is indicated directly in percentage by the associated Fielden Drimeter to an accuracy within 1 percent. The instrument works equally well on finished textiles coming out of a dryer, and readings are not affected by salts, dyes, size or other finishing materials used on the cloth.

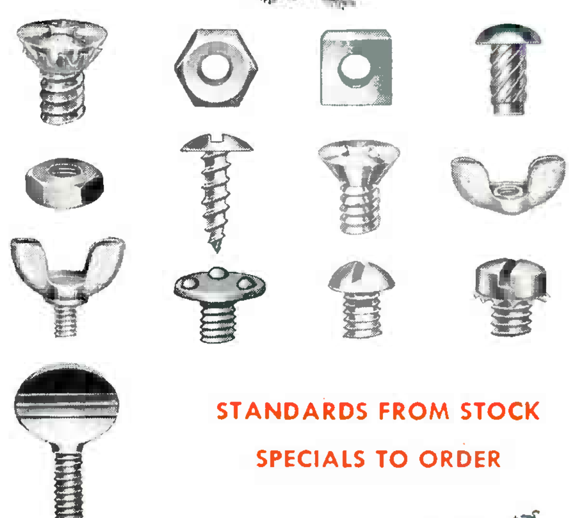
FIG. 2—Electrodes of electronic moisture designed for continuous-duty mounting directly on machines in mills. Installation here is on a slasher. Cables go to the electronic hygrometer unit that indicates percentage moisture directly on a meter as material runs between electrodes

As installed by Fielden Electronics, Inc., Huntington, Long Island, the operation of the Drimeter depends on detection of minute changes in the capacitance of a two-plate condenser through which the material moves. The greater the amount of moisture, the higher is the capacitance. A special drift-free bridge circuit and amplifier convert capacitance changes into current changes with sufficient reliability to permit using standard precalibrated scales on the meter. Scales are available for cotton, wool, viscose, jute and linen.

An automatic control unit is also available for coupling the moisture meter to the speed-changing mechanism of the textile drying machine. Two variables are fed into the auto-

(continued on p 144)

From tiny earring screws that secure milady's jewels, ranging up to heat and torque resistant aircraft fasteners, Central is a leading producer. "Centralize" your fastening purchases at this 2-plant source. Take advantage of Central's *hi-speed* service and scientific "Fasteneering" which simplifies designs for attractive savings along your production lines.



Fast DELIVERIES...

FROM CENTRAL'S 2 BIG PLANTS

STANDARDS FROM STOCK

SPECIALS TO ORDER

A TWO-PLANT ORGANIZATION FOR QUICK NATION-WIDE SERVICE

"You Can Depend on Central"

CENTRAL SCREW COMPANY

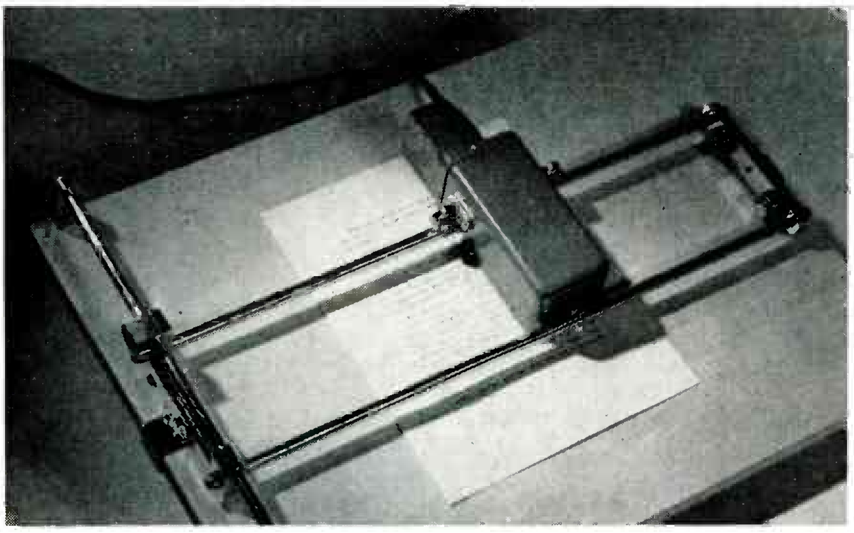
3501 SHIELDS AVE., CHICAGO 9, ILL. • 149 EMERALD STREET, KEENE, N. H.

THE ELECTRON ART

Edited by FRANK H. ROCKETT

Reading Aid for the Blind Pronounces Printed Letters 130
Two Logarithmic Circuits 130
Traveling Wave Amplifier Tube Demonstrated 132
Transistor Characteristics 132
F-M and P-M Demodulator 165
Fractional Frequency Division by Feedback 171
Survey of New Techniques 173

Reading Aid for the Blind Pronounces Printed Letters



Photoelectric reading head analyzes letters into characteristic pulse patterns

A LABORATORY MODEL of an improved electronic reader for the blind was described by L. E. Flory and W. S. Pike of RCA Laboratories before the October meeting of the New York Electrical Society. The device converts printed letters into their individual spoken names as the scanning head, shown in the accompanying picture, moves over the printed page.

Somewhat like earlier models (ELECTRONICS, p 84, Aug. 1946), the reader has a scanning head in which a miniature phototube receives the light reflected from the page. However, in this latest development, as the user moves the scanning head horizontally along a line of type, a miniature cathode-ray tube explores each letter. As the letters interrupt the reflected light to a phototube in their characteristic patterns, impulses are sent synchronously to a selector unit. These impulses are analyzed by the equipment which then selects a disc carrying a magnetic recording of that letter. The disc spins once past its pickup to speak the letter.

Much experimentation will be necessary to determine the applicability of this device, which is suitable for use in institutions rather than in the home. It is being developed as a continuation under the Veterans Administration of work originally begun at the suggestion of Dr. Vannevar Bush through OSRD's committee on sensory devices. In addition to use as a reading device, the principle can be extended to translation of coded patterns such as teletype signals.

Two Logarithmic Circuits

AN AMPLIFIER with logarithmic amplitude response and a meter with logarithmic frequency response form the essential elements in an automatic curve tracer for examining the responses of audio facilities for broadcasting. The complete equipment is described by G. L. Hamburger in the *Journal of the British Institution of Radio Engrs.*, p 154, July-Aug., 1948.

Logarithmic Amplitude Converter

For indicating the amplitude of the response on a logarithmic (linear decibel) scale, the signal is passed through the novel circuit of Fig. 1A, which is derived from an amplifier in which the load impedance for the amplifier tube is another tube. The logarithmic element of this circuit is a variable-mu pentode, a typical characteristic of which is shown in Fig. 1B. This characteristic shows that, if the plate current is proportional to the incoming signal, the grid voltage is its logarithm. To use this characteristic raises the problem of operating the tube so that the output appears, in this case, as the voltage on the control grid.

An analysis of the circuit in the absence of the current biasing resistor shows how it operates. The screen of the amplifier tube and the control grid of the variable-mu pentode are stabilized at a fixed potential; this is the unorthodox aspect of the circuit. The plate of the constant-mu tube and the cathode of the variable-mu tube are thus left floating. The incoming signal directly controls the current through the constant-mu tube thus changing the cathode potential of the variable-mu tube (the change in potential at the plate of the constant-mu tube has no effect). In this way the grid-cathode potential of the variable-mu tube adjusts itself to the operating point at which it passes the same current as the other tube.

This action would suffice for producing an output proportional to the logarithm of the input were it not that the useful logarithmic range of the variable-mu tube lies in the microampere region whereas, for the same currents, a constant-mu pentode is nonlinear, having the characteristic shown in Fig. 1C. The current biasing resistor is therefore added to move the operation of the constant-mu pentode into its linear region.

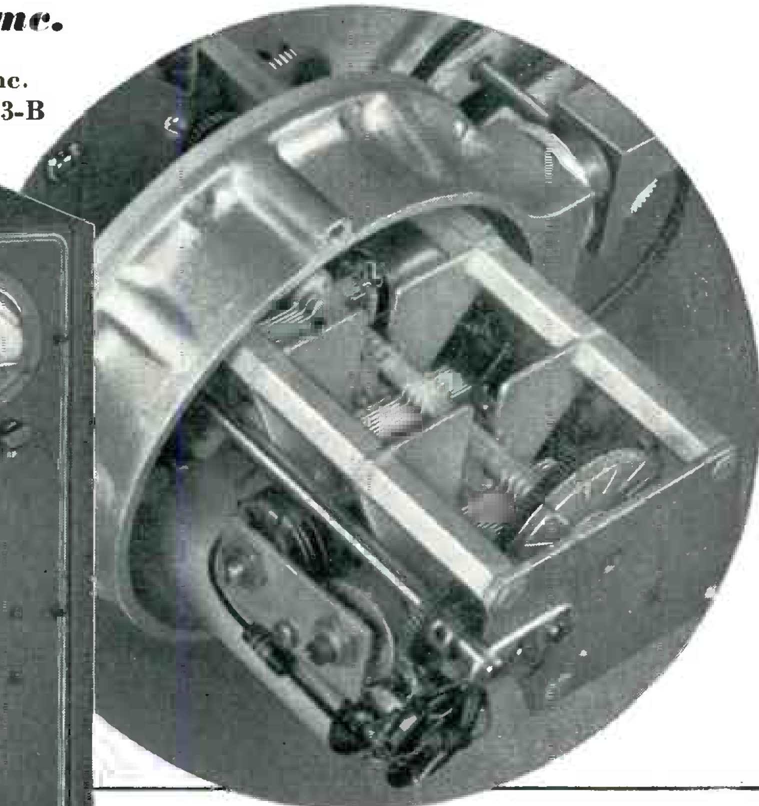
Logarithmic Frequency Meter

The basic circuit of a linear frequency meter of Fig. 2 (F. V. Hunt

FM SIGNAL GENERATOR

Type 202-B 54-216 mc.

Additional coverage from 0.4—25 mc. with accessory UNIVERTER Type 203-B



Shown above is an interior view of the 202-B Signal Generator RF assembly with shield cover removed. Heavy aluminum castings form the mounting base of this RF unit resulting in a compact and highly rigid structure. Girder type condenser frame construction, multiple rotor shaft grounding contacts, and welded interstage shield plates are but a few of the many design features of this unit which give added circuit stability.

Designed to meet the exacting requirements set forth by leading FM and television engineers throughout the country, the 202-B FM Signal Generator has found widespread acceptance as the essential laboratory instrument for receiver development and research work.

Frequency coverage from 54 to 216 megacycles is provided in two ranges, 54 to 108 megacycles and 108 to 216 megacycles. A front panel modulation meter having two deviation scales, 0-80 kilocycles and 0-240 kilocycles, permits accurate modulation settings to be made.

Although fundamentally an FM instrument, amplitude modulation from zero to 50%, with meter calibrations at 30% and 50%, has been incorporated. This AM feature offers increased versatility and provides a means by which simultaneous frequency and amplitude modulation may be obtained through the use of an external audio oscillator.

The internal AF oscillator has eight modulation frequencies ranging from 50 cycles to 15 kilocycles, any one of which may be conveniently selected by a rotary type switch for either amplitude or frequency modulation.

The calibrated piston type attenuator has a voltage range of from 0.1 microvolt to 0.2 volt and is standardized by means of a front panel output monitor meter.

The output impedance of the instrument, at the terminals of the R.F. output cable, is 26.5 ohms.

AVAILABLE AS AN ACCESSORY

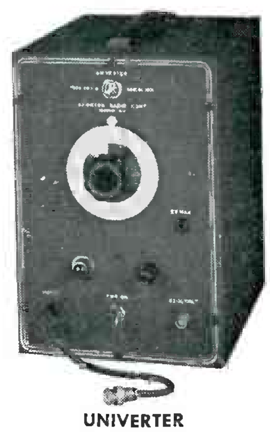
is the 203-B Univerter, a unity gain frequency converter which, in combination with the 202-B instrument, provides the additional coverage of commonly used intermediate and radio frequencies.

R.F. Range: 0.4 mc. to 25 mc.

R.F. Increment Dial: ±250 kc. in 10 kc. increments.

R.F. Output: 0.1 microvolt to 0.1 volt. Also approximately 2 volts maximum (uncalibrated).

For further information write for Catalog E



UNIVERTER
Type 203-B

BOONTON RADIO *Corporation*
BOONTON·N·J·U·S·A·

DESIGNERS AND MANUFACTURERS OF THE "Q" METER . . . QX-CHECKER . . . FREQUENCY MODULATED SIGNAL GENERATOR . . . BEAT FREQUENCY GENERATOR . . . AND OTHER DIRECT READING TEST INSTRUMENTS

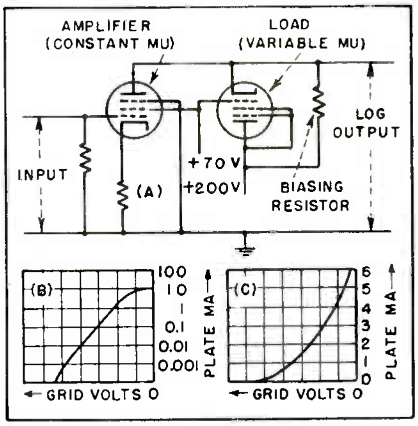


FIG. 1—Balancing voltage developed by variable-mu tube acting as load gives amplifier a logarithmic amplitude response

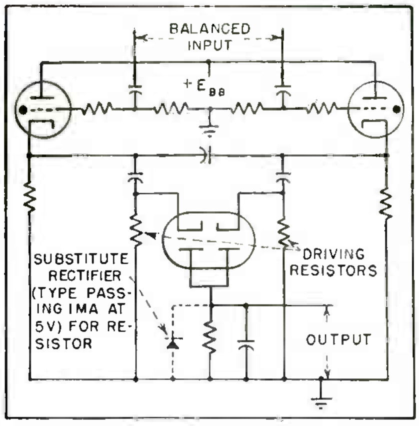


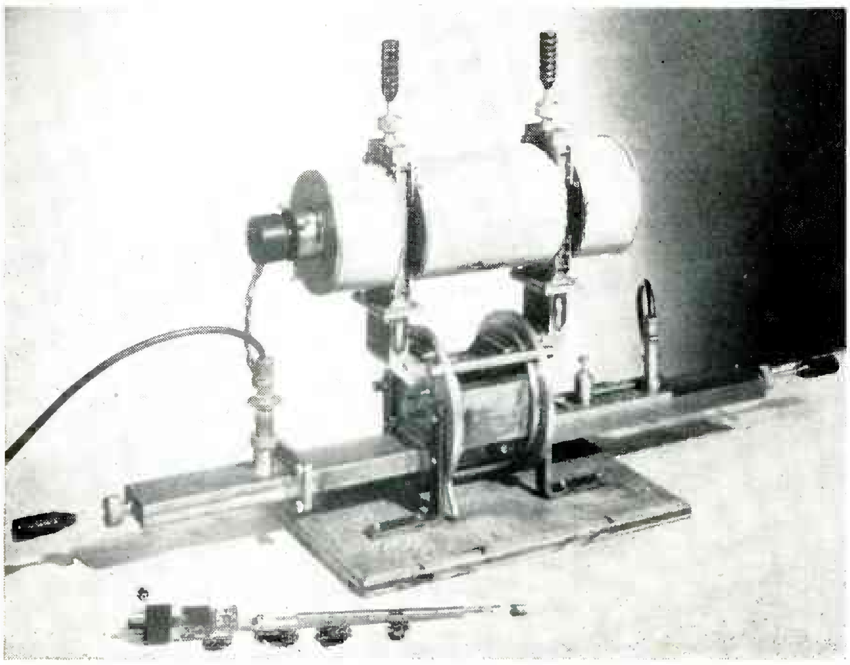
FIG. 2—By adjusting frequency meter circuit so that it has a constant-current output to a metallic rectifier, it is logarithmic

A Direct-Reading Frequency Meter, *Review of Scientific Instruments*, p 43, Feb. 1935) can be slightly modified to give logarithmic response by replacing the output resistor with a metallic rectifier. The action of this type of frequency meter is to produce uniform pulses of current through the output load every time the input wave reverses polarity. Thus the pulse rate is proportional to the incoming audio frequency.

The characteristic of metallic rectifiers is logarithmic within a limited, but, for this application, sufficient range. However, because in this circuit the rectifier is being used as a current operated device, the voltage drop across the rectifier must not react on the driving circuits; that is, the impedance of the rectifier must always be small compared to that of the driving circuit. By adjusting the magnitudes of the integrating capacitors and the two diode driving resistors, the constant-current condition can be fulfilled. Because of the temperature coefficient of metallic rectifiers, the output may drift as much as two octaves while the meter is warming up, hence a calibration system is incorporated in the complete equipment both as a convenience and to guard against this.

Traveling-Wave Amplifier Tube Demonstrated

DEVELOPMENTAL traveling-wave tubes in which noise factors of 20 decibels are obtained were demonstrated at the recent exhibition of the Physical Society in London, England by Standard Telephone & Cables, Ltd., an IT&T associate. The tube in the illustrated equipment operating with a beam potential of 1,400 volts and giving 100 milliwatts output, amplifies a total bandwidth of about 1,400 megacycles. Experimental tubes with a noise factor of 13db have been made.



Traveling-wave amplifier tube in foreground is operated in waveguide circuit to give a gain from 20 to 30 db within plus or minus 1.5 db from 6.0 to 8.3 cm

Transistor Characteristics

THE PHYSICAL AND ELECTRICAL properties of the transistor semiconductor amplifier were discussed at a joint meeting of the New York sections of the IRE and AIEE. William Shockley of the Bell Telephone Laboratories described the theoretical background of transistors (ELECTRONICS, p 69, Sept. 1948) and J. A. Becker, also of the Bell Labs, presented their electrical characteristics as summarized below.

Static Characteristics

Figure 1 shows the relationship between emitter (input) and collector (output) circuits in which collector voltage is plotted against collector current for constant values of emitter current (solid curves) and for constant values of emitter voltage (dashed curves). The solid curve for zero emitter current is the familiar diode characteristic of the collector. The other curves show how the emitter affects this characteristic. The amplifying action can be seen by noting that, for constant collector voltage, the collector current increases more than the causal increase in emitter current. This current amplification plus the voltage amplification re-

(Continued on p 164)

NEW PRODUCTS

Edited by A. A. McKENZIE

STL Parabolas

ANDREW CORP., 363 East 75th St., Chicago 19, Ill. A new series of high-gain parabolic antennas designed for use in the 920 to 960-mc f-m relay band is available with

dish diameters of two, four, or six feet. Field gains over a half-wave dipole are respectively 10, 15, and 20 db. Input impedance is 51.5 ohms and $\frac{3}{8}$-in. air coaxial line is recommended. Write for Bulletin 902.

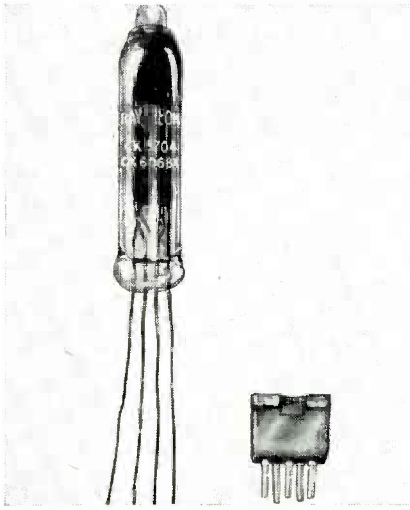
Musical Instrument Tuner

C. G. CONN LTD., Elkhart, Ind., has introduced the Lektro Tuner, an electronic device for tuning musical instruments. The unit,

can produce by means of vacuum tubes two tone qualities, oboe and flute, at musical A or B flat.

Subminiature Diode

RAYTHEON MFG. CO., Newton, Mass. Type CK5704/CK606BX is a sub-



miniature diode with characteristics similar to those of one-half of a 6AL5. Resonant frequency is over 1,200 mc. The tube has a 6.3-volt 150-ma heater and is intended for applications up to a few hundred megacycles where very small size is important.

Bar-Dot Generator

TEL-INSTRUMENT CO., INC., 50 Paterson Ave., East Rutherford, N. J. Type 2000 bar and dot generator provides signals needed for adjustment of horizontal and vertical

sweep linearity of television receivers. The apparatus provides standard blanking, vertical bars only, vertical and horizontal bars, or complete dot pattern.

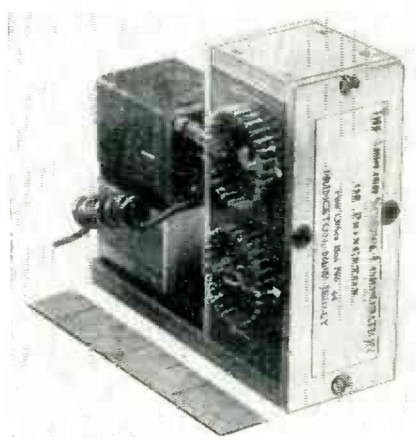
Tele Slide Projector

GENERAL ELECTRIC CO., Syracuse, N. Y. A new slide projector, type PF-3-C, for use in television stations will accept standard slides, cards,

and strips. The projector has dual lenses and provides for dissolves. Light intensity is between 10 and 15 foot-candles.

Multichannel Switch

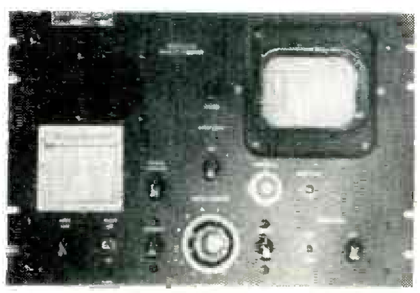
APPLIED SCIENCE CORP., Princeton, N. J. A subminiature multichannel mechanical switch includes two- and four-pole switches each pole of



which has 15 channels. Sampling rates up to 3,000 rpm can be obtained.

Modulation Monitor

HAZELTINE ELECTRONICS CORP., 58-25 Little Neck Parkway, Little



RAYTHEON PRESENTS A

NEW TUBE

Video Output Amplifier

Wide Band RF Amplifier

Wide Band IF Amplifier

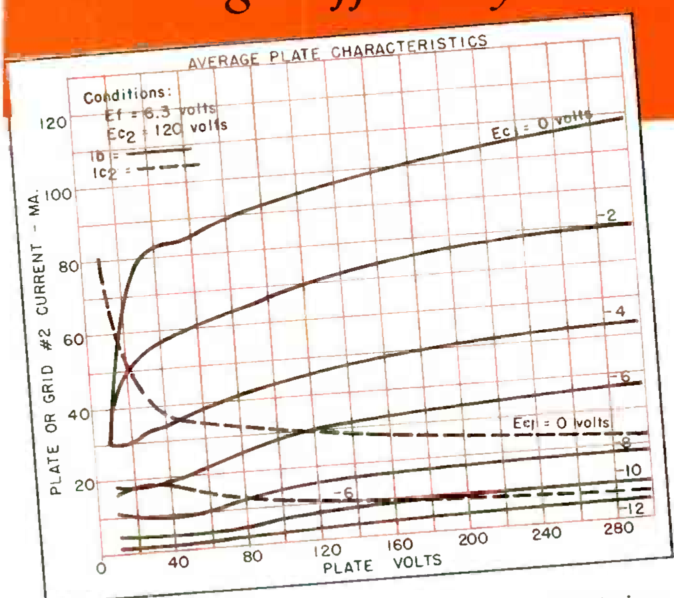
RF Class C. Amplifier

Class C. Frequency Multiplier

Computer Switch Operation

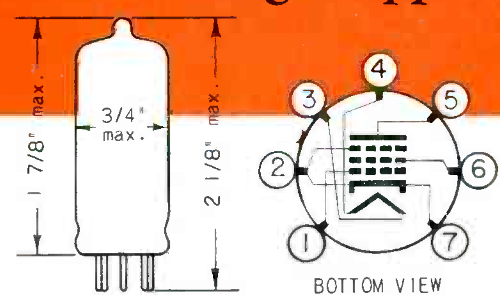
THE 6AN5 MINIATURE PENTODE

For High Efficiency with Low Plate Voltage Supplies



Note the low voltage "knee" on the chart. The design factors of low triode mu and optimum beam plate shapes combined with high mutual conductance make this a *high efficiency* video output tube. It produces ample video output voltage with a 120 volt plate supply.

The design of this new tube makes it particularly useful for high signal level operation in some of the extremely wide band IF amplifiers of special military equipment. It may be just the ticket for your low power Class C RF amplifiers and multipliers, too.



The Raytheon 6AN5

Direct Interelectrode Capacitances:

Grid #1 to Plate	0.075 uuf. max.
Input	9.0 " "
Output	4.8 " "
Plate Dissipation	1.70 watts
Transconductance at 35 ma. Ib	8000 umhos

NOW AVAILABLE FOR IMMEDIATE DELIVERY

Write for Data Sheets giving complete information on this and many other Raytheon Special Purpose Miniature and Subminiature Tubes.

Available Soon — the Raytheon Type CK5656 Miniature Twin Tetrode with a plate dissipation rating of 3.5 watts per unit — for push-pull RF receiver or transmitter amplifier service up to 400 megacycles.

RAYTHEON

Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY

SPECIAL TUBE SECTION · Newton 58, Massachusetts

RADIO RECEIVING TUBES · SUBMINIATURE TUBES · SPECIAL PURPOSE TUBES · MICROWAVE TUBES

Neck, N. Y. In the line of television test equipment described in bulletin 14 is the model 1323 modulation monitor receiver. This equipment facilitates study of the modulation envelope of the video carrier waves of all television broadcast stations. By its use the receiver permits measurement of modulation depth of any portion of the composite television signal from approximately two lines to slightly more than a complete field.

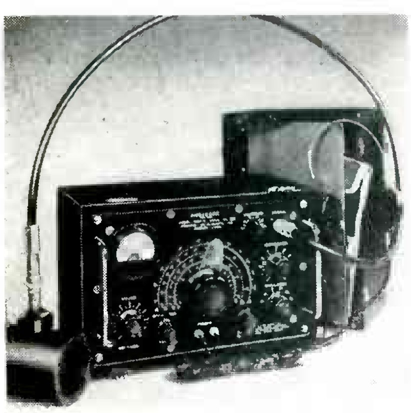
Rotary Tap Switches

COLE INSTRUMENT CO., 1320 South Grand Ave., Los Angeles 15, Calif. Model 24 switches are precision,

multipoint devices for commercial, industrial, and laboratory use. They are available from 2-contact single-deck types up to 24-point, six-deck models. Maximum load is about 40 amperes, and resistance is constant over long periods.

Ultrasonic Gage

BRANSON INSTRUMENTS INC., Danbury, Conn. The new model FMSS-5 Audigage thickness de-



tector contains new features such as instrument indication (for use in noisy locations) adjustable frequency-modulation (facilitating measurement of seriously corroded parts), permeability tuning unit, and increased frequency range for measurement of steel down to $\frac{1}{16}$ inch. Normally battery powered, the unit can be furnished for a-c power if desired.

Midget Meter

INTERNATIONAL INSTRUMENTS, INC., 331 East Street, New Haven 11, Conn. New small meters having a

scale arc of 270 degrees have a diameter of only one inch. The instrument is watertight and mounts by means of a threaded ring.

Pulse Generators

RAYMOND M. WILMOTTE INC., 1469 Church St., N. W., Washington 5, D. C. Two pulse generators, models P55 and P54, cover the repetition frequencies 60 cycles to 100 kc. Pulse widths down to 0.75 and up to 70 microseconds are available. The units are designed as the foundation of control equipment. An extensive brochure is available.

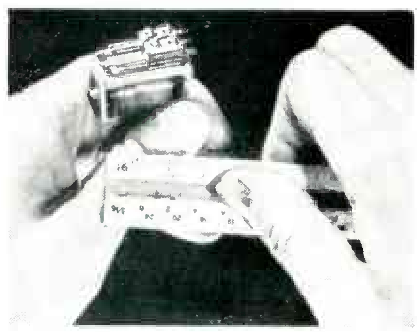
Tone Oscillator

TOKYO COMMUNICATION ENGINEERING CO., LTD., 351 Kitashinagawa 6-Chome, Shinagawa-ku Tokyo, Japan. The Clear Tone generator comprises a microphone hummer with a loudspeaker cone mechanically coupled to the reed. Five milliamperes from a 1.51-volt battery is sufficient to operate. The unit illustrated operates at 600 cycles and

can be used as a sound source, as an annunciator, code practice oscillator, or similar device. Frequency can be adjusted over about 10-percent range.

Midget Relays

THE POTTER & BRUMFIELD SALES CO., 549 W. Washington St., Chicago 6, Ill., has made available the Series MTA telephone-type relays for a-c operation up to 220 volts, 60-cycles. They are fitted with

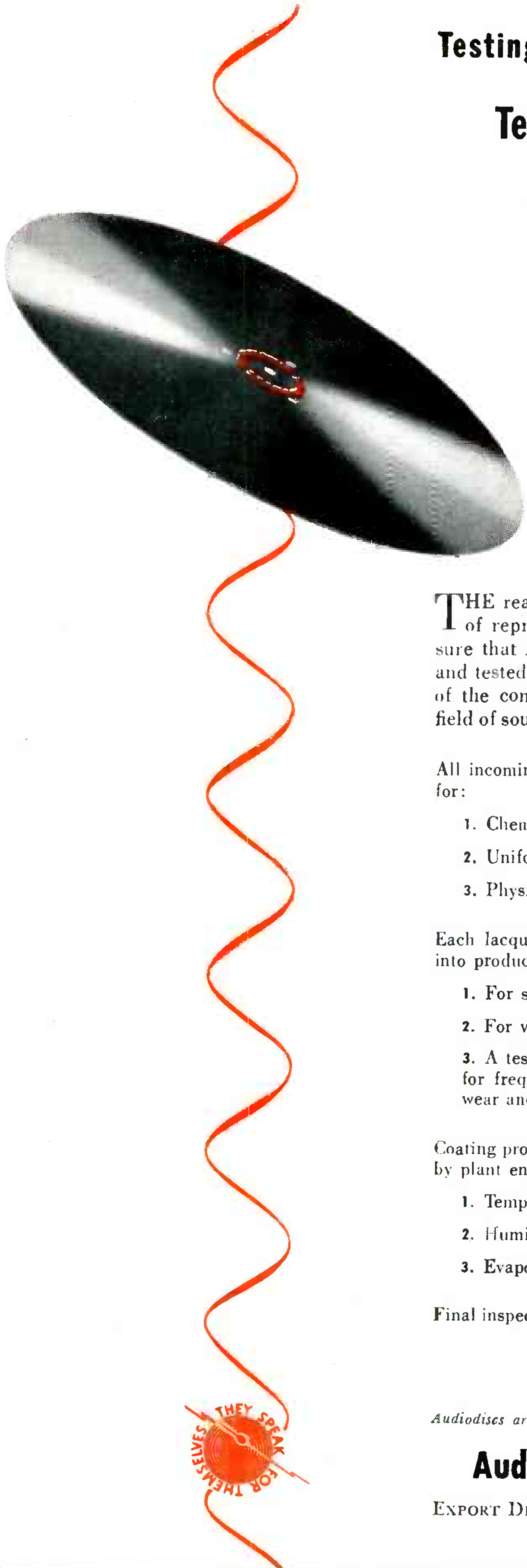


twin palladium contacts which will carry approximately 2 amperes non-inductive load and are available in single- or double-spring stack with any contact combination up to 12 springs.

Sonic Analyzer

PANORAMIC RADIO CORP., 92 Gold St., New York 7, N. Y. Model AP-1 sonic analyzer automatically separates the frequency components constituting a complex audio wave and simultaneously measures their frequency and amplitude on a c-r tube screen. Frequency range is from 40 to 20,000 cps. Input voltage range is from 500 μv to 500 volts,

(continued on p 176)



Testing—1, 2, 3

Testing—1, 2, 3

Testing—1, 2, 3

Here's how continual testing assures consistent, uniform, and lasting quality in every **audiodisc***

THE real test of any recording disc is its performance on the job—the fidelity of reproduction, both at the time of recording and years after. And, to make sure that AUDIODISCS will pass this test *every time*, they are continually checked and tested in manufacture—from raw material to finished product. Here are some of the control measures that are responsible for AUDIODISC leadership in every field of sound recording.

All incoming lacquer materials are tested for:

1. Chemical purity
2. Uniformity
3. Physical properties

Each lacquer mix is tested before going into production:

1. For solids
2. For viscosity
3. A test coating is made and checked for frequency response, surface noise, wear and thread throw

Coating process checks throughout the day by plant engineers:

1. Temperature control
2. Humidity control
3. Evaporation rate and final cure

Final inspection of finished discs:

1. Visual grading by trained inspectors
2. Spot checking by chief inspector
3. Production discs tested for surface noise, wear and thread behavior at regular intervals

Final evaluation—on all production:

1. Comparison with competitive discs
2. Ageing effect—before and after recording
3. Effects of storage under varying climatic conditions

In addition, sample discs of each day's production are filed by serial number, with the complete history of actual recording behavior under controlled conditions. This practice, which has been followed for the past 10 years, has helped us make many refinements and improvements in lacquer formulation and control.

If you want to be SURE of matchless recording quality—ask your dealer for AUDIODISCS.

**Reg. U.S. Pat. Off.*

Audiodiscs are manufactured in the U.S.A. under exclusive license from PYRAL, S.A.R.L., Paris.

Audio Devices, Inc., 444 Madison Ave., N.Y.C.

EXPORT DEPT: ROCKE INTERNATIONAL, 13 EAST 40TH STREET, NEW YORK 16, N.Y.

audiodiscs *they speak for themselves*

NEWS OF THE INDUSTRY

Edited by WILLIAM P. O'BRIEN

Chicago Conference Report

OVER 2,000 ENGINEERS, managers, and students in the field of electronics attended the 1948 National Electronics Conference which was held November 4, 5, and 6 at the Edgewater Beach Hotel in Chicago.

A total of 64 technical papers on electronic research, development and application were presented at the conference, in technical sessions held three-at-a-time.

Anton J. Carlson, Professor Emeritus, Department of Physiology, University of Chicago, spoke on "Science, Industry, and the Future of Man" at the initial luncheon meeting on Thursday. The talk centered around the effects of modern medicine and war on the world's population and the necessity for increasing productivity to meet the evergrowing demands brought about by an expanding civilization.

Donald G. Fink, editor of ELECTRONICS, was the speaker at the Friday luncheon meeting, the topic being "The Decline and Fall of the Free Electron." This talk dealt with present and future trends affecting the field of electronics.

The conference, along with the associated commercial show by approximately seventy exhibitors, was under the joint sponsorship of the Illinois Institute of Technology, Northwestern University, University of Illinois, the American Institute of Electrical Engineers, and the Institute of Radio Engineers. On Friday evening Radio Corporation of America presented a large-screen television demonstration.

IRE-RMA Fall Meetings Move to Syracuse in 1949

THE TWENTIETH annual Rochester Fall Meeting of members of the IRE and the RMA Engineering Department was held Nov. 8-10 at the Sheraton Hotel in Rochester, New York.

At the Tuesday night banquet meeting, Dorman D. Israel of the Emerson Radio and Phonograph Corp. received the RMA award for his work in connection with the advancement of radio broadcasting.

In a talk entitled "What's When With America," consulting engineer Ken Jarvis made a series of predictions for the future of the industry. He announced that in his opinion, television would practically eliminate a-m and f-m broadcasting in about 5 years.

At the meeting it was announced that future Fall meetings of the group will be held in Syracuse instead of Rochester because of the limited facilities of the latter city. It was also decided that exhibits would be eliminated from future meetings.

IRE Elections

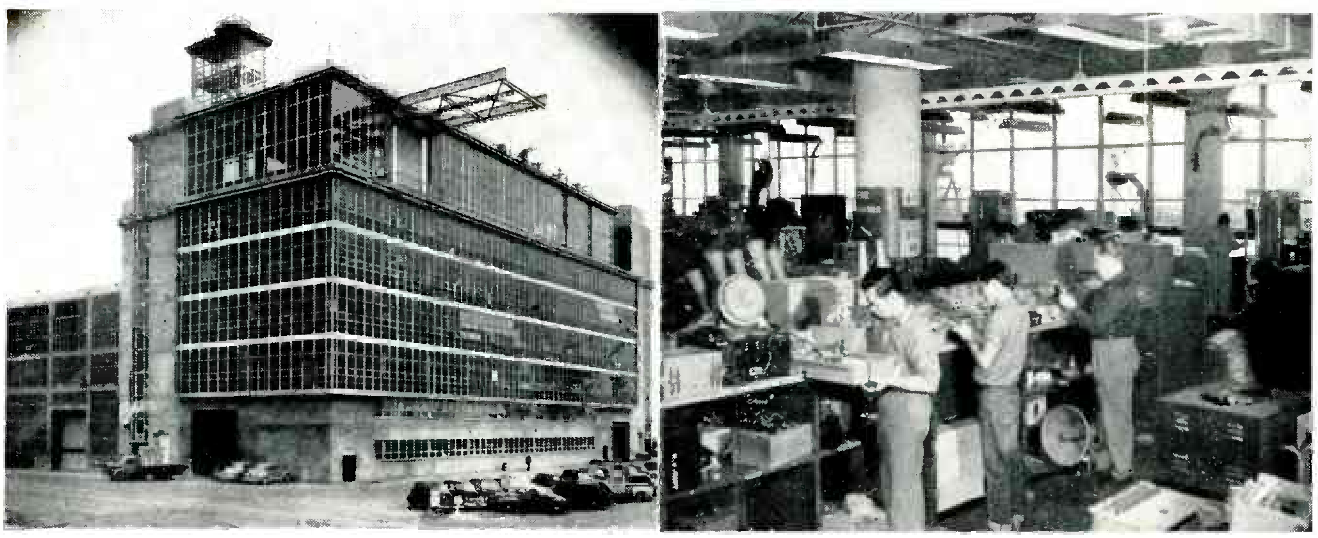
NEWLY ELECTED officers of the IRE and their terms of office have been announced as follows:

Stuart L. Bailey, president (1949), is a consulting engineer and partner of the firm of Jansky and Bailey, Washington, D. C.

Arthur S. McDonald, vice-president (1949), is presently chief engineer of the Overseas Telecommunication Commission, Sydney, Australia.

Directors-at-large (1949-1951)

NAVAL ORDNANCE GLASS HOUSE



Nearly two acres of exterior glass provide daylight illumination for civilian technicians in the Navy's new six-story Ordnance-Electronics and Optical Building, San Francisco. Building contains an escalator extending from main to third floors, and a 39-foot outrigger crane capable of a 15-ton lift from railroad track at ground level. In the radio and repair section (right), all marine communications equipment is overhauled and tested

U·H·F EQUIPMENT

DEVELOPED • DESIGNED • PRODUCED

RADAR RECEIVERS
OSCILLOSCOPES
RECEIVERS
TRANSMITTERS
TEST EQUIPMENT
SQUARE WAVE GENERATORS
FIXED FREQUENCY RECEIVERS
HARMONIC GENERATORS
SIGNAL GENERATORS
FREQUENCY METERS
U H F
FREQUENCY STANDARDS
ANTENNAS and MOUNTS
ELECTROMYOGRAPHS
WAVEMETERS
UHF RADIO SETS

We are prepared to assist you with *any* phase of U.H.F. work from idea to finished product . . . either in the development of new products or the improvement of old products. Precision work and low unit cost are based on specialized U.H.F. technique and production methods acquired by years of practical experience.

Literature . . . Information

A resume of LAVOIE facilities may be had if you will request one on your letterhead.

Lavoie Laboratories

RADIO ENGINEERS AND MANUFACTURERS
MORGANVILLE, N. J.

Specialists in the Development and Manufacture of UHF Equipment

are William L. Everitt, professor and head of the department of electrical engineering, University of Illinois, and Donald G. Fink, editor of ELECTRONICS.

Regional director (1949-1950) for the North Central Atlantic Region—John V. L. Hogan; for the East Central Region—George R. Town, manager of engineering and research, Stromberg-Carlson Co., Rochester, N. Y.; for the Southern Region—Ben Akerman, chief engineer of WGST, Atlanta, Ga.; for the Canadian Region—Frank H. R. Pounsett, now chief engineer of the Stromberg-Carlson Co., Ltd., Toronto, Ont., Canada.

Conference on H-F Measurements

LATEST DEVELOPMENTS in high-frequency measurements are being presented at a conference sponsored by the IRE, AIEE and the National Bureau of Standards, January 10, 11 and 12 in the Dept. of the Interior Bldg., Washington, D. C.

Technical program is as follows:

Monday, Jan. 10

1:30 P.M.—Measurement of Frequency—E. I. Green of Bell Labs, presiding:

Microwave Spectroscopic Frequency and Time Standards and Measurements, by Harold Lyons of National Bureau of Standards.

Frequency Stabilization with Microwave Spectral Lines, by W. D. Hershberger of RCA Laboratories.

Stabilization of Microwave Oscillators, by E. W. Fletcher of Harvard University.

Superconduction Resonant Cavities—Measurements of the Surface Impedance of Normal and Superconductors at Low Temperatures and Microwave Frequencies, by E. Maxwell of National Bureau of Standards.

A Stabilized Variable Frequency Oscillator for Precision Frequency Measurements, by L. F. Koerner of Bell Labs.

The Measurement of Frequency in the Millimeter Bands, by John B. Hagen.

Tuesday, Jan. 11

9:30 A.M.—Measurement of Power and Attenuation—F. J. Gaffney of Polytechnic Research and Development Co., presiding:

Power Sources for Microwave Measurements, by G. Hackley of Sperry Gyroscope Co.

Bolometric Measurement of Microwave Power Over Broad-Frequency Bands, by Herbert J. Carlin of Microwave Research Institute.

Microwave Metallized-Glass Attenuators, by Dr. John W. E. Griemsmann of Microwave Research Institute.

A Method for Measuring the Effective Conductivity of Wires at Microwave Frequencies, by A. C. Beck and R. W. Dawson of Bell Labs.

X-Band Phase Shiftless Power Splitter, by H. J. Riblet of Submarine Signal Co.

A Figure of Merit for Directional Couplers, by G. James of Sperry Gyroscope Co.

Wednesday, Jan. 12

9:30 A.M.—Measurement of Impedance—Hugh E. Webber of Sperry Gyroscope Co., presiding:

A Precise Direct-Reading Phase and Transmission-Measuring System for Video Frequencies, by D. A. Alsberg and D. Leed of Bell Labs.

Methods of Measuring Impedance and Voltage Standing-Wave Ratio at Microwave Frequencies, by F. Klawanik of Sperry Gyroscope Co.

Generator Mismatch Measurement in Transmission Lines, by P. E. Gilmer of Bell Labs.

A Method of Measuring Phase at Microwave Frequencies, by Sloan D. Robertson of Bell Labs.

Dielectric Measurement Techniques in the UHF Region, by W. B. Westphal of MIT.

A Null Type of Impedance-Measuring Device in the UHF Range, by J. F. Byrne of AIL.

Measurement of the Electrical Characteristics of Quartz-Crystal Units by Use of a Bridged-T Network, by Charles H. Rothauge of The Johns Hopkins University.

2:00 P.M.—Measurement of Noise, Antenna Measurements—H. A. Wheeler of Wheeler Laboratories, Inc., presiding:

Reduction of Cable Reflections in Antenna Pattern Measurements, by E. Fubini of AIL.

Program of Instrumentation for Antenna Measurements, by L. C. Van Atta and O. A. Tyson of NRL.

Measurement of Artificial Dielectrics for Microwaves, by W. E. Kock of Bell Labs.

Microwave Noise Sources, by I. Mirman and J. H. Vogelman of Watson Laboratories, and R. H. George of Purdue University.

Measurement of Noise Interference Caused by Radar Equipments, by J. R. Logie, Jr. of Bell Labs.

Transmission-Line Method for Measuring Sensitivity of Receivers with Loop Antennas, by C. E. Kilgour of Crosley Radio Corp.

MEETINGS

JAN. 10–12: Symposium on high-frequency measurements, held by Instruments and Measurements Committee jointly with the IRE and National Bureau of Standards, at Washington, D. C.

JAN. 22: IRE New York Section television symposium, Engineering Societies Building, New York City.

MARCH 7–10: IRE annual convention, Hotel Commodore and Grand Central Palace, New York City.

APRIL 6–12: 27th annual convention of the National Association of Broadcasters, Stevens Hotel, Chicago.

APRIL 11–15: Sixth Western Metal Congress and Exposition, Shrine Auditorium, Los Angeles, Calif.

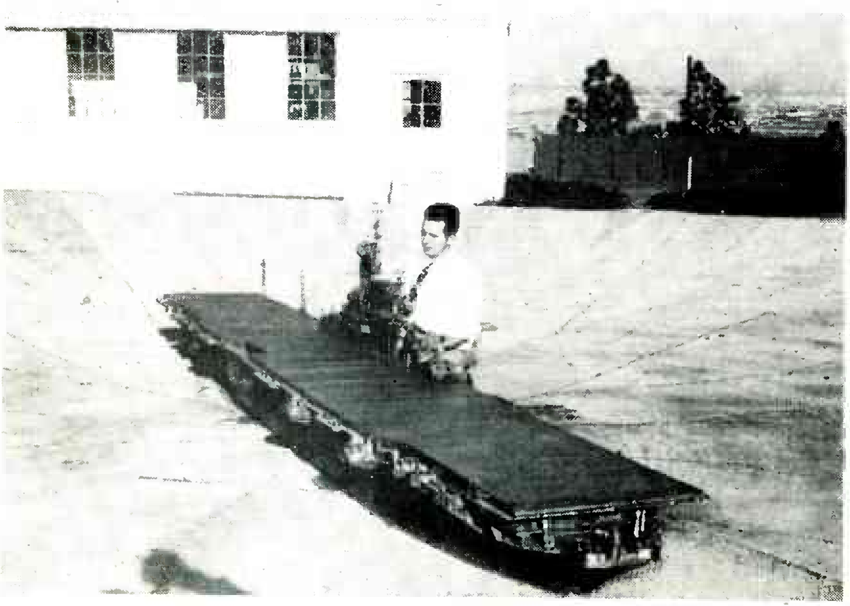
MAY 16–20: Radio Parts Industry Trade Show and RMA Silver Anniversary Convention, Hotel Stevens, Chicago.

IRE Awards and Citations

THREE MAJOR decisions and numerous citations were recently approved by vote of the IRE Awards Committee. The Morris Liebmann Memorial prize will be awarded to C. E. Shannon for contributions to the theory of the transmission of information in the presence of noise. The Medal of Honor goes to Ralph Bown for extensive contributions to the field of radio and for

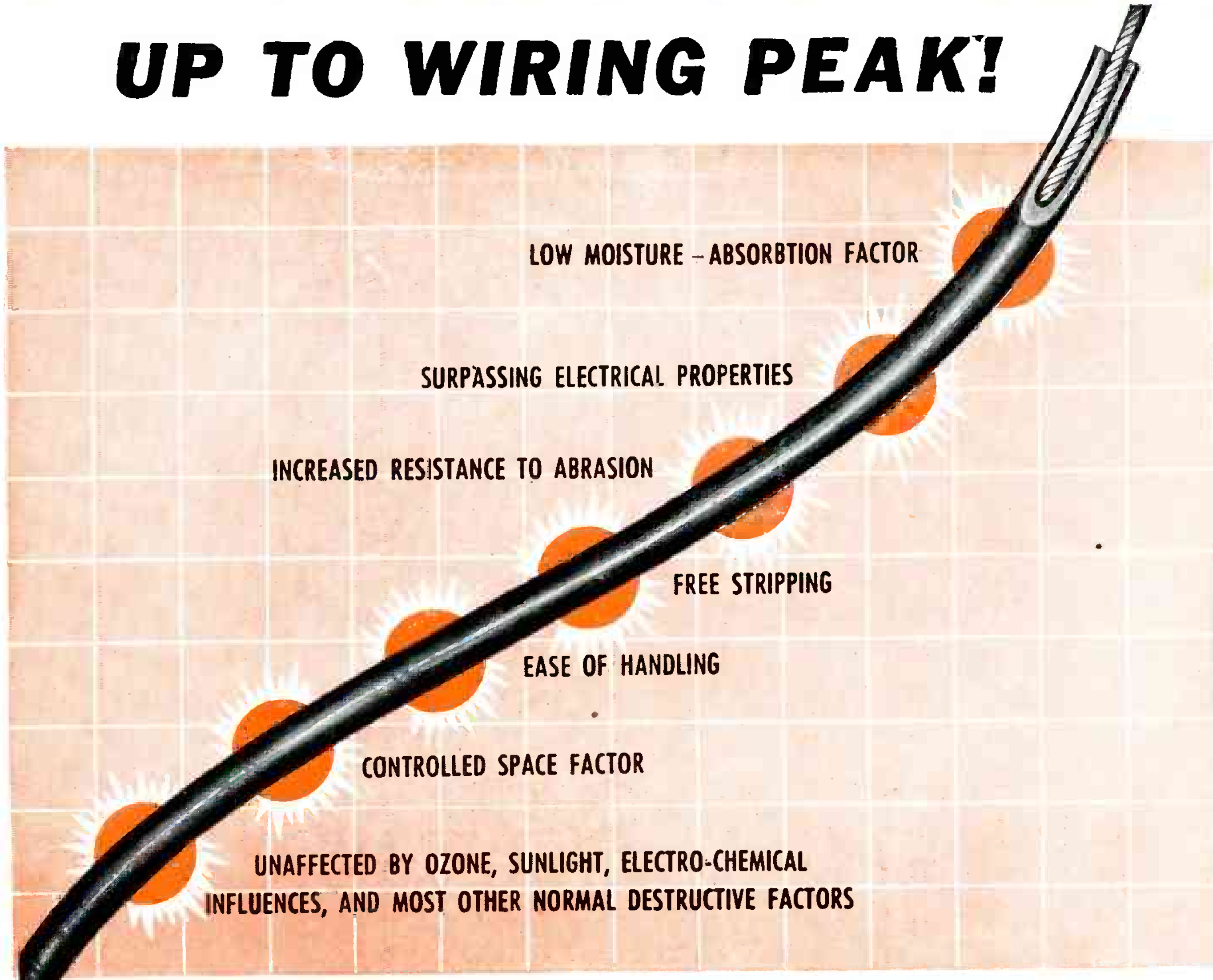
(Continued on p 204)

NAVY RADAR TESTED ON WIRE OCEAN



An 18-foot scale model Essex-type aircraft carrier is used to test equipment at the Navy's Electronics Laboratory, San Diego, Calif. While revolving on a turntable in the center of a wire-covered "ocean", the performances of the model's scaled-down radio and radar antennas are traced on plotting machines in the office at the rear

UP TO WIRING PEAK!



Electrical Insulation Performance takes a JUMP! with new TURBOTHERM PLASTIC INSULATED WIRE

Beyond which TURBOTHERM Insulated Wire, available with solid or stranded copper conductor, offers a flexible, assembly-facilitating process. This means production-time economy right at your own line and bench-manufacturing points. Your requirements of insulated wire within the gauge range of No. 14 down to No. 30 can be most advantageously served by TURBOTHERM. Ask for samples and become convinced.

Underwriters Laboratories Approved for 80 degree C. Appliance, Radio Hook-up and Instrument Wire; T. F. and T. F. F. for decorative wall brackets and candlelabra lighting fixtures, and small electrical tools and controls, where operation in oil at 60 deg C. is a requisite.

WILLIAM BRAND & COMPANY

276 FOURTH AVENUE, NEW YORK 10, N. Y.—325 W. HURON STREET, CHICAGO 10, ILL.

OIL TUBING • SATURATED SLEEVING • VARNISHED CAMBRIC • PAPER AND TAPE • MICA AND MICA PRODUCTS

New Headquarters for UNTREATED COTTON SLEEVING by virtue of our acquisition of the Tubular Braiding Division of INTERNATIONAL BRAID CO., Providence, R. I.

PICTURE OF A COMPLETE YEAR'S ADVERTISING CAMPAIGN IN ....

FOR MANUFACTURERS OF ELECTRONIC AND

The 12 monthly issues of electronics and the

Editorially, the 12 monthly issues of ELECTRONICS bring to its more than 30,000 subscribers authentic and complete reviews of technical developments and applications vital to all whose interests lie in any phase of the vast aspects of the electronic industry. Because this technical coverage is so complete and timely — because ELECTRONICS has been outstanding in its field for better than a decade and a half, design engineers of all types, and management, consider it essential to their work.

Manufacturers have learned, either by observation or through conversation with their own engineers, of the industry-wide acceptance and coverage of ELECTRONICS. To them, as well as to engineers, its leadership has been, and is an accepted, proven fact.

It follows, therefore, that there is no better place for a manufacturer to tell his product story — each month — than in the publication read by users of his products. Manufacturers are certain of reaching old customers and prospects or developing new ones. Inquiries from ELECTRONICS' advertising develop new applications and new markets in industries other than are presently utilizing a manufacturer's products. Advertising is certain of careful readership — where it will do the most good in terms of eventual sales. The reason, therefore, that more manufacturers names, both big and small, are regularly seen in the advertising pages of ELECTRONICS.

ABC **electronics** — *First in* **RECOGNITION** —

A McGRAW-HILL PUBLICATION 330 WEST 42nd ST. NEW YORK 18, NEW YORK

electronics

INDUSTRIAL CONTROL EQUIPMENT

Mid-June issue of the BUYERS' GUIDE

Budget **NOW**

FOR THE 1949

13

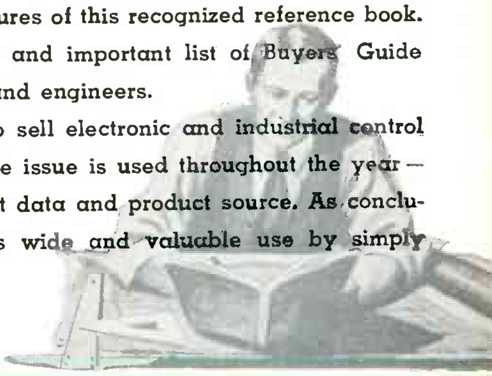
ISSUES OF

electronics

The Buyers' Guide serves several distinctly different functions than those of the monthly issues of ELECTRONICS. First: It is accepted and used as the only complete reference book in the industry. Secondly: It includes a "where-to-buy-it" function in the carefully compiled Directory Section. Thirdly: Its catalogue-type of advertising provides design engineers with technical data on ALL of the manufacturers' products. In this respect it serves as a condensed summary of the advertising in the 12 monthly issues and permits a manufacturer to catalogue his entire line in one issue. Lastly: It saves valuable time for the busy engineer in locating data on a particular component he is designing into some equipment.

These are only a few of the many exclusive features of this recognized reference book. They are, however, the basic reasons for the long and important list of Buyers' Guide advertisers and its wide use by both management and engineers.

Plan now to use it in any campaign designed to sell electronic and industrial control equipment manufacturers. Keep in mind that this one issue is used throughout the year—that it is the only complete reference book on product data and product source. As conclusive proof a manufacturer can quickly determine its wide and valuable use by simply questioning his own engineering staff.



First in **IMPORTANCE** — *First in* **PREFERENCE**

ABP

(continued from p 128)

matic control—a voltage varying with moisture content, derived from the Drimeter, and a voltage varying with drying machine speed, obtained from a small alternator belted to the machine. The control unit applies a speed correction to the machine that is proportional to deviation from desired moisture content. The higher the speed of the machine, the more frequent are corrections in speed. The control becomes inactive if the machine stops or if the yarn or fabric runs out, and is insensitive to wet patches such as are produced by damp seams.

Installation of this moisture meter has increased the output of slashers or driers an average of about 25 percent through elimination of overdrying; drying only to normal moisture content also saves fuel and power, lowers operating costs and improves quality of fabrics.

Also exhibited was a portable battery-operated moisture tester for sampling rather than continuous measurements. Electrodes in a gun unit are pressed against the textile material under test, and moisture content is evaluated by measurement of volumetric resistance and dielectric properties. Readings of the 50-microampere indicating meter are converted to percentage moisture by reference to calibration charts. The instrument can also be obtained with a direct reading scale calibrated for a specific material by the manufacturer, Moisture Register Co. of Alhambra, California.

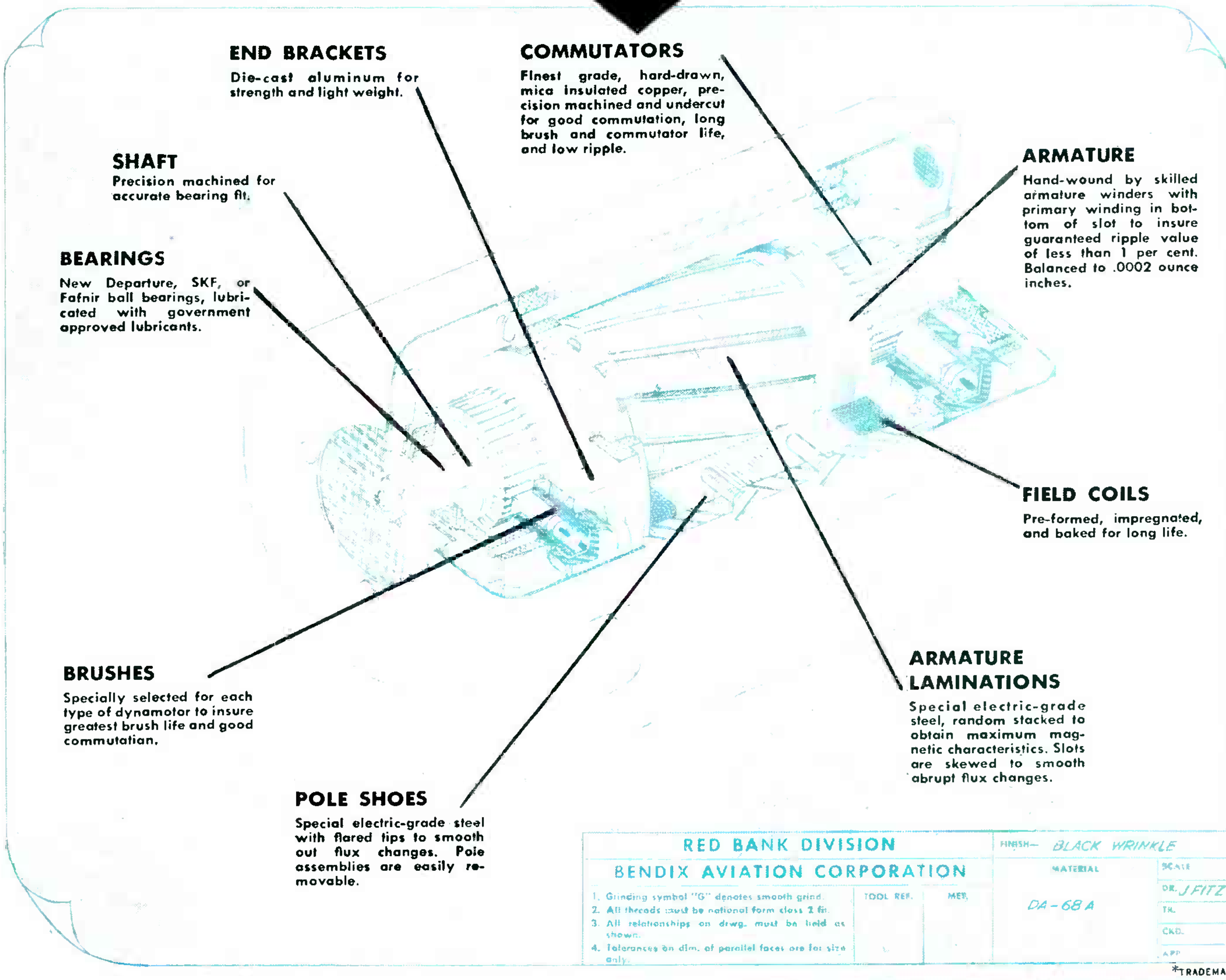
A laboratory-type instrument for measuring moisture regain of fabrics was exhibited by Seedburo Equipment Co. of Chicago. This Steinlite moisture tester employs electronic circuitry to provide an accuracy within 0.25 percent, but requires weighing of a sample of the bulk material prior to insertion in a cell for compression to a definite volume.

Thread Diameter Measurement

Yarn or thread run through the slot of the SERC Electron Micrometer at speeds up to 800 ft per min or even higher is checked for size and denier variations instantly, continuously and with high accu-

What makes BENDIX* dynamotors SO MUCH BETTER?

For the answers look inside!



*TRADEMARK

It Pays to buy Quality . . .
and no finer Quality Dynamotor
is available than a
BENDIX DYNAMOTOR

Dynamotors • Inverters • Convertors • D.C. Motors • Carbon Pile Voltage Regulators

RED BANK DIVISION of Bendix AVIATION CORPORATION

RED BANK, N. J.

Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, New York

TEMPERATURE RISE—40° C.

STARTING TIME—.03 seconds (or less if specified).

VIBRATION RESISTANCE—Will withstand .03 inches (.06 total excursion) between 10 and 60 c.p.s., without special mounts.

TEMPERATURE RANGE—Will operate through ambient range of —55°C to +85°C.

ALTITUDE—Will operate normally to 20,000 feet and higher if special altitude brushes are specified.

CAA APPROVAL—All Bendix dynamotors are capable of meeting Civil Aeronautics Authority type Certification tests and are in use by major, scheduled airlines and government services.

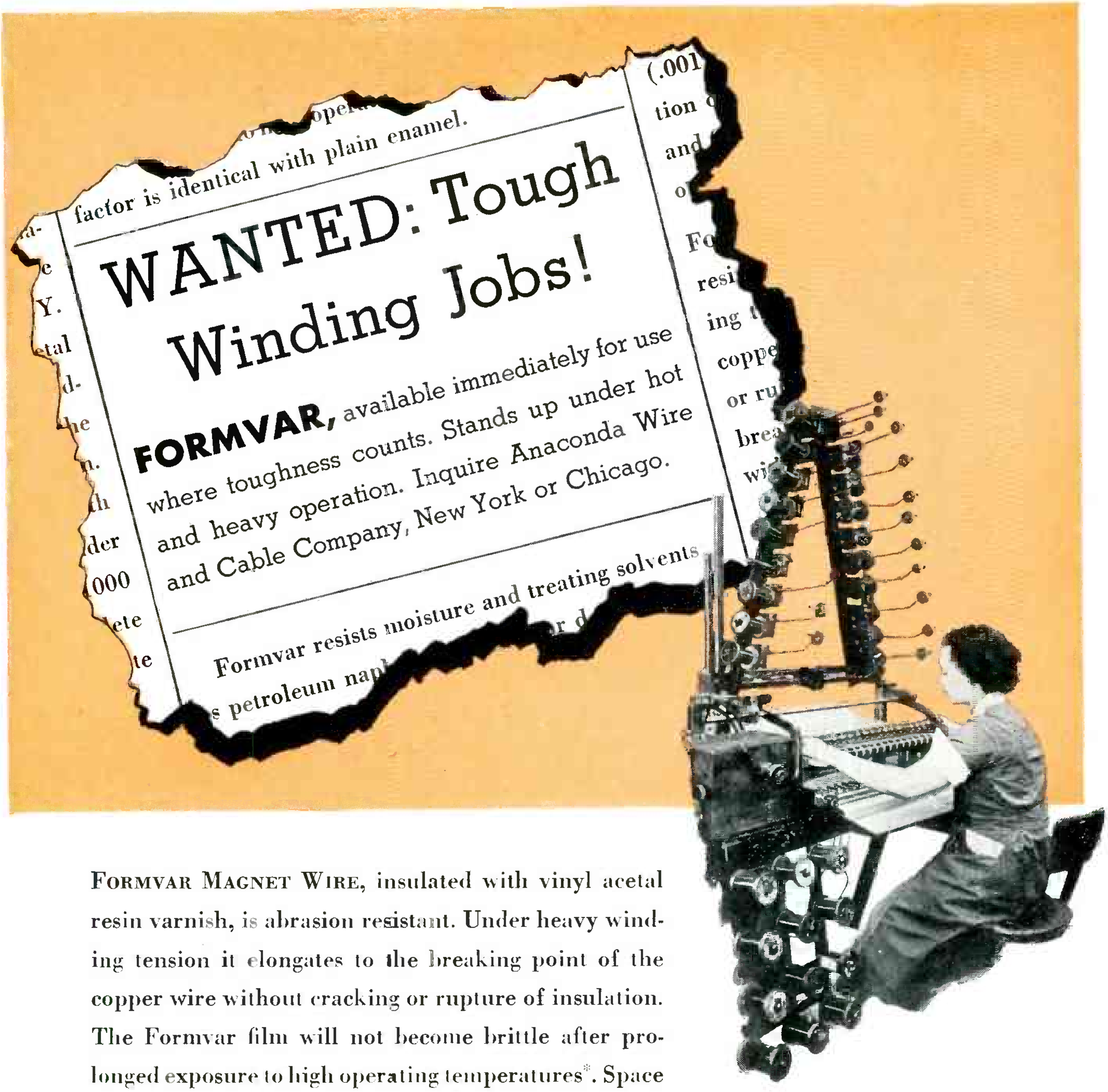
INSPECTION AND TEST—*All* Bendix Dynamotors are carefully inspected in every step of production. Every unit receives a six to twelve hour run-in, depending on type, to insure proper brush seating.

racy. The instrument can be coupled with high-speed charting devices to obtain permanent recordings for future study, or can be hooked to a counter that indicates the number of times the yarn diameter drops below a predetermined minimum thickness. A light source and phototube form the sensing element. This unit is manufactured by Standard Electronics Research Corp., New York, N. Y.

Tensile Testing Instruments

Application of a GE electronic constant-rate-of-load control unit to a pendulum-type tensile tester made by Scott Testers Inc. of Providence, R. I. minimizes variations in results due to operator errors, eliminates possibility of shock loading when starting a test, compensates for sample-to-sample variations in stretch characteristic, and compensates for inherent machine characteristics. The rotor of a selsyn turns with the pendulum arm to generate a voltage proportional to the sine of the angle traversed. This voltage is rectified, filtered, and applied to a resistor and capacitor. The resulting voltage, proportional to rate of change of pendulum angle, is impressed on the grid of the phase-control tube of a standard electronic motor-control circuit serving the d-c driving motor of the tester. Operation of the control in providing constant loading is so fast that there is no trace of jerkiness in the pendulum motion.

Constant rate of elongation during tensile testing is maintained by a servocontrolled amplidyne drive acting as a positional follow-up system in the Instron tensile testing instrument made by Instron Engineering Corp. of Quincy, Mass. The load applied to the sample under test is measured and recorded with high accuracy in four groups of ranges extending from 2 grams to 1,000 pounds full scale, by means of a precision electronic weighing system using strain gages on the upper jaw as sensing elements. Load variations due to changes in the properties of the sample during elongation produce electrical signals that are amplified and made to operate a high-speed graphic recorder. The resulting curves reveal



FORMVAR MAGNET WIRE, insulated with vinyl acetal resin varnish, is abrasion resistant. Under heavy winding tension it elongates to the breaking point of the copper wire without cracking or rupture of insulation. The Formvar film will not become brittle after prolonged exposure to high operating temperatures*. Space factor is identical with plain enamel.

Formvar resists moisture and treating solvents such as petroleum naphtha and coal tar derivatives. In dielectric strength, it withstands 1000 volts per mil. (.001″) of insulation. For complete detailed information on magnet wire and coils, write Anaconda Wire and Cable Company, 25 Broadway, New York 4, N. Y. or 20 N. Wacker Drive, Chicago 6, Illinois. 48471

*Based on AIEE temperature rating this is a class A material capable of withstanding a "Hottest-spot" temperature of 105° C which is a rise of 65° C over an ambient of 40° C.

LOOK TO *Anaconda* FOR ENGINEERED MAGNET WIRE AND COILS

hysteresis changes in elongation properties as well as relaxation effects occurring with time after a fixed elongation.

Power from Photocells

THE BEHAVIOUR of barrier-layer photocells in a-c circuits and characteristics of the cells reveal that they have an important place in industrial electronics. In darkness, the cells act simply as rectifiers but when exposed to light they act as nonlinear conductors of current in both directions. This change can be used in designing photocell-operated equipment and when so used, the cell is about 300 times more sensitive than when used as a detector of light.

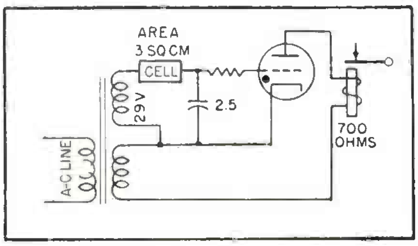


FIG. 1—Typical circuit for photocell and thyratron that supplies 88 milliwatts to operate the relay

Although d-c can be used to increase the sensitivity of the cell, a-c is more satisfactory since heating and hysteresis effects are very much less.

Figure 1 shows a typical practical circuit where the relay will drop out when the cell is illuminated. A typical set of values for this type of circuit it shown.

In darkness it was found that 88 milliwatts was generated in the coil and was ample to operate a relay with a large bank of springs. When the cell was exposed to an illumination of 10^4 lux from an under-run lamp, the power fell to 3 milliwatts and the relay released. There was thus available a differential power of 85 milliwatts to operate the relay.

With the same cell used in the usual self-generating manner and with a 700-ohm meter the differential output was only 0.3 milliwatt for the same illumination.

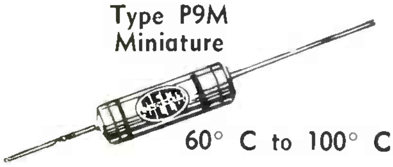
Figure 2 shows a similar circuit to that in Fig. 1 but the relay will release when the illumination is removed.

By arranging the relay to switch

Announcing DUMONT GLASSITE COLD MOULDED CAPACITORS

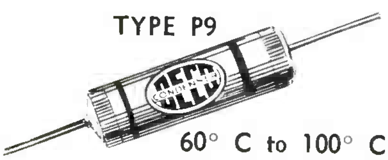
At last . . . the only true moulded oil capacitor made without pressures or high heat assuring a long life capacitor. Made in sizes from .00005 to 1.0 MFD . . . from 100 Volts to 10,000 Volts.

Type P9M
Miniature



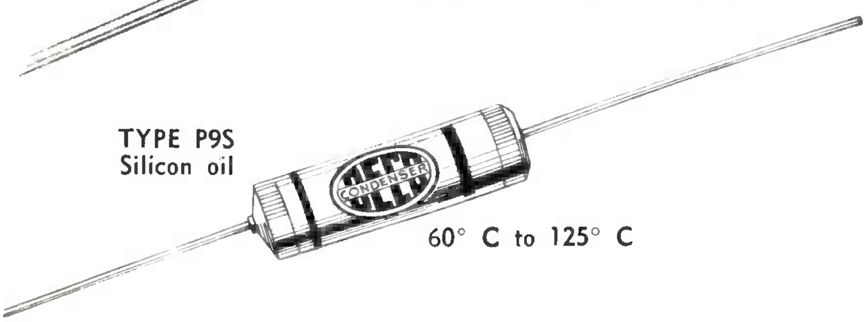
60° C to 100° C

TYPE P9



60° C to 100° C

TYPE P9S
Silicon oil



60° C to 125° C

- MINERAL OIL SECTION
- 100% HUMIDITY OPERATION
- HEATPROOF . . . . 60°C TO 125°C
- NO HIGH PRESSURE . . . . NO HEAT
- GREATLY INCREASED LIFE
- LEAD WIRE CANNOT PULL OUT

•

Write for Literature Now

DUMONT ELECTRIC CORP.

MFR'S OF CAPACITORS FOR EVERY REQUIREMENT

308 DYCKMAN ST., NEW YORK, N. Y.

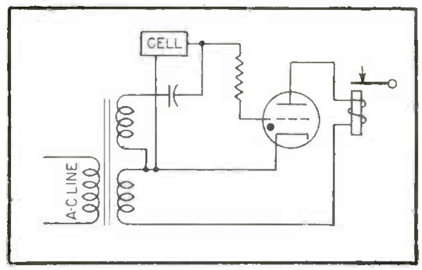


FIG. 2—The relay releases when illumination is removed from the photocell

in various capacitors when it operates, the opening and closing time can be varied and the sensitivity to a small change of illumination increased.

Applying these cells to thyratrons is quite simple and Fig. 3 gives another typical circuit. Motors 1 and 2 might be the first of a series of motors in a grading machine. Each relay will operate at a different low level of illumination and both will be inoperative with much illumination.

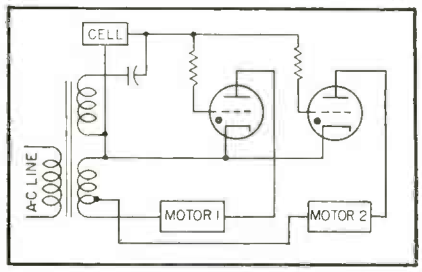


FIG. 3—Suggested circuit for operating a series of motors from different light levels

More complete data for operation of the barrier-layer cells is given by J. A. Sargrove in *Journal of the British Institution of Radio Engineers* for May-June 1947.—J.H.J.

Microwaves for Railroad Control

USE of microwave beam radio, employing frequency modulation on a frequency of 6,660 megacycles, is made by the Long Island Railroad for remote-control operation of some of the new electric power distributing sub-stations now being constructed as part of the railroad's $17,656,000 improvement program. Experiments are also being made for remote control of switches and signals as in Centralized Traffic Control and interlocking systems, the metering of electric power used, teletype and telephone communica-

For new simplicity, wide range, and high accuracy in the control of modern electronic circuits...

Cutaway view of the HELIPOT (Model A—10 Turn—1¾" Diameter)

THE BECKMAN Helipot

(Trademark of the HELIcal POTentiometer)

Provides *many times* greater resistance control in *same* panel space as conventional potentiometers!

IF YOU are designing or manufacturing *any type* of precision electronic equipment be sure to investigate the greater convenience, utility, range and compactness that can be incorporated into your equipment by using the revolutionary HELIPOT for rheostat-potentiometer control applications...and by using the new DUODIAL turns-indicating knob described at right.

Briefly, here is the HELIPOT principle...whereas a conventional potentiometer consists of a *single* coil of resistance winding, the HELIPOT has a resistance element *many times* longer coiled *helically* into a case which requires no more panel space than the conventional unit. A simple, foolproof guide controls the slider contact so that it follows the helical path of the resistance winding from end to end as a single knob is rotated. Result...*with no increase in panel space requirements,* the HELIPOT gives you as much as 12 times* the control surface. You get far greater accuracy, finer settings, increased range—with maximum compactness and operating simplicity!

COMPLETE RANGE OF TYPES AND SIZES

The HELIPOT is available in a complete range of types and sizes to meet a wide variety of control applications . . .

MODEL A: *5 watts, 10 turns, 46" slide wire length, 1¾" case dia., resistances 10 to 50,000 ohms, 3600° rotation.*

MODEL B: *10 watts, 15 turns, 140" slide wire length, 3¼" case dia., resistances 50 to 200,000 ohms, 5400° rotation.*

MODEL C: *3 watts, 3 turns, 13½" slide wire length, 1¾" case dia., resistances 5 to 15,000 ohms, 1080° rotation.*

MODEL D: *15 watts, 25 turns, 234" slide wire length, 3¼" case dia., resistances 100 to 300,000 ohms, 9000° rotation.*

MODEL E: *20 watts, 40 turns, 373" slide wire length, 3¼" case dia., resistances 150 to 500,000 ohms, 14,400° rotation.*

Also, the HELIPOT is available in various special designs . . . with double shaft extensions, in multiple assemblies, integral dual units, etc.

Let us study *your* potentiometer problems and suggest how the HELIPOT can be used—possibly is already being used by others in your industry—to increase the accuracy, convenience and simplicity of modern electronic equipment. No obligation, of course. Write today outlining your problem.

**Data for Model A, 1¾" dia. Helipot. Other models give even greater control range in 3" case diameters.*

THE BECKMAN Duodial

The inner, or Primary dial of the DUODIAL shows exact angular position of shaft during each revolution. The outer, or Secondary dial shows number of complete revolutions made by the Primary dial.

A multi-turn rotational-indicating knob dial for use with the HELIPOT and other multiple turn devices.

THE DUODIAL is a unique advancement in knob dial design. It consists essentially of a primary knob dial geared to a concentric turns-indicating secondary dial—and the entire unit is so compact it requires only a 2" diameter panel space!

The DUODIAL is so designed that—as the primary dial rotates through each complete revolution—the secondary dial moves one division on its scale. Thus, the secondary dial counts the number of complete revolutions made by the primary dial. When used with the HELIPOT, the DUODIAL registers *both* the angular position of the slider contact on any given helix as well as the particular helix on which the slider is positioned.

Besides its use on the HELIPOT, the DUODIAL is readily adaptable to other helically wound devices as well as to many conventional gear-driven controls where extra dial length is desired without wasting panel space. It is compact, simple and rugged. It contains only two moving parts, both made entirely of metal. It cannot be damaged through jamming of the driven unit, or by forcing beyond any mechanical stop. It is not subject to error from backlash of internal gears.

TWO SIZES—MANY RATIOS

The DUODIAL is now available in a 2" diameter model and soon will also be available in a new 4¾" diameter model for main control applications. Standard turns-ratios include 10:1, 15:1, 25:1 and 40:1 (ratio between primary and secondary dials). Other ratios can be provided on special order. The 10:1 ratio DUODIAL can be readily employed with devices operating *fewer* than 10 revolutions and is recommended for the 3-turn HELIPOT. In all types, the primary dial and shaft operate with a 1:1 ratio, and all types mount directly on a ¼" round shaft.

Send for this HELIPOT AND DUODIAL CATALOG!

Contains complete data, construction details, etc., on the many sizes and types of HELIPOTS...and on the many unique features of the DUODIAL. Send for your free copy today!

THE Helipot CORPORATION, SOUTH PASADENA 2, CALIFORNIA

tion and facsimile reproduction of written orders and messages.

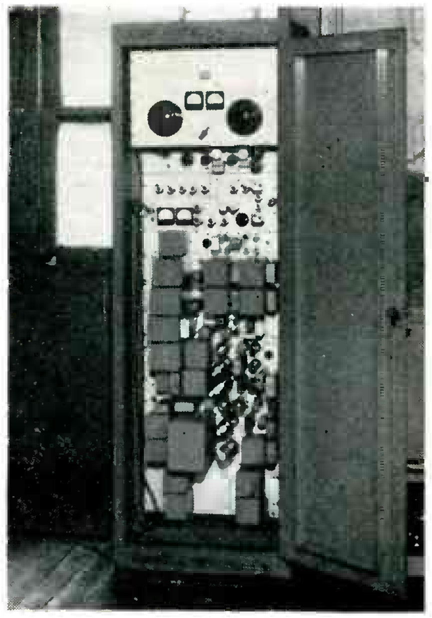
Two 4-foot parabolic reflectors are installed on the roof of the Jamaica station building, 100 feet off the ground, and two similar reflectors are mounted on a 60-foot pole at Floral Park. One reflector is used for transmission and the other for reception of signals. The reflectors were aligned between Jamaica and Floral Park by means of contour maps and the path was checked at night by means of floodlights and a surveyor's transit.

Four-foot parabolas installed on the roof of Jamaica station for beam transmission and reception

At Jamaica, transmitters, receivers and associated devices are located in a small structure on the roof of the station building and linked to control and communication devices in the third-floor office of the power director. From control panels there, switches in the Floral Park sub-station are operated, with a panel light flashing an indication that the operation has been carried out.

For experimental purposes, similar remote control of switches and signals and the metering of electric current have also been done. Likewise, the teletype and facsimile machines have been installed purely for demonstration. Radio control of sub-station switches at Floral Park and the attendant two-way voice communications are in regular operation.

The beam from Jamaica to Floral Park is on a frequency of 6,660 megacycles. The beam in the



Sperry transmitter and receiver and power supplies used at both ends of the beam installation

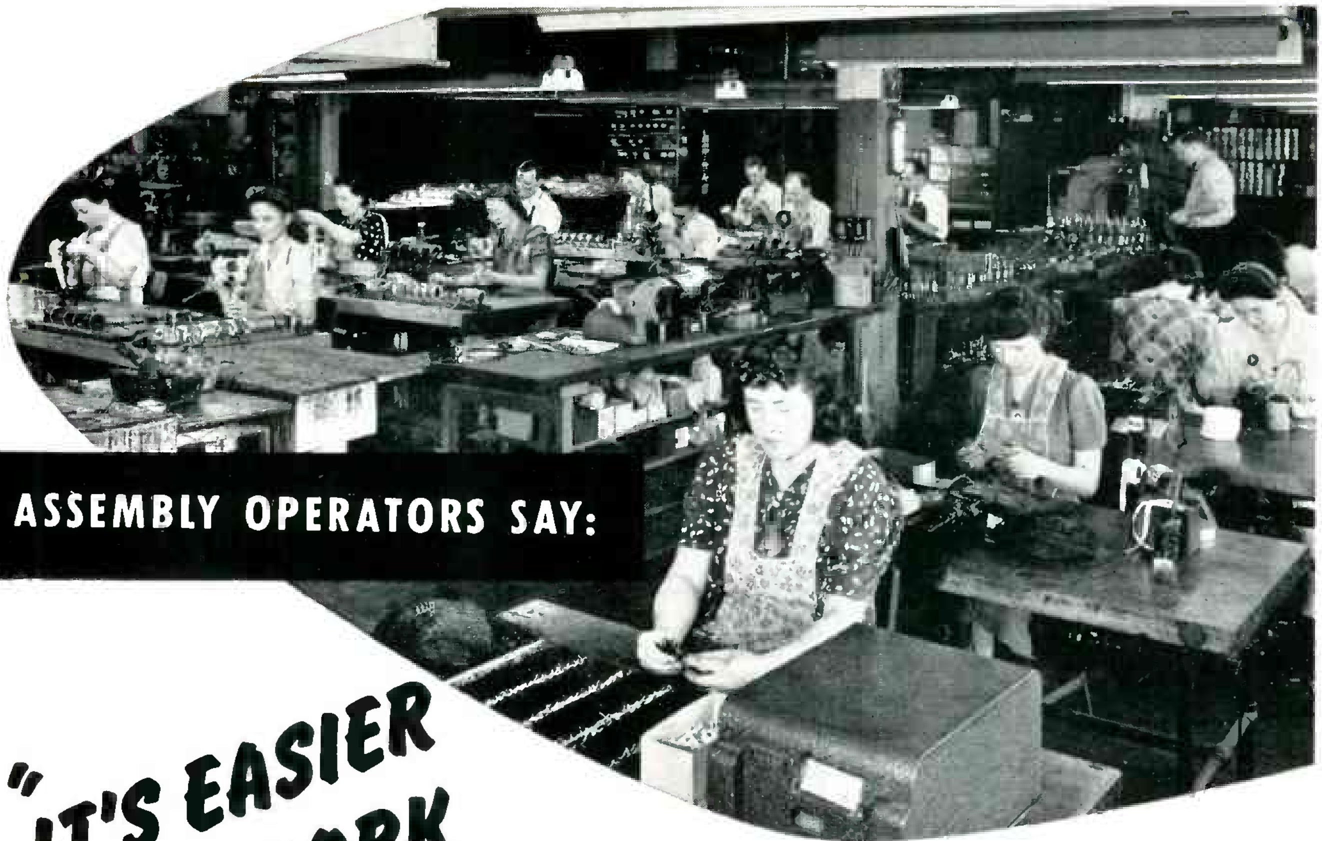
reverse direction, is on 6,640 megacycles. After demonstration signals and switches at Floral Park have been activated from Jamaica, indications are flashed back to show signal positions. Continuous indications of track occupancy by trains are received at Jamaica, and teletype, telephone and facsimile communication also work both ways. Eight channels in all are used.

To test the operation of the apparatus over a potentially longer distance, certain devices were introduced into the circuits to simulate conditions at a distance of 48 miles between the two installations. The results were entirely satisfactory. For greater distances, use of relay and repeater stations at various intervals may permit using microwave radio for control and communication on railroads with many more miles of line than the Long Island. The present installation has been achieved by collaboration of engineers of Sperry Gyroscope Co. and the Union Switch and Signal Co.

Television Crosshatch Generator

LINEARITY ADJUSTMENTS in television receivers may be expedited by the use of a relatively simple crosshatch generator, the circuit of

ASSEMBLY OPERATORS SAY:



"IT'S EASIER TO WORK WITH DIEFLEX"

VARNISHED TUBING PRODUCTS

. . . because Dieflex Tubing and Sleeving have the qualities that make assembly work easier—flexibility, smooth bore, good push-back, and non-frayability. Let your operators work with Dieflex and you will see the difference . . . see how it saves lost motion, lost time, and needless aggravation.

Engineers like Dieflex, too, because of its uniformly complete impregnation and high dielectric strength. There is a Dieflex product for every tubing and sleeving requirement—with a base of either finely braided cotton or glass fibre, impregnated with oleoresinous varnish or silicones, as your applications may require.

We would like an opportunity to show you how much Dieflex can reduce your assembly costs—will you let us?

DIEFLEX PRODUCTS LIST

MADE WITH BRAIDED COTTON SLEEVING BASE

Grade A-1 Magneto Grade Varnished Tubings
Grade B-1 Standard Grade Varnished Tubings
Grades C-1 and C-2 Heavily Coated Saturated Sleevings
Grade C-3 Lightly Coated Saturated Sleevings
Heavy Wall Varnished Tubings and Saturated Sleevings

MADE WITH BRAIDED GLASS SLEEVING BASE

Grade A-1 Magneto Grade Varnished Fiberglas Tubings
Grade C-1 Extra Heavily Saturated Fiberglas Sleevings
Grade C-2 Heavily Saturated Fiberglas Sleevings
Grade C-3 Lightly Saturated Fiberglas Sleevings
Silicone Treated Fiberglas Varnished Tubings and Sleevings

INSULATION
MANUFACTURERS CORPORATION

Chicago 6 • 565 W. Washington Blvd.

MILWAUKEE 2
312 E. Wisconsin Ave.

CLEVELAND 14
1231 Superior Ave., N. E.

DETROIT 2
15 Lawrence Ave.

DAYTON 2
1315 Mutual Home Bldg.

IMC Representatives
W. C. JOHNSON—PEORIA 5—101 Heinz Court
H. A. HOLDEN—MINNEAPOLIS 3—1208 Harmon Place
H. R. BRETHEN—DETROIT 2—15 Lawrence Ave.

Authorized Distributors
INSULATION and WIRES INCORPORATED
St. Louis 3, Mo. • Atlanta, Ga. • Boston 20, Mass.
Detroit 2, Mich. • Houston 2, Tex. • Hillside, N. J.
and other cities.

TRI-STATE SUPPLY CORPORATIONS
Los Angeles 13, Cal. • San Francisco 7, Cal.
Seattle 4, Wash.

ELECTRICAL IMC INSULATION

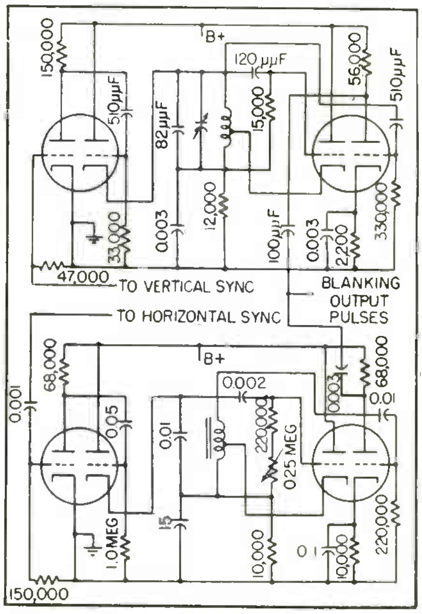


FIG. 1—Circuit diagram of crosshatch generator. Type 12AU7 tubes are used throughout

which appears in the accompanying diagram. This unit blanks the electron beam at regular intervals to form 12 horizontal and 16 vertical lines on the screen of the picture tube. Since the generator is connected directly to the receiver being adjusted, test pattern distortion errors introduced in camera chains and transmitters are avoided.

The generator has sufficiently low power requirements to allow the necessary voltages for its operation to be taken from the receiver being tested without undue strain on the components of the receiver power supply.

The number of lines is adjustable,

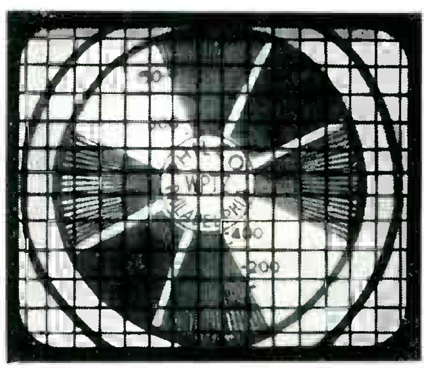
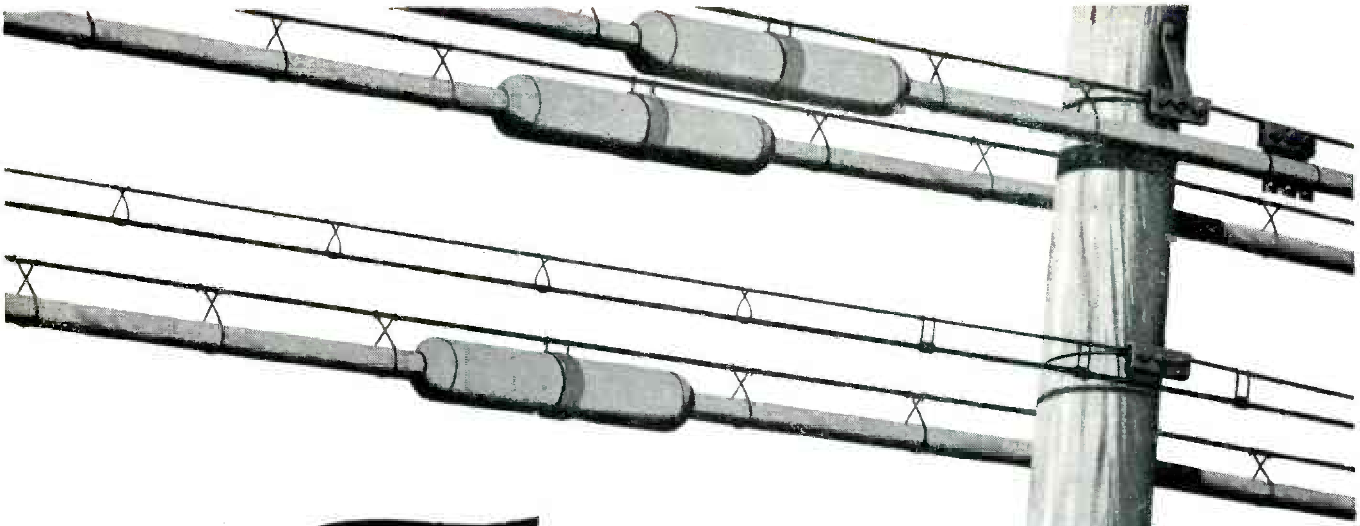


FIG. 2—Crosshatch pattern obtained with properly adjusted receiver using crosshatch generator

but the 12 to 16 ratio has been found to be most convenient for most linearity adjustments. Thus the proper aspect ratio, as well as both horizontal and vertical linearity adjust-



The case of the Creeping Sleeve

Lead sheathing on telephone cable meets many stresses — the tug of its own weight, wind pressure, contraction and expansion from cold and heat. Then, too, there's the pressure of nitrogen gas put in Long Distance cable to warn of sheath breaks and keep out moisture.

And, sometimes, lead is subject to "creep"— a permanent stretching — even when the stress is but a fraction of the normal tensile strength. Creep is especially likely at the lead sleeves used where two lengths of cable are joined. The sleeve may stretch and break open exposing telephone circuits to the elements.

So Bell Laboratories scientists have developed methods to test and control creep. In a special testing room, weights are applied to scores of samples of lead, under controlled conditions. Exact records of the amount of creep are obtained with a precision instrument.

Years of careful study have produced a lead composition which resists creep and yet has all the other properties required of sleeves. This means better telephone service for you and helps give that service at lowest possible cost. It is an example of the way Bell Telephone Laboratories scientists study and improve every part of the great telephone plant.

BELL TELEPHONE LABORATORIES

EXPLORING AND INVENTING, DEVISING AND PERFECTING, FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE.

ments, may be made easily and accurately. Philco Corporation is responsible for the development of the instrument.

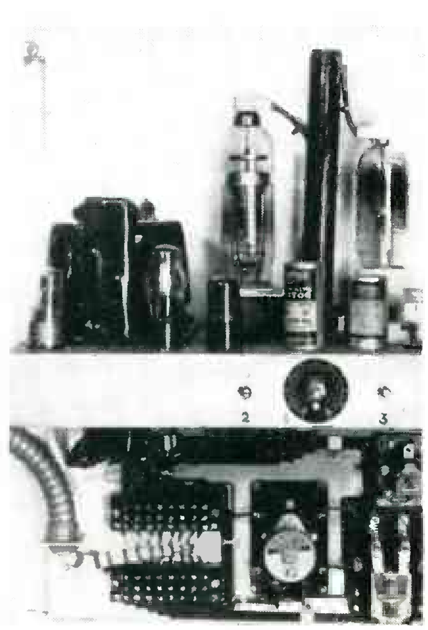
Electronic Control for Milk Pasteurization

IN MILK PASTEURIZATION it is essential that every particle of milk is heated to a certain temperature (usually 162 F) for a specified interval, and that this temperature be held within extremely close limits. One system for pasteurization temperature control makes use of electronic circuits.

The actual controlling unit or control head is a variable impedance bridge which is actuated by a bulb and bellows arrangement. The output of the control head is proportional to the temperature of the milk.

The control head has two input windings mounted on the outside legs of an E-shaped core. These coils are connected in series and wound to set up a flux flowing in the same direction in each leg. Two output windings are also mounted on these legs. These output windings are linked by the flux generated by the input coils and are connected to oppose each other.

The bellows rocks a pivoted armature which varies the amount of flux threading the output coils by changing the air gaps between the



Electronic unit for control of milk pasteurization temperature

for MORE POWER

The Type V-20 VARIAC* . . . one of the newer additions to our VARIAC line . . . is proving exceedingly popular. With its load rating of almost 3½ kw it is filling a definite need which could not be met with a single Type 100 which it replaces. The V-20 is rated at 20 amperes, with a 30 ampere maximum; the 230-volt V-20H at 8 and 10 amperes respectively.

These latest VARIACS are provided with heavier barrier terminals in a box equipped with knockouts for standard ¾-inch BX or conduit. The new combination knob and hand wheel makes it much easier to vary voltage. The V-20 dials have extra large calibration figures, easy to read at a distance.

As with all VARIACS, output voltages are continuously adjustable from ZERO to 17% above line voltage.

* The trade name VARIAC is registered at the U. S. Patent Office. VARIACS are manufactured and sold under Patent No. 2,009,013.

SPECIFICATIONS

	TYPE V-20	TYPE V-20H
LOAD RATING (KVA)	3.45	2.3
Input Voltage	115	230 or 115
Output Voltage Zero to	115 or 135	270 or 230
Rated Current (Amperes)	20	8
Maximum Current (Amperes)	30	10
PRICE	$55.00	$55.00

WRITE FOR THE "VARIAC BULLETIN"

GENERAL RADIO COMPANY

Cambridge 39, Massachusetts

90 West St., New York 6 920 S. Michigan Ave., Chicago 5 1000 N. Seward St., Los Angeles 38

armature and the core. When the two air gaps are equal the output voltage becomes zero. Any unbalance of flux will result in the generation of an a-c voltage whose magnitude depends on the degree of unbalance. The core spacing is adjustable and is set for the desired pasteurizing temperature.

The output of the control head is fed through suitable amplifiers and rectifiers so that a direct current proportional to milk temperature is produced. The resulting direct current energizes the control coil of a saturable reactor which in turn determines the current through the heating element.

Single and 3-phase units have been developed. The single-phase unit uses a first-stage saturable reactor to increase the effect of the temperature increment, and Fansteel rectifiers are used throughout. The 3-phase unit is similar in principle, but it is electronically controlled. It is divided into two main portions. One consists of two large power tubes, an EL C-6-J and an EL-6-B or NL-617.

The other section of the 3-phase unit is made up of three vacuum tubes and various other standard circuit elements. This combined network controls the grid of the EL C-6-J rectifier tube. The output of the two power tubes is fed into the d-c portion of the large saturable reactor which in turn controls the a-c current in the heating element.

The a-c voltage applied to the heater electrode varies in the range from 140 volts to approximately 230 volts. These limits may be adjusted by controls 1 and 2 as shown in the accompanying illustration. With an increase in milk temperature the direct current to the control coil of the saturable reactor decreases, the voltage drop across the a-c windings of the reactor increases, the electrode heater voltage decreases, less heating occurs, and the temperature returns to the correct value.

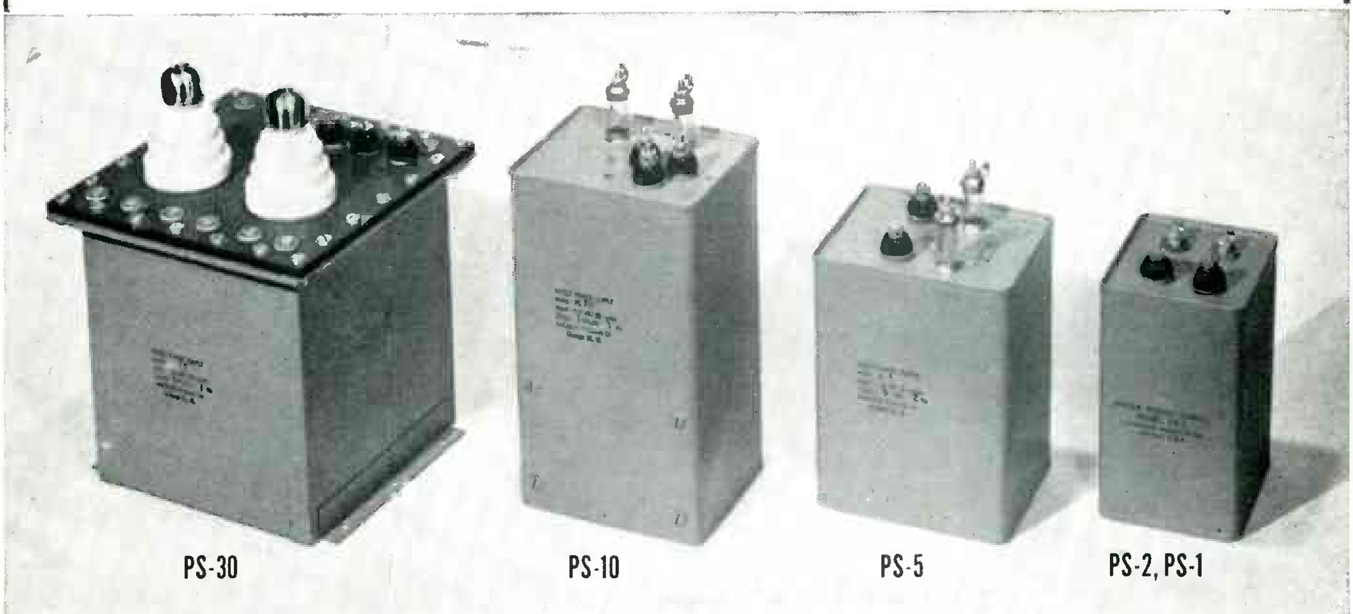
Wire Recorder Techniques

EXTERMINATING rats is a unique use of a wire recorder being accomplished in Vancouver, B. C. There a specialist in rodents caught a

Introducing—

Another Plasticon Development

HIVOLT POWER SUPPLIES



HiVolt Supplies are self-contained in hermetically sealed metal containers. They are designed to transform low voltage AC to high voltage—low current DC.

PS-30-30,000 VDC; 1 Ma.; dimen. 7" x 7" x 7"

PS-10-10,000 VDC; 2 Ma.; dimen. 3¾" x 4 9/16" x 8"

PS-5-5,000 VDC; 5 Ma.; dimen. 3¾" x 4 9/16" x 6"

PS-2-2400 VDC; 5 Ma.; dimen. 3¾" x 3 3/16" x 5½"

PS-1-2400 VDC — Capacitor load; dimen. 3¾" x 3 3/16" x 5½"

High Voltage-Low Current DC Power Supplies

for

Television — Radiation Counters — Photoflash Devices—Electrostatic Precipitators —Spectographic Analysers—Oscilloscopes, etc.

Write for descriptive literature

Plasticon Capacitors, Pulse Forming Networks and HiVolt Power Supplies are available at all leading jobbers.

CP **Condenser Products Company**

1375 NORTH BRANCH STREET • CHICAGO 22, ILLINOIS couple of live rats in a trap and poked and prodded them until they squealed. Their cries were picked up by a microphone and recorded on wire. When played back in a rat-infested buildings, there was a stampede of rats to the exits.

In another recording, the plaintive cries of a lonesome lady rat were put on the wire and played back in a rat-infested building. Male rats came running from all directions and were disposed of with a special pistol.

Squeals of rats are recorded on a Webster Chicago Unit

Other applications of wire recorders reported by Webster-Chicago include criminal cases in which the prisoner's confession in his own words and his voice inflections help in judging the evidence.

Hospitals use wire recorders to supply music through a stethoscope device to relax certain patients, tense with fear before operations; and a Cincinnati clergyman makes wire recordings of his Sunday morning service and takes the playback unit to shut-in parishioners who are then able to hear the service and sermon in the presence of their pastor.

One Chicago company reports a saving of $50,000 in inventory-taking by using wire recorders. Using the new system, one man calls off articles and later checks lists from the recording. A side-show barker has his patter on wire so he can take a day off occasionally while a wire record does the job of luring the customers.

THE ELECTRON ART

(continued from page 132)

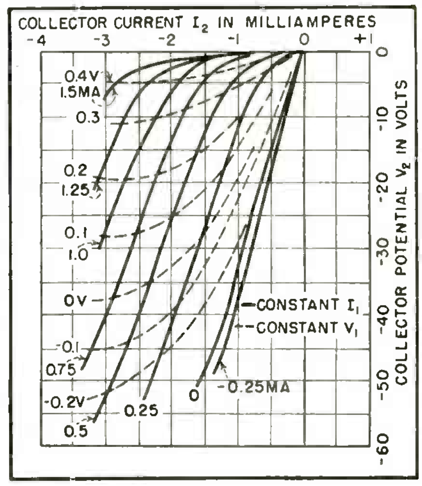


FIG. 1—Typical operating point on the static transfer characteristics of a transistor is at a few milliamperes reverse current in the collector and about one milliampere forward current in the emitter

sulting from the output circuit being of higher impedance than the input circuit produce the power amplification of the transistor. Although this family of curves can be used to determine the small-signal performance of the transistor, the equivalent circuit is more simply used.

Equivalent Circuit

From circuit theory the equivalent transistor circuit of Fig. 1 can be deduced. The values for the equivalent circuit elements are those for a typical operating point and transistor. The coupling between input and output circuits is accounted for by r_b and r_m. The apparent generator voltage in the output circuit is the product of the mutual transfer resistance and the change in input current. Although

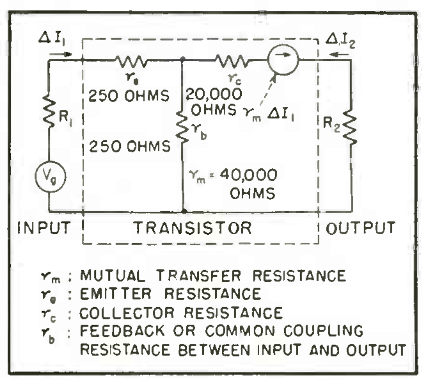


FIG. 2—The transistor can be represented by an equivalent resistance network at low frequencies. A typical load would be 10,000 ohms, a typical input resistance is 500 ohms

other circuits could be deduced, this one permits simple analysis of circuits in which transistors are used.

Preliminary data show that the transistor characteristics do not change much from zero to one or two megacycles; beyond that the gain decreases. The noise per unit bandwidth at one kilocycle is about 60 db greater than the Johnson noise for an equivalent input resistance, but decreases with increasing frequency to be about 30 db above Johnson noise at one megacycle. How much improvement can be made cannot be anticipated.

F-M and P-M Demodulator

By JOHN A. SARGROVE
Chairman and Managing Director
and R. E. BLAISE
General Manager
Research Laboratories
Sargrove Electronics, Ltd.
Walton-on-Thames, England

A SINGLE MULTIGRID TUBE can be used as a demodulator for frequency or phase modulation in a newly developed Phasitron circuit (not to be confused with the Phasitron tube used in the frequency modulators of transmitters). Conventional pentodes, hexodes or heptodes having two signal input grids can be used in the circuit, for example, a 6L7 can be used. With the British equivalent of this type tube, demodulation slopes as high as 2 ma per 100-kc deviation at a carrier frequency of 45 mc have been obtained. The efficiency of the circuit increases with frequency. By thus providing a sensitive demodulator for frequency or phase-modulated signals, this circuit extends the utility of these methods of modulation and simplifies the equipment used with them.

Resultant Output

The signal to be demodulated is applied to one grid of the tube; the other grid is attached to a high-Q circuit tuned to the undeviated carrier frequency. The resultant output in the anode circuit is

$$I_A = C\,(E_1 \sin\omega_0 t)\,(E_2 \sin\omega_0 t + \alpha)$$
$$= \frac{CE_1E_2}{2}\left[\cos\,(2\omega_0 t + \alpha) - \cos\,\theta\right]$$

where C is a constant of the tube. Operation of this simple circuit, shown in Fig. 1A, relies on the

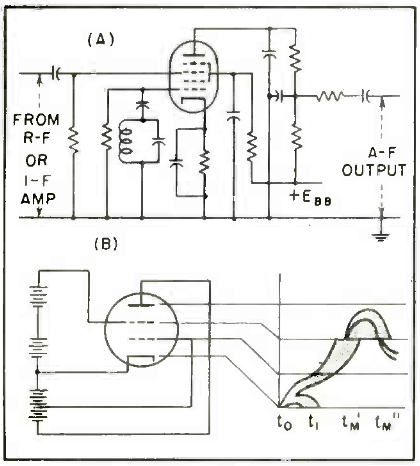


FIG. 1—(A) Phasitron circuit is a multigrid demodulator for f-m having the characteristic shown here. (B) Action of demodulator depends on the space charge coupling between two control grids

coupling provided by the electron stream, as described later, between the two signal input grids. When a large-amplitude undeviated carrier is applied to the second input grid, the high-Q circuit, which is tuned to the mean carrier frequency, is excited. Because of the electronic coupling, the resonant circuit oscillates at about 90 degrees out of phase with the incoming carrier, producing a mean plate current. As the incoming signal deviates, because of its modulation, to a higher or lower frequency, the oscillations in the tuned circuit will be less or more than 90 degrees out of phase. Consequently the resultant plate current will vary about the mean plate current. This circuit thus converts the frequency-modulated signal directly into an a-f current. The r-f components in the plate circuit are grounded.

The efficiency of this demodulator is proportional to the Q of the resonant circuit and to the amplitude of the input signal. Efficiency increases with carrier frequency. The demodulation characteristic was taken with an input carrier of 45 mc at an amplitude of 20 rms volts. With the usual value of plate resistance, 50,000 ohms, the 100-kc deviation gives 100 volts peak-to-peak audio output. A tube similar to the American 6L7 was used for these measurements.

Potential Applications

In addition to the obvious application as a demodulator in f-m re-

FIG. 2—Small capacitor microphone modulates high-frequency oscillator in high-fidelity sound recording system that uses new demodulator circuit

ceivers, this circuit is finding applications in industrial equipment and motion-picture studios. (The application of this circuit to sound reproduction was discussed in a series of papers published in *The Jour British Kinematograph Soc.*, p 189–200, June 1948.) In obtaining an indicator card of an internal combustion engine, showing pressure as a function of piston position on an oscilloscope, small diaphragms are used to translate pressure and position into capacitance variations in tuned circuits of oscillators. The frequency changes thus produced are demodulated by Phasitron circuits and feed directly to the oscilloscope. Such a system avoids the need for direct-current amplifiers. The transducers can also be sturdy and compact.

Improved sound recording in the studio is made possible using this circuit with the capacitor microphone of Fig. 2. Because of the sensitivity of the Phasitron circuit, the microphone itself can be very small, about half an inch in diameter, and thus can respond to high audio frequencies. The microphone then frequency modulates a miniature oscillator at the end of its boom. A coaxial cable hundreds of feet long can be used from the microphone boom oscillator to the demodulator at the mixer panel without affecting the frequency response of the circuit. This system is flat to 50,000 cps, has excellent transient response and is free of frequency doubling effects because the microphone diaphragm is so small. A further advantage is that the capacitor microphone requires no polarizing voltage or high-impedance shunting resistor, thus doing away with the crackle associated with capacitor microphones.

Electronic Coupling

The action of the demodulator depends on the electronic coupling between the grids. Figure 1B shows the space charges and transit times in a multigrid tube connected for this circuit. Only those electrons leaving the cathode at one instant in time are considered in this simplified discussion.

At the beginning of the action t_0, electrons of various initial velocities are emitted from the cathode. The slower electrons are returned to the cathode, arriving at t_1. The faster electrons pass through the first control grid and, under the influence of the positive potential of the second control grid, are accelerated on toward the anode. The electrons reach the second grid at t_M', some striking it and passing out of the picture, others continuing through toward the anode. However, the anode is electrically neutral and therefore returns the electrons through the second grid. The electronic space charge thus oscillates about the second control grid.

The number of electrons in the space charge between the second control grid and the anode is a direct function of the voltage which existed on the first control grid a short instant before. The transit time between the grids is, therefore, an important factor in the use of these phenomena. With usual potentials on the tube elements, transit times of the order of 10^{-7} to 10^{-8} seconds are obtained, thus the operating frequency must be high, between 10 and 100 mc.

When a signal is applied to the second grid, it becomes highly negative at one time in its cycle, thus repelling the electrons back toward the first grid. In effect the action of the tube is now reversed. Electrons from the space charge near the anode travel back to the first control grid forming a new space charge in the vicinity of this grid. Again, the space charge about the first grid is a function of the voltage that prevailed at the second grid a short time previously. Because the motion of the space charge induces a current in the

grids, the two grids of the tube are coupled together, giving the demodulation action previously described.

Fractional Frequency Division by Feedback

FREQUENCY DIVIDERS are discussed in detail in current literature, but usually these circuits are limited to integral step-down ratios. This restriction can be removed by the application of feedback networks to a multivibrator chain. Besides making prime ratios readily available this method also permits the utilization of nonintegral rational numbers such as 14–95/121.

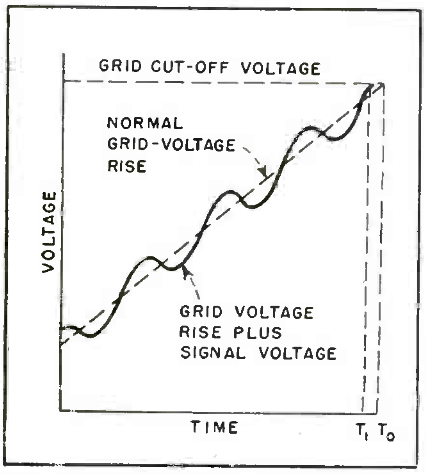


FIG. 1—Signal voltage superimposed on regular discharge curve causes grid voltage to reach cut-off at T_1, whereas without signal, tube would have triggered at T_0

The integral submultiplying circuits involve the superposition of the signal voltage on the regular discharge curve of one of the multivibrator waveforms as shown in Fig. 1. Without the superimposed voltage, the circuit would trigger at time T_0, but with it, the flip occurs prematurely at time T_1. Since the submultiplying ratio is limited to around 15 (for reasons of stability), multivibrators in series are usually used where larger ratios are required as shown in Fig. 2.

A few cycles of plate voltages are shown by the solid lines in Fig. 3. At time T_1, triode A_1 (Fig. 2) starts to conduct and the resultant voltage drop at its plate causes B_1 to cut off. If the circuit constants of stage 2 are adjusted so that B_2 starts to conduct on the third pip from the first stage, the period of stage 2 will be from T_1 to T_3, and

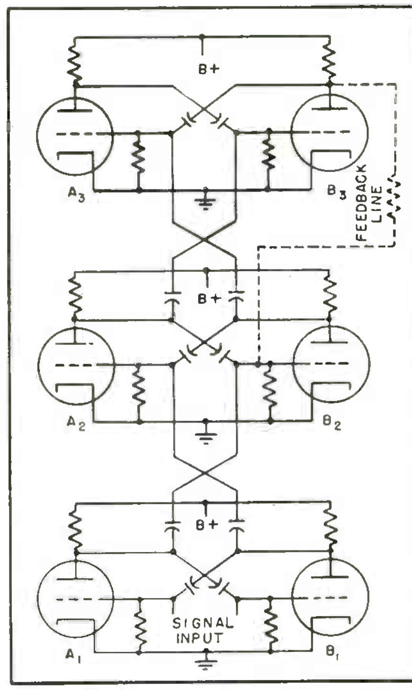


FIG. 2—Multivibrators in series. Dotted portion shows feedback network for non-integral frequency division

the frequency division is 5 to 1.

If the plate voltage of B_3 is coupled back to the grid of B_2 as shown by the dotted line in Fig. 2, the increased voltage at that plate will increase the rate of rise at the grid of the second-stage tube. As a result, B_2 will require fewer pips from A_1 before it passes current. The resulting waveforms are shown by the dotted lines in Fig. 3.

While B_3 is conducting, the feedback voltage will be so low that it will not affect the oscillations of stage 2, then stage 2 will follow one pattern while B_3 is blocked, and another while it is conducting. Therefore, the waveform of tube 3 will be unsymmetrical.

If the division ratios of the various stages are designated by the letter R, while N is the number of pips from a preceding stage required to trigger a particular stage, the overall reduction ratio may be represented by $(R_2 \times R_3) - N_{B3}\delta$ where δ is the number of units by which N_{B2} is shortened by the feedback voltage. The ratio of stage 2 is this expression divided by R_3.

Since the ratio between stages 3 and 2 is not changed by the feedback voltage, R_3 will be equal to the second stage as altered by the feedback or, $R_3 = R_2 - N_{B3}\delta/R_3$. The dividing ratio as seen at the output

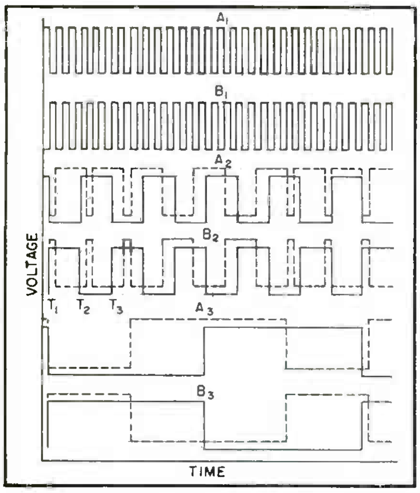


FIG. 3—Plate voltage waveforms for a three-stage multivibrator with and without feedback

of the third stage would be 5 − (3 × 2)/5, or, 3-4/5, using the original factors with a δ of 2. Thus a nonintegral ratio has been obtained.

With feedback spanning more than one stage, the calculations become more involved, but similar reasoning will produce the desired results. The output waves from such circuits are flat-topped. Where sine waves are desired, suitable filters may be employed. (K. H. Davis, Multivibrator Step-Down by Fractional Ratios, *Bell Labs Record*, p 114, March 1948.)

SURVEY OF NEW TECHNIQUES

ENERGY DISTRIBUTION of 100,000,000-volt x-rays produced by the betatron in the General Electric Research Lab is measured with 100 G-M tubes and some 300 additional vacuum tubes. This electronic instrument utilizes the direct transformation from energy to mass in which pairs of electrons and positrons are produced by high-energy x-rays when passing through matter. The x-ray beam bombards a thin metal target in the evacuated 8-ton mobile instrument. Pairs of electrons and positrons so produced are deflected, each according to its electrical charge and initial velocity, in the field of an electromagnet to a bank of G-M tubes. Because the initial velocity of a pair depends on the energy of the incident x-ray, pairs of different energies will intercept different G-M

tubes. The counts so produced are tabulated by the electronic register to show directly the spectrum of the betatron's x-rays. The apparatus, developed under Office of Naval Research sponsorship, is described by Dr. J. L. Lawson in the October *General Electric Review;* a discussion of the experimental results is planned for publication in the *Physical Review.*

SHORT-ARC high-pressure cadmium-mercury vapor lamps have been developed experimentally. A 10,000-watt d-c lamp with a three-eighths-inch arc enclosed in a quartz bulb and having about half the brightness of the sun was demonstrated for spot and floodlighting of studios by E. W. Beggs of the Westinghouse Lamp Division at the recent conference of the SMPE. The shortness of the arc makes possible a high degree of optical control. The small amount of cadmium adds enough red to the mercury spectrum to make the lamp suitable for color movies. In 400 and 1,000 watt a-c sizes the lamp can be used in television studios.

CONTRAST characteristics of optical and electrical lenses can be measured objectively by an electronic method described by O. H. Schade, development engineer in the Tube Department of RCA, at the American Optical Society convention in Detroit in October. A test pattern consisting of vertical and horizontal lines of graded sizes is mounted before the lens to be tested, which in turn produces a greatly reduced image of the pattern. A microscope enlarges this image before it is picked up by a television camera. One square of the image may cover the camera tube. The electrical image so formed is reproduced on a kinescope and its waveshape is displayed on an oscilloscope. Using these displays, the contrast or detail response of the lens at any degree of resolution can be determined. The technique can be modified for evaluating electrostatic or electromagnetic lenses in camera and kinescope tubes, or for studying whole systems such as motion picture or television channels from camera to projection screen.

NEW PRODUCTS

(continued from p 136)

and input impedance is 250,000 ohms. The instrument is useful for determining the characteristics of p-a systems, hearing aids and a wide variety of audio devices.

Aluminum Counter

VICTOREEN INSTRUMENT CO., 5806 Hough Ave., Cleveland 3, Ohio. Type 1B85 aluminum-wall, beta-gamma counter tube is designed to replace thin-walled glass tubes previously employed in laboratory and field radiation measuring instruments. The new tube operates at 900 v. Plateau length is not less than 200 v and the plateau slope does not exceed 3 percent per 100 v. Nominal recovery time is 100 microseconds. Maximum operating life is 10^8 counts with life test end point plateau 850 to 950 v. The wall thickness is 30 mg per square centimeter of aluminum.

Remote-Control Unit

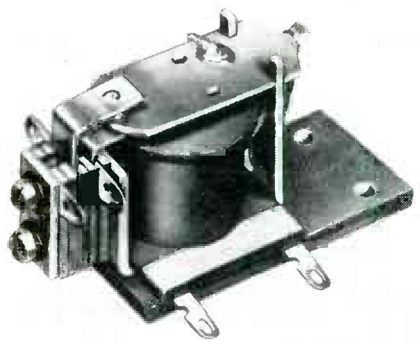
GENERAL ELECTRIC CO., Syracuse, N. Y. Type EC-8-A remote-control unit was designed for controlling a remote central station combination in a land-mobile radio communications system. It employs an automatic level control preamplifier to modulate the transmitter and to maintain the maximum allowable signal.

Flame Failure Guard

COMBUSTION CONTROL CORP., 77 Broadway, Cambridge 42, Mass. To meet the need for flame failure safeguards on gas-oil conversion burners Fireye systems FF-2 and FF-6 are available. The former is used on oil burners which use gas as an alternate fuel, while the second is for gas burners that use light oil as alternate fuel. They are described in Bulletin CH4753.

D-C Relay

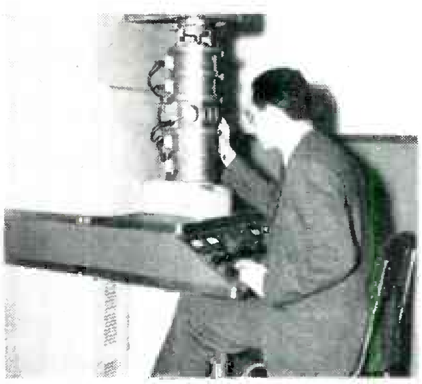
COMAR ELECTRIC CO., 3148 N. Washtenaw Ave., Chicago 18, Ill. The new type E relay has been designed for use in electronic circuits and similar applications. It has contact rating up to 5 amperes



at 25 volts noninductive load. Power to operate is 60 milliwatts. Contact combinations do not exceed single-pole double-throw.

Electron Diffraction

RADIO CORP. OF AMERICA, Camden, N. J. Model EMD-2 diffraction unit permits chemical analysis of substances weighing as little as 1/28 millionth of an ounce. It reveals the



chemical composition and atomic arrangement of crystalline substances by directing a beam of electrons through a minute specimen,

onto either a fluorescent plate or a photographic print.

Photoelectric Street Light

GENERAL ELECTRIC CO., Schenectady 5, N. Y. Form 110 Luminaire illustrated has a built-in photoelectric control. The control comprises

a red-sensitive gas-filled phototube, two amplifier tubes, a filament transformer, and a relay element.

Small Relay

STRUTHERS-DUNN INC., 150 North Thirteenth St., Philadelphia 7, Pa. Type 118XBX miniature relay can be used on d-c, a-c, or halfwave rectified a-c. It has dpdt contacts rated at 2 amperes for 115 volts a-c. Normal d-c operating power is 0.15 watt with a maximum coil resistance of 2,200 ohms. Relays for a-c operate on approximately 9 volt-amperes with coils available for operation up to 115 volts, 60 cycles.

Fixed F-M Receiver

COMMUNICATIONS COMPANY, INC., 300 Greco Ave., Coral Gables, Florida. Comco model 389-R receiver is designed for services operating in the band of frequencies between 152 and 162 megacycles. Looking towards the time when closer spac-

ing of channels may be necessary, the receiver is designed to have a selectivity of at least minus 80 db for 60 kc off resonance.

Noise Suppressor

HERMON HOSMER SCOTT, INC., 385 Putnam Ave., Cambridge 39, Mass. Type 110-A dynamic noise suppressor can be added to existing audio equipment. Its features are low

cost, remote control, and single connection for installation. A specially matched pickup is included.

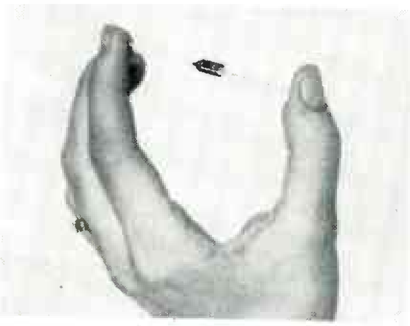
Resistance Thermometer

RUGE-DEFOREST, 76 Massachusetts Ave., Cambridge 39, Mass. A new

bonded wire resistance thermometer element with rapid response, called the RdF Stikon, consists essentially of a grid of fine nickel wire bonded into a paper-thin Bakelite wafer. Bakelite cement can be used to attach the wafer to the surface of interest. Type BN-1 units give long service in the range from −40 F to +300 F.

Germanium Diodes

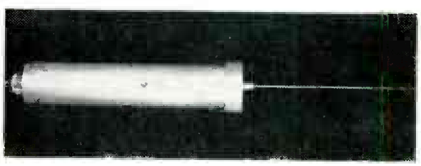
GENERAL ELECTRIC Co., Syracuse, N. Y. Five new types of germanium diodes feature a welded whisker which eliminates contact variation. They are designed to



replace such elements as 6H6 and 6AL5 tubes, copper oxide, selenium, and silicon rectifiers. Safe forward current is 0.05 amp and safe back voltage, 60 volts. Shunt capacitance is 0.8 $\mu\mu$f maximum.

Outdoor Transmitter

SCHUTTIG AND Co., Ninth and Kearny Sts., N. E., Washington 17, D. C. The type S206A outdoor vhf transmitter is a complete 5-watt a-m station including antenna and weatherproof housing. It is designed for fixed frequency intermittent operation in the frequency range from 100 to 150 mc. Carrier control is provided by a tube-operated relay so arranged that control can be obtained by a 60-cycle tone or simplexing.



Mercury Switches

DURAKOOL, INC., Elkhart, Indiana. The new metal-cased mercury switches have an electric weld which seals hydrogen gas under pressure to kill the usual arc between the mercury and the contact points of the switch. Designed for high-capacity, highly inductive cir-

PRECISION POTENTIOMETERS

Toroidal and Sinusoidal

For use in computing and analyzing devices; generation of low frequency saw tooth and sine waves; controls for radio and radar equipment; position indicators; servo-mechanisms; electro medical instruments, measuring devices—telemetering; gun fire control where 360° rotation, high precision and low noise levels are essential.

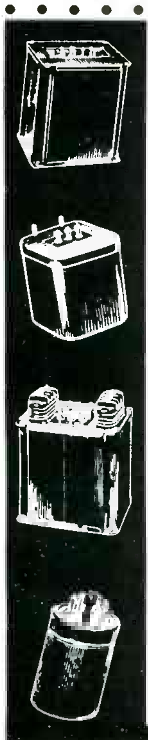
The type RL14MS sinusoidal potentiometer is illustrated. It is wound to a total resistance of 35,400 ohms and provides two voltages proportional to the sine and cosine of the shaft angle. It will generate a sine wave true within ±.6%. Overall dimensions are 4⅜″ diameter x 4 11/32 long plus shaft extension ¼″ diameter x 1¼″ long.

Write for Bulletin F-68

THE GAMEWELL COMPANY

Newton Upper Falls 64, Massachusetts

Now! Specify KENYON



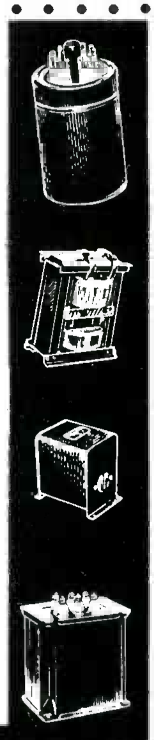
KENYON one of the oldest names in transformers, offers high quality specification transformers custom-built to your requirements. For over 20 years the KENYON "K" has been a sign of skillful engineering, progressive design and sound construction.

KENYON now serves many leading companies including: **Times Facsimile Corporation, Western Electric Co., General Electric Co., Schulmerich Electronics, Sperry Gyroscope Co., Inc.**

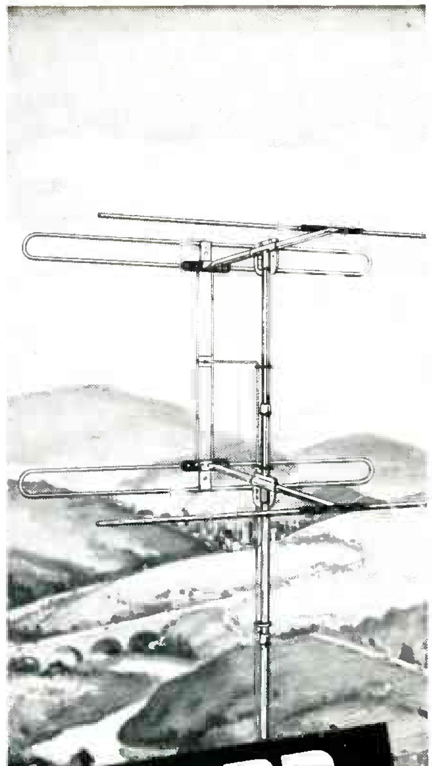
Yes, *electronification* of modern industrial machinery and methods has been achieved by KENYON'S engineered, efficient and conservatively rated transformers.

For all high quality sound applications, for small transmitters, broadcast units, radar equipment, amplifiers and power supplies — Specify KENYON! *Inquire today for information about our JAN approved transformers.*

Now — for the first time in any transformer catalog, KENYON'S new modified edition tells the full complete story about specific ratings on all transformers. Our standard line saves you time and expense. Send for the latest edition of our catalog *now!*



KENYON TRANSFORMER CO., Inc. 840 BARRY STREET NEW YORK 59, N.Y.



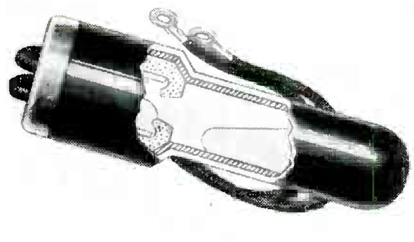
WARD *Magic Wand* ANTENNAS

THE ONLY BROAD BANDED, HIGH GAIN, STACKED ARRAY ON THE MARKET

Many times more sensitive for TV reception in fringe areas and poor signal locations, the WARD TVS-6 STACKED ARRAY achieves maximum forward gain by stacking two high gain folded dipoles and reflectors with effective ½ wave spacing rather than the ordinary ⅛ or ¼ wave which materially reduces sensitivity. THE ONLY STACKED ARRAY ON THE MARKET THAT IS BROAD BANDED, it will give excellent results with MANY CHANNELS where others are too selective. The advanced engineering and PRE-ASSEMBLED design of the WARD TVS-6 is only one of the reasons why WARD is the largest exclusive manufacturer of antennas in the world. See any leading parts distributor or write for catalog.

THE WARD PRODUCTS CORPORATION

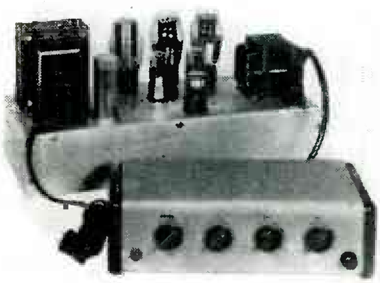
1523 E. 45TH STREET, CLEVELAND 3, OHIO.



cuits, or where variable loads place undue strain on ordinary switches, models range from 1 to 65 amperes in capacity.

Triode Amplifier

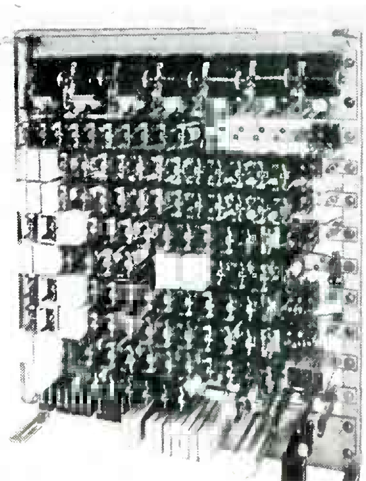
BROOK ELECTRONICS, INC., 34 De Hart Place, Elizabeth 2, N. J. Model 12A3 remote-control amplifier has a virtually flat response from 20 to



20,000 cycles. Intermodulation and harmonic distortion are negligible. A new circuit permits the amplifier to handle power peaks considerably higher than its 10-watt rating.

PABX

FEDERAL TELEPHONE AND RADIO CORP., Clifton, N. J. A new line of private automatic branch exchanges (PABX) provides service from 6



lines upward. Besides handling dial intercommunication, these systems take care of incoming and outgoing calls on central office trunks. Features such as trunk transfer, partial or complete restriction of service, and trunk holding are all available.

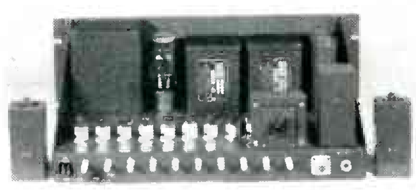
Power Rheostat

REX RHEOSTAT CO., 3 Foxhurst Road, Baldwin, L. I., N. Y. A new vitreous enameled round power rheostat described in catalog 4 uses a self-lubricating powdered metal

washer between the stationary and movable parts of the contact arm to prevent freezing and insure continuous smoothness of operation. There are seven types in this series.

Antenna Multicoupler

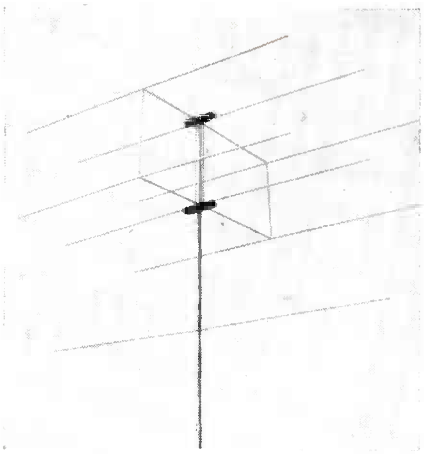
SCHUTTIG AND CO., Ninth and Kearny Sts., N. E., Washington 17, D. C. Type S178A antenna multicoupler provides for coupling one antenna with a balanced or unbal-



anced transmission line to two receivers with unbalanced inputs. The unit covers the frequency range from 2 to 20 mc and can be supplied to match any antenna impedance from 50 to 1,000 ohms.

Television Array

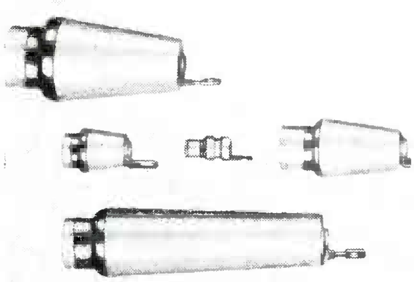
EASTERN TRANSFORMER CO., INC., 147 West 22nd St., New York, N. Y. The new Double-U antenna has



been designed to increase f-m and television reception in fringe areas. There are two antennas, two directors, and three reflectors that make up the array.

Tinned Steatite

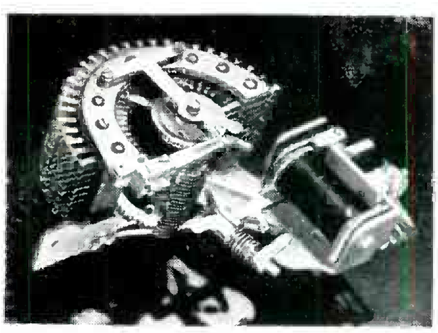
GENERAL CERAMICS AND STEATITE CORP., Keasbey, N. J. A new line of tinned steatite, sealed terminals is presently available for use on



metal enclosures ,such as transformer cans and relay covers. The tinned surface permits easy soldering. Connection is made to an axial lead equipped with a tinned lug.

Stepping Switch

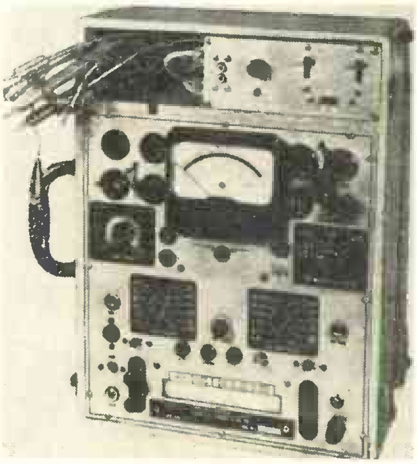
AUTOMATIC ELECTRIC Co., 332 S. Michigan Ave., Chicago 4, Ill. A new 25-point automatic rotary stepping switch, type 45, operates from



46-volt d-c impulses. Speeds up to 70 steps per second are possible when the unit is self-pulsed, or up to 35 steps a second with external pulsing.

Tube Test Meter

RADIO CITY PRODUCTS CO., INC., 152 West 25 St., New York 1, N. Y. Servishop model 8573 has 50 ranges in addition to its function as a com-



plete tube tester. The instrument represents a combination of the model 805B tube and set tester with the model 730 signal generator.

New Core

ELCOR, INC., 4525 N. 124th St., Butler, Wisconsin. A new flexible core is available that can be used for radio transformers, rectifiers,

and battery chargers. A greater flux density may amount to copper savings as high as 30 percent.

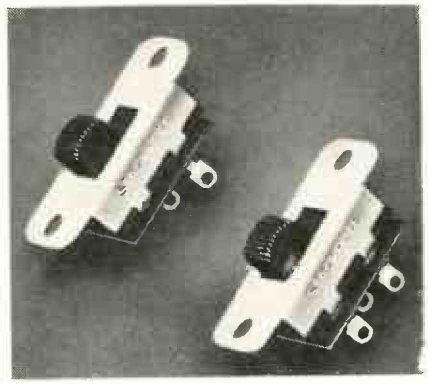
Regulated Power

HASTINGS INSTRUMENT CO., INC., Box 1275, Hampton, Va. A new precision regulated power supply gives any voltage up to 100 volts at specified current in the range from

5 to 30 milliamperes. Regulation within plus or minus 0.1 percent for input line voltages from 75 to 135 volts a-c at frequencies from 50 to 400 cycles is obtainable. Output ripple is better than 0.01 percent.

Slide Switches

STACKPOLE CARBON CO., St. Marys, Pa. Two new slide switches are rated at 1 ampere, 125 volts d-c or 3 amperes, 125 volts a-c. Type



SS26 is single-pole, single-throw, while type SS26-1 is single-pole, double-throw. Colored knobs, terminal enclosures, and other special features can be supplied.

Current Transformers

ASSOCIATED RESEARCH, INC., 231 S. Green St., Chicago 7, Ill. Model 313 Donut type instrument current transformers are of the insert primary type, compensated for

phase angle and ratio error. Designed for 5-volt-ampere burden they are provided with 2-foot secondary leads which may be connected directly to the instrument. The units are insulated for 4,500 volts a-c and can be used on 25 to 133 cycles.

Brightness Tester

PHOTOVOLT CORP., 95 Madison Ave., New York 16, N. Y. Model 205 video brightness tester is a photoelectric instrument for measuring the brightness of television tubes,

screens and c-r tubes. It is designed for laboratory tests, production control, installation and service. Range extends to 100 footlamberts.

Sealed Relays

ADVANCE ELECTRIC AND RELAY CO., 1260 West Second St., Los Angeles 26, Calif. Any type or size of the company's relays can be sealed in octal-plug, Cannon-plug, solder-lug,

or screw-terminal covers. A vacuum seal can also be provided if desired. Dust-tight seals with removable covers are also available.

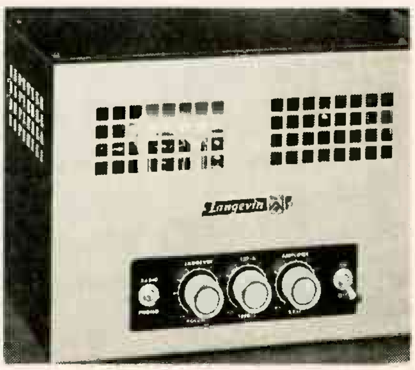
Automatic Dehydrator

ANDREW CORP., 363 E. 75th St., Chicago 19, Ill. Type 1900 automatic dehydrator is designed for pressurizing coaxial transmission

line systems with dry air. Capacity is 1.25 cubic feet per minute. The silica gel dessicant is automatically reactivated. Bulletin 85 gives complete details.

Music Amplifier

LANGEVIN MFG. CORP., 37 W. 65th St., New York 23, N. Y. Type 127-A amplifier is equipped to operate with a radio tuner and a phonograph pickup, either variable re-



luctance type, crystal cartridge, or L-P microgroove pickup cartridges. Power output is 4 watts with less than 5-percent total rms harmonic distortion over the range 50 to 15,000 cps.

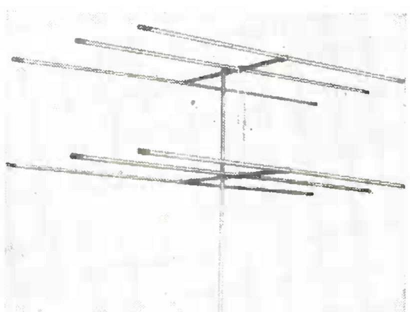
Penicillin Tester

G. C. WILSON & CO., Chatham, N. J. The equipment illustrated measures

the potency of antibiotic by electronic means. Since the potency is proportional to the diameter of the area inhibited by the antibiotic in a germ culture, the diameter is measured by recording elapsed time between selected interruptions of a light beam scanning the inhibited area under study while the area is moving at a constant known speed.

Television Antenna

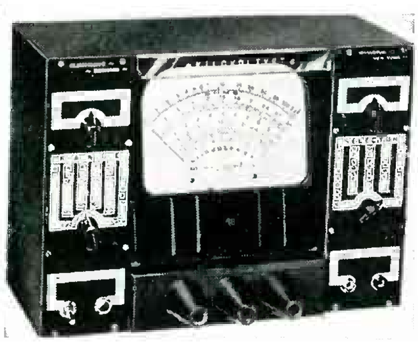
NETWORK MFG. CORP., 19 Cottage St., Bayonne, N. J. Type LF-3E-D three-element double-stack beam television antenna, suitable for re-



ception in areas remote from transmitters, is constructed of one-inch aluminum tubing stock.

Tele VTVM

ELECTRONIC DESIGNS, INC., Irvington, N. Y. The Kilovoltyst is a vacuum-tube voltmeter with a range up to 30,000 volts for use in television applications. Resistances



up to 1,000 megohms can be measured. The radio-frequency response ranges between 300 cycles and 300 megacycles, input impedance being 1 megohm and 3.4 μμf. The r-f voltage range is 100 volts. Maximum drain at 10 and 30 kilovolts is 20 microamperes.

Literature

Production Measurement. Raymond M. Wilmotte Inc., 1469 Church St., N. W., Washington 5, D.C. An eight-page brochure is devoted to description and specifications of the type W Visi-Limit micrometer, primarily designed for continuous production measurement of the outside diameter of insulated wire.

Student Publication. Crystal Research Laboratories, 29 Allyn St., Hartford, Conn. Recently off the press is the first issue of the "Telecaster" published by the CRL School of Electronics, Inc. Included are the course purposes and prerequisites for entrance in the school which prepares men for the television and industrial electronics field.

Miniature Bearings. Miniature Precision Bearings Inc., Keene, N. H. Catalog 49 gives comprehensive specifications on more than 40 types and sizes of standard miniature ball bearings ranging in outside diameter from 2 mm to $\frac{5}{16}$ inch. Design variations, lubrication, weights and application data are furnished.

Radiation Measurement. Nuclear Instrument and Chemical Corp., 223-233 W. Erie St., Chicago 10, Ill. On one side of a sheet appear an illustration and outline of the chief features of the "Q-Gas" self-quenching Geiger counter for detecting soft ionizing radiation. The instrument has a 1,450-volt anode potential.

Voltage Regulation. The Superior Electric Co., 377 Hannon St., Bristol, Conn. Bulletin 448 discusses automatic regulation of line voltage input to broadcasting equipment, and describes in detail equipment recommended to overcome voltage fluctuations and prolong the life of transmitter tubes and associated apparatus.

Dry-Type Transformers. Allis-Chalmers Mfg. Co., Milwaukee 1, Wis., has issued a 16-page booklet, 61X7088, on the installation, care and operation of dry-type transformers. Also included are switchplate information and a description of induced cooling.

Retaining Rings. Truarc Division, Waldes Kohinoor, Inc., 47–16 Austel Place, Long Island City 1, N. Y. A 28-page catalog contains engineering specifications and data on a complete line of retaining rings. Requests for copies should be made on company stationery.

UHF Noise Diode. Eclipse Pioneer Division, Bendix Aviation Corp., Teterboro, N. J. Folder 86-30B is devoted to the TT-1 uhf diode tube which supplies an electrical noise to measure sensitivity of radar and television receivers. The tube described has an upper limit of 3,000 megacycles and is adaptable for wide-band circuits.

Deposited Carbon Resistors. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. Complete electrical characteristics and mechanical specifications of types DCF and DCH deposited carbon resistors are contained in bulletin B-4. Resistance values for the type DCF range from 200 ohms to 5 megohms; for type DCH, 500 ohms to 20 megohms.

Television Signal Generator. Measurements Corp., Boonton, N. J. Model 90 television standard signal generator permits modulation frequencies up to 5 mc. Carrier range of 20 to 250 mc is covered in eight coil ranges. Setting accuracy of the direct-reading frequency dial is 0.1 percent. The unit is completely described in a four-page folder.

Relay Catalog. Advance Electric and Relay Co., 1260 W. Second St., Los Angeles 26, Calif. The latest catalog illustrates the entire line of more than 50 relays, complete with descriptive detail, dimensions, contact combinations and

prices. The 48-page booklet is available upon request.

Socket and Mounting Notes. Raytheon Mfg. Co., 55 Chapel St., Newton 58, Mass. An 8-page looseleaf stapled folder gives socket and mounting notes for a line of flat press subminiature tubes. Complete description and 22 illustrations are included.

Broadcasters Information. National Association of Broadcasters, 1771 N Street, N. W., Washington 6, D. C. The newly revised "NAB Sample Transmitter Operating Logs and Pertinent FCC Rules and Regulations" replaces a previous guide published in 1946.

Tube Information. Radio Corp. of America, Harrison, N. J. Technical data sheets have recently been released on the 6W4 rectifier used as a television damper; type 19J6 miniature twin triode; type 5696 miniature thyratron; and type 5713 power triode, for grounded-grid service.

Binding Posts. Superior Electric Co., 477 Hannon Ave., Bristol, Conn. The new 5-way binding post is described and uses enumerated in a recent folder.

Power Tetrode. Eitel-McCullough, Inc., San Bruno, Calif. Latest data sheet on the Eimac 4-65A power tetrode gives the usual constant current characteristics on a three-color chart as well as separate graphs showing control grid, screen grid, and plate currents versus plate voltage.

Magnet Charger. Radio Frequency Laboratories, Inc., Boonton, N. J. Model 107 magnet charger is described in a new folder that shows new uses for the instrument developed since it was first announced.

Mechanical Rectifiers. ITE Circuit Breaker Co., Nineteenth and Hamilton Sts., Philadelphia 30, Pa. Bulletin 4809 is a 14-page bulletin describing low-voltage power conversion using mechanical rectifiers that operate on the interrupter principle.

Flexible Shafting. F. W. Stewart Mfg. Corp., 4311 Ravenswood Ave., Chicago 13, Ill., has recently published an illustrated booklet showing a variety of uses for flexible shafts in the industrial field.

G-M Survey Meter. Precision Radiation Instruments, Inc., 1101 North Paulina St., Chicago 22, Ill. describes the model 101 radiation survey meter on two sides of a sheet. All the major components are arranged for plug-in replacement.

Audio Amplifier. Brook Electronics, Inc., 34 DeHart Place, Elizabeth 2, N. J. Model 12A3, ten-watt remote control audio amplifier selling for $169.50 is pictured and the characteristics are listed on two sides of a catalog sheet.

Instrument Filter. Kalbfell Laboratories, Inc., 1076 Morena Boulevard, San Diego 10, Calif. The Bridged-T filter model 503A for 60-cycle rejection is described in a flyer that shows frequency characteristic curves and data on filters for other frequencies.

Miniature Relays. Ward Leonard Electric Co., Mount Vernon, N. Y. Bulletin 102 miniature magnetic relays for direct or alternating current are described in a catalog sheet recently issued.

Sales Engineers' Newsletter. The Representatives of Radio Parts Manufacturers, Inc., One North La Salle St., Chicago 2, Ill. First issue of the "Representor" is dated October 1948. The publication is designed to encourage cooperation between manufacturers and their customers via independent sales engineers.

Panoramic Equipment. Panoramic Radio Corp., 92 Gold St., New York 7, N. Y. A four-page bulletin gives complete data on both the Panalyzor, series SB3, and SB6, as well as the Panadaptor, series SA3 and SA6. Both instruments are automatic scanning superheterodyne devices for panoramic analysis of signals in the r-f spectrum.

Television Components. Standard Transformer Corp., 3580 Elston Ave., Chicago 18, Ill. Bulletin DD337 is a 4-page circular giving illustrations, specifications and prices of a new line of television transformers and components.

Audio Transformers. Standard Transformer Corp., 3580 Elston Ave., Chicago 18, Ill. A recent 4-page folder illustrates and gives chief features and specifications of the HF and WF series of high fidelity audio transformers for amplifier circuits, speakers, microphones and pickups.

Measuring Instruments. Boonton Radio Corp., Boonton, N. J. Catalog F is a 34-page publication covering Q-meters, a QX checker, signal generators and accessories. Operating principles and specifications for each are given.

C-R Oscilloscope. Tektronix, Inc., 1516 S. E. Seventh Ave., Portland 14, Oregon. Type 511 cathode-ray oscilloscope, a portable unit using a 5-in. tube, is completely described and illustrated in a 4-page folder. The unit has a continuously variable triggered sweep circuit which synchronizes with frequencies as high as 10 mc.

Capacitor and Component Catalog. Hammarlund Mfg. Co., Inc., 460 West 34th St., New York 1, N. Y. A new 16-page catalog in two colors lists complete technical data on the company's line of capacitors and components. Emphasis is placed on the employment of miniature components for more compact equipment.

R-F Inductors. Andrew Corp., 363 East 75th St., Chicago 19, Ill., has just printed up bulletin 83 describing a line of r-f inductors designed for phasing and antenna tuning networks used in a-m broadcasting and similar applications.

Transmission Line Pressure. Andrew Corp., 363 East 75th St., Chicago 19, Ill. Bulletin 85 describes a line of equipment used to pressureize coaxial transmission lines with dry air. The devices cycle automatically to maintain pres-

sure and reactivate the dessicant so that it can be used indefinitely.

War On Corrosion. The International Nickel Co., Inc., 67 Wall St., New York, N. Y. A 24-page catalog entitled "Standard Specialties" is a complete compilation of Monel, nickel, and Iconel products for corrosive and high temperature service.

Accelerometers. Schaevitz Engineering, 226 Harding Ave., Collingswood, N. J. A useful pamphlet entitled "Notes on Linear and Angular Accelerometers" is available free of charge. Applications and curves are included.

Signal Generator. Measurements Corp., Boonton, N. J. A 4-page catalog sheet is now being distributed that describes the model 80 standard signal generator with a frequency range from 2 to 400 mc, with output continuously variable from 0.1 microvolt to 0.1 volt.

Meters. Dale Instruments, Electronic Development Co., Omaha, Nebraska. Catalog 11 is an 8-page publication that lists characteristics and prices of a line of meters for all uses.

Insulators. American Lava Corp., Chattanooga 5, Tenn. Standard insulators shown in bulletin 143 formerly made in L4 material are now available in L5 ceramic for use at higher radio frequencies.

Flexible Tubing. Pennsylvania Flexible Metallic Tubing Co., 72nd St. & Powers Lane, Philadelphia 42, Pa., has recently issued bulletin 52-9 describing a line of galvanized steel hose and bronze hose.

Plastics Check Chart. Durez Plastics and Chemicals, Inc., North Tonawanda, N. Y. The Durez Check Chart is a slide-rule type of reference for engineers and others working with plastic materials. As a slide is pulled to a desired application, the material number appears in a cutout window.

Hard Rubber Handbook. American Hard Rubber Co., 11 Mercer St., New York 13, N. Y. The 56 pages of this first edition of a new handbook are filled with information on the physical and electrical properties of hard rubber and plastics in all standard sizes and shapes. A formal request will bring your copy.

Instruments. Bradshaw Instruments Co., 348 Livingston St., Brooklyn 17, N. Y. The latest 4-page catalog of meters, multitesters and a signal generator has recently been put into circulation.

Mica Products Catalog. The Macallen Co., 16 Macallen St., Boston, Mass. Price list and discounts on compressed sheet mica products are given in a new booklet which contains corrections and additions to catalog 24.

Analytical Instruments. Consolidated Engineering Corp., 620 North Lake Ave., Pasadena 4, Calif. General catalog 1300A covers a variety of analytical instruments for science and industry, including mass spectrometers, recording oscillographs, leak detectors and electrical computers. Illustrated descriptions and specifications are included.

Electric Plants. D. W. Onan & Sons Inc., Minneapolis 5, Minn. Catalog A-138A is a guide to a-c, d-c and battery-charging electric plants. Instructions are given for choosing the proper type, size and starting method.

Battery Connectors. Cannon Electric Development Co., 3209 Humboldt St., Los Angeles 31, Calif. Photos, dimensional drawings and technical data on a line of battery connectors designed for starting equipment are found in bulletin GB-648.

Solder Catalog. Alpha Metals, Inc., 363 Hudson Ave., Brooklyn 1, N. Y. Catalog 201 condenses into four pages an explanation of rosin-filled and acid-filled solders, a comprehensive solder selection guide and tables of physical characteristics.

F-M Tuner. Edwards F-M Radio Corp., 168 Washington St., New York 6, N. Y. A 12-page reprint gives an illustrated description, servicing information and circuit analysis of the Fidelotuner, an f-m tuner employing the limiter-discriminator method of detection without an r-f amplifier.

(continued from page 140)

his leadership in Institute affairs. The B. J. Thompson Memorial Award was made to R. V. Pound for his paper in the Dec. 1947 *Proceedings* entitled "Frequency Stabilization of Microwave Oscillators."

Citations for the Fellow grade awards were approved as follows:

H. A. Affel—"For his contributions to the communications art, and his guidance of important developments in carrier systems for multiplex telephone and television transmission".

K. C. Black—"For his outstanding wartime work on radio countermeasures and his many contributions to the design of coaxial cable transmission systems".

J. E. Brown—"For his contributions in the field of broadcast receiver design".

Cledo Brunetti—"In recognition of his pioneering work on printed circuits".

W. L. Carlson—"In recognition of his contributions over many years to the development of radio receivers and their components".

P. S. Carter—"For his many contributions in the fields of radio transmission and communication systems".

F. E. d'Humy—"In recognition of his long service in the communications field and for pioneering in the application of radio relays to telegraph message service".

John N. Dyer—"For administrative and technical contributions to radio, including polar expedition communications and important wartime radio countermeasures".

L. A. Gebhard—"For his pioneering work in the military application of radio".

T. T. Goldsmith, Jr.—"For his contributions in the development of cathode-ray instrumentation and in the field of television".

F. W. Grover—"For his long activities and contributions in the field of electrical units and measurements, and for his publications".

E. A. Guillemin—"For outstanding work in the field of electric circuit analysis and synthesis and for his inspired leadership as a teacher".

Ross Gunn—"For his long service and many technical contributions in

the radio and electronics fields".

A. V. Haeff—"For his contributions to ultra-high-frequency radio tubes and electronics".

L. C. Holmes—"For his contributions to theory and practice in the field of magnetic recording".

J. Kelley Johnson—"In recognition of his leadership in the design and manufacture of radio broadcast receivers".

S. R. Kantebet—"For his services as an educator, engineer and administrator in the fields of radio and cable communication in India".

William B. Lodge—"For his many contributions to broadcast engineering and in particular for his work in the field of frequency allocations".

K. A. Mackinnon—"For his technical contributions in Canada to the theory and design of transmitting antennas and the development of a coverage plan for a national network".

H. F. Olson—"For his outstanding developments and publications in the fields of acoustics and underwater sound".

George O'Neill—"For his work in electron tube theory and design".

L. S. Payne—"For his contributions in Canada to the field of international communications".

L. M. Price—"For his contributions to the development, production and application of electron tubes in Canada".

H. J. Reich—"For his contributions as teacher and author in the radio and electronics fields".

John D. Reid—"For his developments in radio-frequency circuits".

Karl Spangenberg—"For his many technical contributions, particularly his analytical work on vacuum tubes".

George E. Sterling—"In recognition of his long public service in the radio communication field and, in particular, for the organization and operation of radio wartime intelligence activities, which were of significant importance".

C. E. Strong—"For his pioneering work in the radio equipment design and development field, particularly broadcasting transmitters, both medium and high frequency, and his many wartime contributions in England".

Franz Tank—"For his contributions to the field of radio education in Switzerland, and his accomplishments in ultrashort-wave communications".

W. Norris Tuttle—"For his application of sound theoretical principles to the design of commercial measuring equipment".

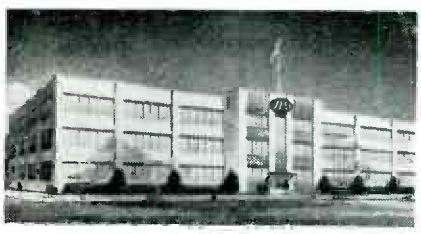
I. R. Weir—"For his pioneering work in the development and application of transmitting equipment for higher frequencies and higher power."

New RMA Standards

ELECTRICAL performance standards for television relay facilities are given in RMA publication TR-106, now available to members from the Radio Manufacturers Association, 1317 F Street, N. W., Washington 4, D.C. Topics covered include overall systems performance characteristics, relay transmitter, relay receiver, repeater, control and auxiliary circuits, antennas and transmission lines, propagation and reliability. An appendix, not part of the standard, gives tentative recommendations.

BUSINESS NEWS

J. F. D. MANUFACTURING CO., INC., Brooklyn, N. Y., recently completed a 3-story plant, with a 60,000-sq ft floor area, for the manufacture



Recently completed J.F.D. plant

of radio parts and tv and f-m antenna equipment and accessories.

SOUND APPARATUS CO. has consolidated its main office and manufacturing plant in Stirling, N. J., and has enlarged its developmental laboratory in Millington, N. J.

ANDREW CORP., antenna equipment manufacturers, have completed a research laboratory on a 400-acre plot twenty-five miles out from the center of Chicago.

TELE-VIDEO CORP., Upper Darby, Pa., has acquired as subsidiaries Airdesign, Inc. of Upper Darby, Pa., and Electronic Controls, Inc. of East Orange, N. J., to increase its supply of television components.

THE ELECTRICAL REACTANCE CORP., Franklinville, N. Y., is adding to its plant a new office building to incorporate an enlarged developmental

Proposed new office building (right) for Electrical Reactance Corp.

and research laboratory and provide space in the present plant for increased production of television receiver components.

RADIOACTIVE PRODUCTS, INC., Detroit, Mich., was formed to design and manufacture instruments and equipment for the measurement and handling of radioactive materials.

MACHLETT LABORATORIES, INC., Springdale, Conn., has taken over the manufacture of Western Electric's line of high-power tubes for broadcast transmitters, f-m and allied purposes. Tubes will be manufactured for Western Electric to Bell Labs designs, and will be distributed as before through Graybar Electric Co.

CORNELL-DUBILIER ELECTRIC CORP., South Plainfield, N. J., has purchased the Faradon Capacitor Division of RCA.

PERSONNEL

A. H. BROLLY, formerly chief engineer with WBKB, Chicago, is now chief engineer of Television Associates, Inc. in Chicago.

VLADIMIR K. ZWORYKIN, vice-president and technical consultant of

RCA Laboratories, has received the Chevalier Cross of the French Legion of Honor for outstanding contributions in the field of television.

A. D. PLAMONDON, JR., president of Indiana Steel Products Co., Chicago, has been appointed to the Munitions Board Electronics Equipment Industry Advisory Committee.

MILTON L. KUDER, formerly with the Naval Research Laboratory in radar and guided missile development, has been appointed to the National Bureau of Standards Ordnance Research Section.

M. L. Kuder

H. Goldberg

HAROLD GOLDBERG, previously associated with Stromberg-Carlson and Bendix in microwave and communication research, was recently named chief of the Ordnance Research Section of the National Bureau of Standards.

GENE CROW, on the engineering staff of WBKB, Chicago for the past three years, has been appointed chief engineer of the Meredith television station in Syracuse, N. Y.

HAROLD A. ZAHL, holder of the Legion of Merit for contributions made in the fields of radar and vacuum tubes, has been appointed director of research of the Signal Corps Engineering Laboratories, Fort Monmouth, N. J.

JAMES L. LAHEY recently resigned as assistant chief engineer at WBKB, Chicago, to join the engineering staff of Television Associates, Inc.

K. C. DEWALT, formerly designing engineer of the Tube Division of General Electric Co., Electronics Park, was reecently appointed an assistant manager of the division to be responsible for c-r tube product lines.

E. F. PETERSON, previously in charge of design engineering of receiving tubes at General Electric Co., has been appointed an assistant manager of the Tube Division with responsibility for design engineering and manufacturing activities in receiving tube product lines.

ROBERT D. HUNTOON, proximity fuze consultant during the war, has been appointed chief of the Atomic and Molecular Physics Division of the National Bureau of Standards. He will also serve as consultant to the Electronics Standards and Ordnance Development Laboratories of the Electronics Division.

R. D. Huntoon

R. Muniz

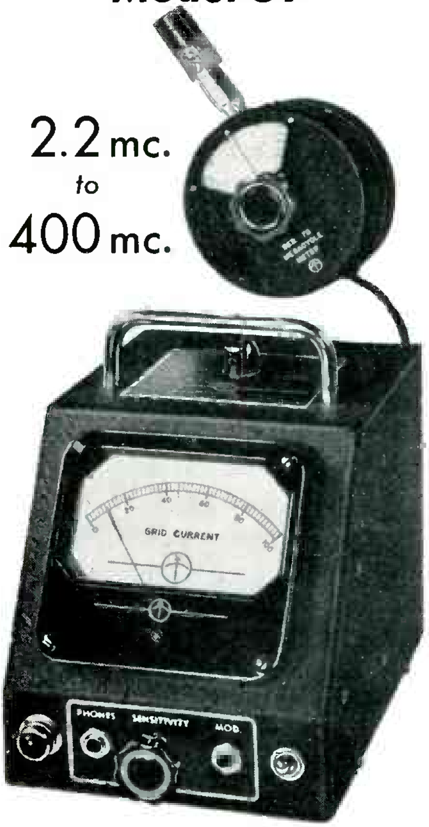
RICARDO MUNIZ, previously technical assistant to the vice-president at Allen B. DuMont Laboratories, Inc., was recently named general manager of the television receiver division.

WAYNE L. BABCOCK, formerly chief engineer at KCRG and KCRK, Cedar Rapids, Iowa, has been appointed to the broadcast transmitter sales staff of RCA.

KENNETH W. JARVIS, after heading his own electronics consulting firm for the past 14 years, has been named manager of the new electronics department of Automatic Electric Co., Chicago, Ill., which will be devoted to electronic applications in the telephone field.

CHARLES L. TOWNSEND of NBC has been transferred to Chicago as television operations supervisor for WNBQ.

ROBERT S. MARSTON, formerly project engineer in the research labora-



tories of Sperry Gyroscope Co., Inc., was recently elected president of Teletronics Laboratory, Inc., Westbury, N. Y.

DONALD BURCHAM, recipient of the Naval Ordnance Development Award in 1945, is now alternate chief of the Ordnance Research Section of the National Bureau of Standards.


D. Burcham


A. P. Massey

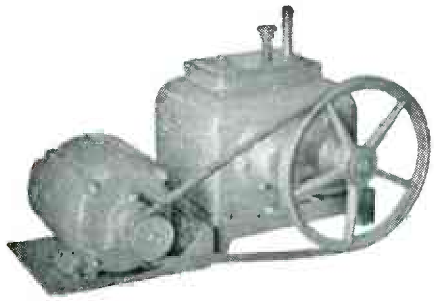
ANDREW P. MASSEY, responsible for development of a special communications jeep for Navy landing operations, has been appointed to the Engineering Electronics Section of the National Bureau of Standards, to head the electronics standardization group.

A. HOYT TAYLOR, after more than 31 years of continuous civilian and commissioned service in the Navy, was honored at his retirement for outstanding services in the field of radio and radar research and development.

G. HAMILTON BEASLEY has been named new president of Bardwell & McAllister, Inc., Burbank, Calif., manufacturers of electronic apparatus.

THOMAS MORRIN, former chief of the microwave engineering department at Raytheon, has been appointed chairman of electrical engineering research at Stanford Research Institute, Stanford U., Calif.

WILLIAM P. LEAR, president of Lear, Inc. since its inception almost twenty years ago, has been elected to the newly created post of chairman of the board, in order to devote his efforts to technical development of aircraft radio, automatic flight control and wire recorder products.



BAACH-INTERNATIONAL
COMPOUND
HIGH VACUUM PUMP

This high vacuum pump is widely known and used extensively in the manufacture of electric lamps, radio tubes, fluorescent lamps, for laboratory work and for many industrial applications where high vacuum, plus rapid exhausting are essential requirement in processes of manufacturing.

In free air capacities ranging from 1 cubic foot to 50 cubic feet per minute.

Readings on all sizes guaranteed 0.50 microns or better.

Operates quietly. Prompt deliveries
Write for details.

INTERNATIONAL MACHINE WORKS

Manufacturers of Baach-International Hot Cut Flare machine.

2027 — 46th STREET
NORTH BERGEN, N. J., USA
Tel. UNion 3-7412
Cable Address "INTERMACH" North Bergen, N. J.

The PIERCE CHRONOGRAPH
4-in-1 watch

1. STOP WATCH . . . Times to 1/5 second your favorite sporting events, radio shows, scientific experiments, pulse, etc., with *time* out feature for interrupted sequence timing.
2. TACHOMETER . . . Shows speed of plane, boat, car, train, etc., in miles per minute.
3. TELEMETER . . . Tells distance in miles from simultaneous source of light and sound —i.e., impending storm, etc.
4. WRIST WATCH . . . For general timing use.

- Unbreakable Crystal
- Fine Leather Strap
- Shock resistant
- Anti-magnetic
- Radium Dial
- Sweep Second Hand
- 60-minute Totalizer Dial
- Year Guarantee against mechanical defects

AN ESSENTIAL TOOL FOR EVERY ENGINEER

17 JEWEL—2 PUSHBUTTON

Only $37.00

INCLUDING 10% FEDERAL TAX

OUR GUARANTEE

Your money refunded within ten days if you are dissatisfied

FOR ANY REASON

Shipped C.O.D. or send check or money-order and we pay postage
Mail Orders Promptly Filled

ENGINEERING ASSOCIATES

FAR HILLS BRANCH BOX 26, DAYTON 9, OHIO

---

free
1949 NEWARK CATALOG

For EVERYONE interested in

TELEVISION • RADIO • ELECTRONICS
SOUND SYSTEMS • INDUSTRIAL EQUIPMENT

EVERYTHING in standard brand equipment!

Professionals! Radio Hams! Television Enthusiasts! Beginners! Oldtimers! Amateurs! Hobbyists! Here's one book that's a MUST for you! Our FREE 148 page catalog jammed with over 20,000 different items. The smallest part to the most complete industrial system from one dependable source!

24-HR. MAIL ORDER SERVICE ● ONE YEAR TO PAY

3 GREAT STORES: Uptown at 115 West 45th St. and Downtown at 212 Fulton St. in **NEW YORK**
323 W. Madison St. in the heart of **CHICAGO**

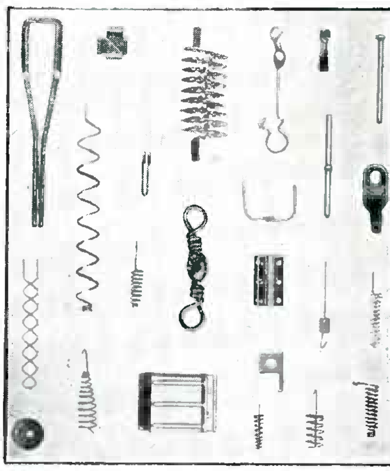
MAIL ORDER DIVISIONS: 242 W. 55th St., N. Y. 19 and 323 West Madison St., Chicago 6, Illinois

NEWARK RADIO & TELEVISION

MAIL COUPON NOW

Newark Electric Co.
Dpt A-8, 242 W. 55th St.
New York 19, N. Y.

Please send me FREE the Newark 1949 Catalog
NAME ____
ADDRESS ____ CITY ____ STATE ____



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 ⅛-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.

VITAMITE

RECHARGEABLE — NON-SPILL
STORAGE BATTERIES

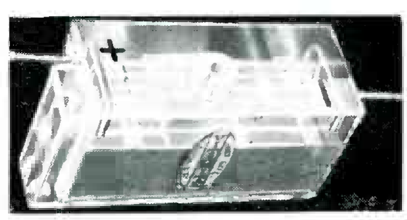
Among unusual properties are excellent operation under low temperature and low pressure conditions

4 Ampere Hour Capacity

6½ oz. weight

Other models—one oz. to one lb.

Write for data and literature



Model 2A3.00
Size 1 3/16" x 3 3/16" x 1 7/16" High

THE VITAMITE COMPANY

227 West 64th St. New York 23, N. Y.

NEW BOOKS

Vacuum Tubes

BY KARL R. SPANGENBERG, *Professor of Electrical Engineering, Stanford University. McGraw-Hill Book Co., New York*, 1948, 860 *pages*, $7.50.

A WEALTH of material on vacuum tubes and their characteristics is presented in this text. To the reviewer, it is the most complete treatise on this subject that is now available in one volume.

The text begins with a discussion of the nature and number of the devices using vacuum tubes and of the basic functions of these tubes. Then the essential characteristics of the various tube types are briefly but well previewed. The basic types considered are the vacuum diode, vacuum triode, screen-grid tube, pentode, beam-power tubes, cathode-ray tubes, klystron, magnetron and phototubes.

Fundamentals necessary to tube behavior analysis are then presented in chapters on electrons and ions, electronic emission, determination of potential fields, laws of electron motion, a consideration of the electrostatic field of a triode, and space-charge effects. The characteristics of triode, tetrode, and pentode tubes are then discussed in much greater detail in individual chapters. An interesting discussion on tube noise then follows.

Electron optics, both electrostatic and magnetic, and cathode-ray tubes are next considered. After a discussion of ultrahigh-frequency effects in conventional tubes, the klystron and magnetron are studied. The text concludes with chapters on photoelectric tubes, special tubes including television camera pickup tubes and electron microscopes, and a thorough discussion of high-vacuum techniques.

Thoroughness of discussion and explanation seems to typify the book. Although many references to other sources are included, the author includes sufficient material so that recourse to the references is generally not necessary. This thoroughness can be shown by an example. If the text were first opened to the section between pages 89 and 96, one would feel that he was reading a text on geography because of the discussion of Mercator and various forms of polar azimuthal equidistant projections, given to illustrate the nature of the logarithmic transformation used in determining the fields in a plane-electrode triode. Nevertheless, this and similar discussions are pertinent and quite helpful. Incidentally, the subject of vacuum-tube circuits is wisely avoided.

The large number of figures, including charts and tables and especially nomographs, makes this text quite useful. Most all of the important relationships that can be shown with various types of alignment nomographs are presented in that manner. The author has lost few if any chances to include all pertinent information and to present it in a useful form.

It seems a shame, from the viewpoint of a person not too familiar with the ramifications of all the topics considered, that this text is indexed in only seven pages. Useful information in the text is not always clearly indicated in the index. As an example, the use of electrolytic tanks in determining potential fields is not given in the index. Examination of the text, however, shows that this is discussed not only in the chapter on the determination of potential fields but later specifically in determining the characteristics of cathode-ray tubes.

This book is heartily recommended as a thorough, complete, and very usable reference on all types of vacuum tubes.—JOSEPH KAUFMAN, National Radio Institute, Washington, D. C.

• • •

Books Received for Review

SERVICING THE MODERN CAR RADIO. By A. L. Hurlbut. Murray Hill Books, Inc., New York, Second Edition, 1948, 692 pages, $7.50. Combination text book (119 pages) and circuit manual (572 pages) covering auto radio receivers from mid-30's. Data on specific sets is in most instances reproduced directly from manufacturers' literature. Text covers antennas, set installation, vibrator replacement, loudspeaker servicing, alignment, push-button tuning systems and typical circuit features.

POST WAR AUDIO AMPLIFIERS AND ASSOCIATED EQUIPMENT. Compiled and published by Howard W. Sams & Co., Inc., Indianapolis, Ind., 1948, 352 pages, $3.95. Specialized paper-cover manual of Photofact Folders covering amplifiers, f-m tuners and wire and tape recorders.

Backtalk

This department is operated as an open forum in which our readers may discuss problems of the electronics industry or comment upon articles that ELECTRONICS has published.

Getting Things Done

DEAR SIRS:

THESE NOTES have been prepared as a guide to persons who have an interest in pushing a particular piece of electronic apparatus through the research, development and pre-production stages.

In order that this rather complicated subject may be treated in as simple a manner as possible, we will start by assuming that the item in question is one of the simpler forms of test gear, say a standard signal generator. The first thing to do is to arrive at a set of specifications. This is most easily done by visiting all possible users of the equipment and determining their requirements. Investigate particularly those occasional users in highly specialized fields where one or two units will fill the need for the next twenty years.

The first item to investigate is modulation. The unit must by all means be capable of delivering pulses at least as short as 0.01 μsec, and up to 100 μsec in length. Other forms of modulation such as sine waves, square waves, triangular waves, noise, f-m, a-m, and television should of course be provided. The incorporation of such features should involve no more than six months extra research time over and above the requirements for normal users.

The possibility of tricky things like paired pulses should not be overlooked. Even triple pulses should be considered, to say nothing of the possibility of making each pulse of a pair or triplet of a different (adjustable, of course) length and amplitude. Although the requirement for such refinement is not readily apparent at the moment, there is nothing like antic-

PROFESSIONAL SERVICES

Consulting — Patents — Design — Development — Measurements

in

Radio, Audio, Industrial Electronic Appliances

THE BARRY CORPORATION
Specialists in the Control of
VIBRATION IMPACT NOISE
Engineering Development
Manufacturing
179 Sidney Street Cambridge, Mass.
Telephone: ELIot 0861-0140

WHEN TIME IS SHORT . . . .
put the solution of your problems up to a specialized Consultant whose professional card appears on this page. His broad experience may save you months of costly experimentation.
ELECTRONICS
330 West 42nd St., New York 18, N. Y.

MEASUREMENT ENGINEERING LIMITED
Consultants on Special Equipment for measurements and production tests, communications and audio systems.
Head Office and Plant
Arnprior Canada
60 Front Street West Montreal
Toronto, Canada Canada

H. RUSSELL BROWNELL
Consultant
Specializing in Measurements & Testing Instruments & Techniques - Electrical - Electronic - Magnetic
188 West 4th St. New York 14, N. Y.
Chelsea 2-4208

ERCO RADIO LABORATORIES, INC.
Radio Communications Equipment
Engineering - Design - Development - Production
Pioneers in Frequency Shift Telegraph
Garden City • Long Island • New York

Eugene Mittelmann, E.E., Ph.D,
Consulting Engineer & Physicist
High Frequency Heating — Industrial Electronics
Applied Physics and Mathematics
549 W. Washington Blvd. Chicago 6, Ill.
State 2-8021

CANOGA CORPORATION
Electronic Engineers
Radar, Pulse Techniques, MTI Systems, Pulse and Television Receivers, Video Amplifiers, Test Equipment, Microwave Antenna Applications, Electronic Controls, and Microwave Equipment.
SHOP AND LABORATORY FACILITIES
14315 Bessemer St. Van Nuys, Calif.
STate 5-9722

FRANKEL & NELSON
Consultants in Mathematical Physics
7716 Firenze Ave. Los Angeles 46, Calif.
Granite 6970

PAUL ROSENBERG ASSOCIATES
Consulting Physicists
Main office: Woolworth Building, New York 7, N. Y.
Cable Address PHYSICIST Telephone WOrth 2-1939
Laboratory: 21 Park Place, New York 7, N. Y.

CROSBY LABORATORIES
MURRAY G. CROSBY & STAFF
Specializing in FM, Communications & TV
Offices, Laboratory & Model Shop at:
126 Old Country Rd. Mineola, N. Y.
Garden City 7-0284

GENERAL INSTRUMENT & ENGINEERING
CONSULTATION RESEARCH DEVELOPMENT
IN
ELECTRONICS, E. E., PHYSICS
100 Barr Building Washington 6, D. C.

A. F. SMUCKLER & CO.
Electronic Engineers
Electronic Product Manufacturing
Contractors to United States Government
338-346 East 23rd St. New York 10, N. Y.
GRamercy 5-8151

EDGERTON, GERMESHAUSEN & GRIER, Inc.
Consulting Engineers
Research, Development and Manufacture of Electronic and Stroboscopic Equipment
Specialists in High-Speed Photography
155 Massachusetts Avenue, Cambridge 39, Mass.

PAUL GODLEY CO.
Consulting Radio Engineers
GREAT NOTCH, N. J.
Est. 1926 Little Falls 4-1000

SPECTRUM ENGINEERS
Electronic & Mechanical Designers
540 North 63rd St., Philadelphia 31, Pennsylvania
GRanite 2-2333; 2-3135

ELECTRO IMPULSE LABORATORY
Consulting Physicists
Radio Interference and Noise Meters; Interference Suppression Methods for Ignition Systems and Electrical Devices.
P. O. Box 250 Red Bank, New Jersey
Red Bank 6-4247

HANSON-GORRILL-BRIAN INC.
Product & Mfg. Development
ELECTRICAL - ELECTRONIC
HYDRAULIC - MECHANICAL
One Continental Hill Glen Cove, N. Y.
Glen Cove 1922

TECHNICAL MATERIEL CORPORATION
Communications Consultants
RADIOTELETYPE • FREQUENCY SHIFT
INK SLIP RECORDING • TELETYPE NETWORKS
453 West 47th Street New York 19, N. Y.

ELECTRONIC ENGINEERING CO. of CALIFORNIA
Radio and Electronic Consulting and Designing.
2008 W. Seventh St. Los Angeles
DRexel 8323 California

LERU LABORATORIES, INC.
Design and Development of Electronic Equipment for industrial and scientific purposes
Special experience in microwaves, spectrum analyzers, photo-electric circuits, test equipment, etc.
360 Bleecker Street
New York 14 WAtkins 9-4194

YARDENY LABORATORIES, INC.
Research and Development
Remote Controls and Electro Chemical Generators of Energy
105 Chambers Street WO 2-3534, 35
New York, N. Y.

THE REAL *VALUE* *of placing your unusual problem in the hands of a competent consultant is that it eliminates the elements of chance and uncertainty from the problem and provides real facts upon which to base decisions.*

ipating future needs. No more than eight or nine extra months to get such refinement into production need be allowed.

The output power of a signal generator should be satisfactory to all. At least ten watts should be available to those who need it, and of course an attenuator accurate to 0.1 percent and adjustable over a 200-db range in 1/10-db steps is a must.

The necessity for changing bands or tuning heads when changing frequency by a factor of merely 2 or 3 to 1 is a nuisance and should be at all cost avoided. The minimum tuning range in one band and one dial should be at least 6 to 1. The accuracy with which this frequency may be selected should be of the order of 0.01 percent and the frequency drift over a five-hour period not more than 0.001 percent. These limits should not be construed as an objective but merely as a barely satisfactory minimum to be tolerated over a range temperature from −75 C to +93.6 C.

To make this unit truly universal, it should operate from a-c, d-c or battery power. The total power input should not be more than 30 watts including all pilot lights.

The physical size and weight of signal generators should be kept to a minimum. If these units are to be suitable for use in lifeboats and for dog-team transports as well as in research laboratories, weight should be kept at 14 pounds or less and a maximum dimension limited to 8¾ inches. All devices of this nature should be capable of immersion in salt water for not less than six hours without changing characteristics. The carrying case must, of course, be constructed of material unpalatable to dogs. Units should be capable of being dropped on a concrete floor from a height of 8½ feet without changing frequency or missing a pulse.

It is quite apparent, from the fact that no signal generator with the characteristics outlined above is now in production, that those now making signal generators simply do not know their business. It would seem wise, therefore, to select for this project an organiza-

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.

STRIP WIRE FASTER with *Speedex Wire Stripper*

STRIPS 300 OHM TWIN TELEVISION LINE OR ANY SINGLE OR DOUBLE WIRES — MODELS FOR ALL SIZES.

The Ideal Wire Stripping Tool for Craftsmen; Radio, Maintenance, Auto Ignition Men; Electricians; Manufacturers.

Fast, easy to use. SPEEDEX strips all types of solid and stranded wires. Models for every purpose. Use on job, or in production wiring—FAST—strips 750-1,000 wires per hour, makes anyone an expert wire stripper. Hardened Steel cutting blade, interchangeable. Regular Model No. 733 strips No. 12 to No. 20 wires. ORDER TODAY or write for literature.

$3.60 NET

GENERAL CEMENT MFG. CO., ROCKFORD, ILL., U.S.A.

Kahle

ELECTRON TUBE MACHINERY OF ALL TYPES

STANDARD AND SPECIAL DESIGN

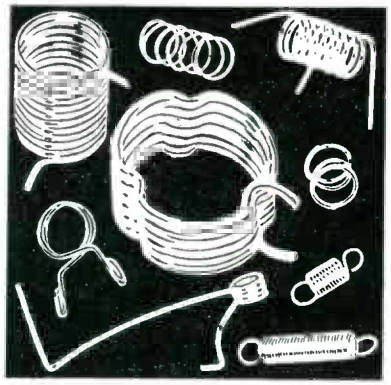
We specialize in Equipment and Methods for the manufacture of

RADIO TUBES
CATHODE RAY TUBES
FLUORESCENT LAMPS
INCANDESCENT LAMPS
NEON TUBES
PHOTO CELLS
X-RAY TUBES
GLASS PRODUCTS

Production or Laboratory Basis

***Kahle* ENGINEERING CO.**

1309 SEVENTH STREET
NORTH BERGEN, N. J., U. S. A.



Antenna Coils, Grid Clips, Dial Cord Springs and Precision Springs of all types pertaining to Radio and Television.

Your inquiries invited

WEBSTER SPRING CORPORATION

97 South 5th Street EV. 7-3224 Brooklyn 11, N. Y.

MICROMETER FREQUENCY METER

for Checking Transmitters from 100 Kc to 175 Mc. within 0.01 per cent

LAMPKIN LABORATORIES, INC.

Bradenton, Fla., U. S. A.

LOCKING TYPE

Stainless Steel

TUBE CLAMPS

Send for illustrated catalog and engineering data

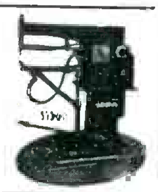
THE GEORGE S. THOMPSON CORPORATION
South Pasadena, California

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



BALL BEARINGS

MPB makes more than 40 different types and sizes . . .

For precision instruments, laboratory equipment, electronic devices, to minimize friction, space, weight, and to overcome starting torque specify MPB bearings.
Radial · Pivot · Angular Contact · Thrust
Promptly Available · Ask for catalog EL

MPB MINIATURE *Precision* BEARINGS
INCORPORATED
KEENE, NEW HAMPSHIRE, U.S.A.

ALLEN FLUXES

SODERING BRAZING & WELDING

L. B. ALLEN CO. INC. Chicago 31, Ill.
6871 Bryn Mawr Ave.

ELECTRO ENGINEERING WORKS

6021 COLLEGE AVENUE · OAKLAND 18, CALIFORNIA

Specializing in High Voltage Filament and Plate Transformers for Electronic Projects

Prompt Deliveries

SCRU-ITS

U. S. Patent No. 1,933,555

SOLDERLESS WIRE CONNECTORS

FAST! EFFICIENT! ECONOMICAL!

STRIP ENDS! SCREW IT!

THAT'S ALL WITH SCRU-ITS!

WRITE FOR DATA SHEET NO. 1057

SOLAR ELECTRIC CORPORATION

WARREN, PA.

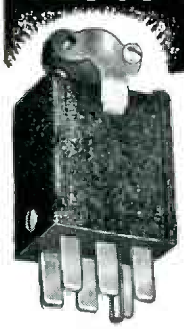
When you're in need of some product or service to speed and improve operation, or save money, you may find it here—in the Contacts Section. . . . *each issue.*

EL-TRONICS, INC.

Research, development, and manufacture of electronic equipment—a single model to large quantities.

Specialists in Geiger-Muller equipment

2647-67 N. Howard St., Phila. 33, Pa.
Garfield 5-2026



tion that has absolutely no experience in this line to draw upon. This would eliminate any possibility of preconceived ideas. The extra year or two spent in educating these people should have little or no effect on the final delivery date of the unit in question.

Although these notes deal chiefly with a specific example, the principles can be applied to most any problem involving the development of electronic gear. They can be summarized by simply stating that one should never be satisfied with anything but the last word regardless of how many decades are required to produce it.

G. E. HULSTEDE
Belmont, Calif.

French Television Tube

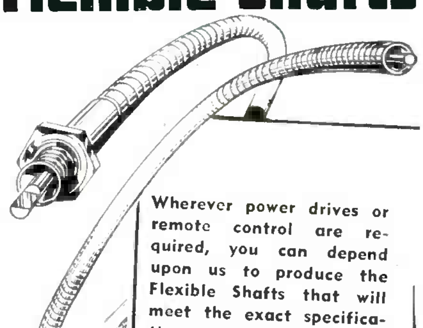
DEAR SIRS:

IN THE ARTICLE on the eriscope camera tube by Boyd France—(ELECTRONICS, p 130, Oct. 1948) is the statement, "Comparative tests of the eriscope and the image orthicon conducted at the Zurich Polytechnical School indicated that . . ." We wish to state that at the Swiss Federal Institute of Technology comparative tests of the French eriscope and the American image orthicon have never been conducted; moreover our Institute has never had an image orthicon for test purposes. As a neutral institution, we ask that you publish this emendation.

H. THIEMANN
Zurich, Switzerland

Ed. Note: A checkup by Boyd France of McGraw-Hill World News revealed that measurements made by students of the Institute on equipment installed elsewhere had been mistaken by his informants as official.

IN THE article, Precision Interval Timer, December 1948 ELECTRONICS, the cathode of the 6AL5 and the attached capacitor should connect to the left-hand side of the relay coil and not to the relay contact. In addition, the lowest contact on the relay should close on break rather than on make.



SEARCHLIGHT SECTION

EMPLOYMENT • BUSINESS • OPPORTUNITIES • EQUIPMENT—USED or RESALE

UNDISPLAYED RATE:

$1.20 a line, minimum 4 lines to figure advance payment count 5 average words as a line.

POSITIONS WANTED (full or part-time salaried individual employment only), ½ above rates.

PROPOSALS $1.20 a line an insertion.

INFORMATION:

BOX NUMBERS in care of any of our New York, Chicago or San Francisco offices count 1 line additional in undisplayed ads.

DISCOUNT of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

DISPLAYED—RATE PER INCH

The advertising rate is $10.25 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page.

E

NEW ADVERTISEMENTS received by 10 A.M. December 29th will appear in the February issue, subject to limitation of space available.

PROJECT ENGINEERS

Real opportunities exist for Graduate Engineers with design and development experience in any of the following: Airplane Stability and control, Servomechanisms, radar, microwave techniques, microwave antenna design, communications equipment, electron optics, pulse transformers, fractional h.p. motors.

Send complete resume to employment office.

SPERRY GYROSCOPE CO.

Division of the Sperry Corp.

GREAT NECK, LONG ISLAND

REPLIES (Box No.): Address to office nearest you
NEW YORK: 330 W. 42nd St. (18)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITION VACANT

DESIGN ENGINEER. Experience on switches, preferably tap switches up to 25 amp. capacity, for Chicago manufacturer. Give complete details and salary desired. P 7125, Electronics.

EMPLOYMENT SERVICES

SALARIED POSITIONS $3,500-$35,000. If you are considering a new connection communicate with the undersigned. We offer the original personal employment service (38 years recognized standing and reputation). The procedure, of highest ethical standards, is individualized to your personal requirements and develops overtures without initiative on your part. Your identity covered and present position protected. Send only name and address for details. R. W. Bixby Inc., 266 Dun Bldg., Buffalo 2, N. Y.

EXECUTIVES $3,000-$25,000. This reliable service, established 1927, is geared to needs of high grade men who seek a change of connection under conditions assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited. Jira Thayer Jennings, Dept. E, 241 Orange St., New Haven, Conn.

POSITIONS WANTED

TELEVISION ENGINEER Graduating American Television Institute of Technology, January, 1949 with B.S.T.E. Age 28. Locate anywhere. Desire sales engineering. PW-7356, Electronics.

(Continued on page 222)

INVESTIGATE THIS OPPORTUNITY

To join the staff of one of the largest research organizations in the country devoted exclusively to

VACUUM TUBE RESEARCH

Working conditions are ideal in these laboratories which are located in the New York Suburb of Orange, New Jersey. Your associates will include men of many years experience in vacuum tube research and development.

This rapidly expanding organization is devoted to both commercial and military research. It is a division of one of the oldest vacuum tube manufacturers in America. Security and stability for the years to come are assured. You will have an opportunity to gain experience with the different kinds of vacuum tubes, receiving, power, cathode ray, sub-miniature, micro-wave, radial beam and various special types.

If you can qualify as a

PHYSICIST • ELECTRICAL ENGINEER • CIRCUIT TECHNICIAN • VACUUM TUBE TECHNICIAN

write at once to

RESEARCH DIVISION

NATIONAL UNION RADIO CORPORATION

350 SCOTLAND RD. ORANGE, NEW JERSEY

PHYSICISTS and ELECTRICAL ENGINEERS

Write to our Personnel Manager for new brochure describing our staff, facilities, projects, and policies. Address

Airborne Instruments Laboratory

INCORPORATED

160 OLD COUNTRY ROAD · MINEOLA, N.Y.

Positions are available for Bachelors, Masters, and Ph.D.'s with research and development experience. Projects are underway in fields of microwave receivers, transmitters, antennas; radar; servos, motor-control systems; instrumentation; and general electronics. Salaries commensurate with abilities. Opportunities for advancement; staff is being expanded.

ELECTRICAL ENGINEERS

Expd. 1 in radar pulse circuit, 1 in circuit development, 1 in radar modulators, 1 in radar devices, 1 in radar receivers, and 1 in radar indicator circuit design & development. Send resume in confidence.

Box E265, 113 W. 42nd St., N. Y. 18

SCIENTISTS AND ENGINEERS

Wanted for interesting and professionally challenging research and advanced development in the fields of microwaves, radar, gyroscopes, servomechanisms, instrumentation, computers and general electronics. Scientific or engineering degrees required. Salary Commensurate with experience and ability. Direct inquiries to Mgr. Eng. Personnel.

BELL AIRCRAFT CORPORATION

P. O. Box 1 Buffalo 5, New York

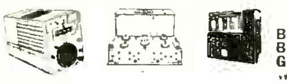
Additional Positions Vacant Ads on pages 222 & 223

POSITIONS WANTED
(Continued from page 221)

EXECUTIVE ENGINEER wide experience design, production administration in electronics. Emphasis on Sonar devices and techniques past several years. B.S. degree. Young, aggressive and adaptable. Position must be responsible and high level. PW 7038, Electronics.

RESEARCH OR Teaching position wanted, advanced degree, now associate professor in electronics, widely published industrial and teaching experience, location immaterial, salary secondary. PW 7285, Electronics.

E.E., 15 years experienced as Project, Product and Process Engineer in the electrical, mechanical, instrumentation, and vacuum tube industries. Familiar with design, shop methods, and fabrication. Desires connection with A-1 organization. Available immediately. PW 7224, Electronics.



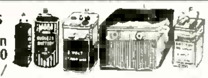
Xmtr Specials!

BC457 (4-5.3Mc) or BC458 (5-7.3Mc) Good Used With Tubes **$5.95**

BC456 Modul As Is less Tubes & Dyn.......... $1.49
BC375 or 191 Good Used w/TU & Tubes....... $12.95
GIBSON GAL Xmtr 8280 KC.......... $5.95
GG Lamp & Ant......89¢; Hav'sack.......... 98¢
Box Kite 17x17x36"..$2.98; Parachute 12 ft.... $2.98
Balloon 50" & Hyd Gas Gen.......... $4.98

"TAB" THAT'S A BUY!

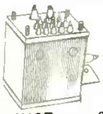
Storage & Dry Batteries



A) BR18/BB52/5oz/36V min S Baty $1.49; 8 for $10
B) BURGESS 3V F2BP/ dated 6/47 Special ....5 for $1.00
D) BB54/2V 27 amp WILLARD S'Baty.......... $1.98
E) WILLARD 4V/40AH/TBY S'Baty.......... $5.95
F) BB206U/2V 11AH WILLARD S'Baty....... $1.89
EVEREADY Hevi-Duty Minimax BA43p/o SCR284 90/45/1½V w/octal sckt & handle 2⅞x4¾x6¼" 3Xsld Late '47 ea. $1.39; 2/$2.49..........10/$10
Battery Acid (R. Exp. Only) 1 pt 59¢; 2 pts 98¢

TELEVISION

COMPLETE TV POWER SUPPLY KITS

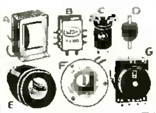


High, Low & Filament Voltages FEATURING Herm Sld W.E. USN oil filled XFMR Inputs 105, 115, 125 VAC 50-425 cps Outputs 600VCT or 300VDC/175Ma and 6.3V/10A, 5V/8A, 2.5V/3A, 5V/3A. H.V. insulated.

10000V & 300VDC & ALL Filaments Supply Kit. Above Xfmr & 2-3B24 Doubler-Rect &5U4G rect. & All cndsrs, sockets, choke & data "TAB" Special **$29.95**

5000V, 300VDC & ALL Filaments KIT. Same Xfmr plus 5U4G & 3B24 rectifiers, cndsrs, choke & sockets, diagram **$21.95**
Transformer Only $16.95

Famous Make TV Components



A. V'outpt Xfmr sim RCA204T2, Only.. 2.98
B. Utah 9318 H'BlkgOsc Xfmr H'sld Only.. 1.49
C. UTC88662 V'BlckgOsc Xfmr H'sld 1.29
D. Erie HiV Cndsr 500mmf/10KV .... .40
D. Jeffers HiV Cndsr 500mmf/20KV .... .75
E. Yoke Magn Defl sim RCA-201D1 .... 4.59
F. Focus Coil for Magn Foc Kinescps 3.95
G. HiV Flybak H'out XFMR Sim RCA211T1 .... 5.49
SPECIAL — 300 ohm TWINEX Cable 2¼c ft.; 100 ft. $2; 1000 ft. $17.98

TUBE SPECIALS—JAN & STANDARD

OA4G	$1.04	5CP1	3.95	6SK7	.58	215A	.89	958A	.63
OZ4	.85	5CP7	13.49	6SL7	.75	250TH	19.49	991	.25
1A7GT	.69	5D21	19.00	6SN7GT	.69	250TL	19.49	1613/6F6X	.69
1B21/471	2.95	5FP7	1.49	6SQ7	.54	304TH	5.95	1614/6L6X	1.50
1B24	4.89	5HP1	4.95	6SS7	.71	304TL	1.98	1616	1.39
1B27	4.89	5R4G	1.25	6V6GT	.69	307A/RK75	4.25	1619	.39
1D5GP	1.25	5T4	1.15	6U7G	.58	388	.40	1622	1.69
1G6GT	.85	5U4G	.53	6X4	.53	393	5.95	1624	.98
1L4	.70	5V4	.87	6X5	.81	450TH/		1625	.40
1LC6	1.05	5W4	.87	6Y6G	.87	6C21	24.90	1626	.45
1LH4	1.05	5Y3	.38	6Z4/84	.69	450TL	29.95	1629	.58
1LN5	.69	5Z3	.81	6Z7GT	1.23	527/1000S	11.95	1635	1.90
1N5GT	.69	5Z4	.88	7A6	.69	632A	8.95	1641	.75
1P5GT	.69	6AB7	.89	7A8	.69	701A	3.95	2050	.69
1P24	2.95	6AC7	.69	7BP7/1813	3.95	702A	3.49	2051	.88
1R4/1294	1.00	6AG5	1.00	7C4 1203A	.49	703A	4.90	7193	.38
1T4	.69	6AG7	1.05	7C29/434	7.95	704A	1.75	8012	4.70
2A3	1.04	6AJ5	.98	7F7	.88	705A	2.25	8013A	3.95
2C21/1642	.81	6AK5	.89	7N7	.69	707B/2K8	10.98	8020	3.49
2C26	.59	6AL5	1.11	9JP1	3.95	710A/8011	2.75	9001	.40
2C34/RK34	.55	6B4G	1.15	9JP12	1.49	717A	1.49	9002	.59
2C40/446A	.75	6B8G	1.05	9LP7	2.69	722 287A	9.95	9003	.49
2D21	1.49	6C4	.23	10Y	.60	723AB	5.50	9004	.49
2E22	1.45	6C5	.54	12A6	.23	726A	6.95	9006	.40
2J21/725	12.95	6C6	.71	12AH7GT	.87	803	7.95	C6J	4.95
2J26	12.95	6C8G	1.05	12AR7	.95	804	9.75	CE206	3.95
2J30	18.50	6D4	1.85	12DP7	14.75	805	4.50	CE215	5.95
2J31	16.95	6D6	.59	12GP7	14.75	807	1.15	CK1005	.35
2J32	16.95	6E5	.71	12H6GT	.39	808	2.25	F127A	18.00
2J33	14.50	6F6/1613	.69	12K8	.85	810	6.95	FG104	14.95
2J34	18.95	6F8	1.04	12SG7	.69	813	6.95	FG105	11.95
2J42/700	29.95	6G5/6U5	.85	12SH7	.71	814	2.98	FG166	49.00
2J49	29.95	6G6G	.86	12SJ7GT	.59	815	2.49	GL434A	7.95
2J55	35.00	6H6	.49	12SK7	.58	816	1.15	KU627	7.95
2J61A	39.95	6H6GT	.49	12SQ7	.58	826	.69	KU628	14.95
2K25	24.49	6J4	5.95	12SR7	.39	828	10.00	M55B	.39
2K28	10.98	6J5	.53	12X3	.90	829B/3E29	3.95	RFL36/6J4	.98
2K29	6.95	6J6	1.00	14B6	.86	832	3.75	RX215	7.95
2V3G	1.05	6J7	.70	15E	1.39	836	1.12	T200	12.00
2X2	.49	6K5GT	.75	24G/3C24	.69	837	2.25	VR/99OZ3	.74
3A4	.70	6K6GT	.63	25L6GT	.68	845	4.75	VR92	.23
3B7/1291	.95	6K7	.75	25Z5	.53	860	2.49	VR105	.74
3B24	1.27	6K8	.86	25Z6GT	.59	864	.67	VR150	.90
3BP1	1.49	6L6	.96	28D7	.39	865	1.00	WE215A	1.80
3BP1A	2.95	6L6G	1.04	32L7GT	1.19	866JR	.89	WL468	9.95
3C23	4.95	6L7	.75	35L6GT	.58	868	1.85	WL530	49.50
3D6/1299	.85	6N7	.85	35Z5GT	.45	872A	2.45	WL531	9.95
3E29/829B	3.85	6S7	.87	37	.78	918/CE1C	1.49		
3FP7	3.98	6SA7GT	.49	41	.58	922	1.49		
3JP12	2.95	6SC7	.70	50L6GT	.53	923	.75		
3S4	.69	6SF5	.60	80	.52	931A	3.95		
4J47	39.95	6SG7	.71	83V	1.05	954	.33		
5AP1	2.75	6SH7	.69	117Z6	1.10	955	.40		
5BP1/5GP1	1.95	6SJ7	.72	205B/VT2	1.98	956	.33		
5BP4	3.95	6SJ7GT	.58	211C	.89	957	.33		

Prices subject to change
TUBES GTD except open fil. & breakage.
CRT tubes GTD only when shipped express

KITS

AMPLIFIERS

Biggest Amplifier Kit Buys—Never Before at these Low Prices!

HIGH FIDELITY—A Hi-Fi circuit with perfect linear response, phase inverter & full tube complement featuring 2-2A3 PP output, 6SJ7 and 6SN7. All parts, tubes, controls, diagram & remarkable RCA Audio Amplif Chassis described below. Less Output Xfmr. THIS IS A TRULY GREAT BARGAIN **$14.95**

17.5 WATT AMPLIFIER KIT—Similar above with all major components except 2-1619/6L6 delivering 17.5 Watts.

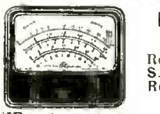
14 WATT AMPLIFIER KIT—Similar above except 2-6V6GT delvrng 14 Watts. 17.5 or 14 Watt Kit, less output Xfmr, ONLY.... **$12.95**

RCA Audio Amplifier Chassis for AMPLIFIER KITS above. Heavy duty porcelainized chassis. Gray rustproofed 7¼x12¼x2¼". 9 Amphenol sockets incl 6 octal, 3 inputs, cutout for pwr transf & choke. Chassis marked for 2 mic, Vol, Tone, Fuse, Tubes (7). Complete with 3-FP triple section Electrolytics.

BASIC ALL-ELECTRONIC VTVM Kit. An ultra-sensitive tester; similar to RCA Volt-Ohmyst Jr. Includes PRECISION resistors, 4" Sq GE 200 microamp meter (reads 2-10-30-100-1000V DC; 10-30-100-300-1000 VDC; 1000/10000/1000000/1 meg/10 megohms). 11 megohm input resistance. Full data Less case **$19.95**

BASIC 3" SCOPE KIT. Sensational visual tester foundation. 3BP1 CRT plus 5Y3GT & 2X2 tubes, 115V60cysXfmr—1320V, 375 VCT/110ma, 5V/3A, 2.5V/3.25A. All cndsrs & choke for Lo & Hi Volts supply & sockets. Less chassis, amplifier & sweep circuits **$16.95**

POPULAR METER BUYS! 200 Microamp DC GE 4"



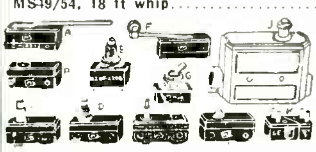
Replaces RCA Volt Ohmyst Jr. Sq. 5 Scales AC & DCV & ohms Red & Black K.E. ptr. **$7.95**

Range	Description	Each
5 Ma	Tuning GE 2½" Bklt Csd	$1.49
25 & 25 Ma	GE Galvnmtr zero ctr	3.95
1 Amp	RF 2½" GE Bklt Csd	3.95
5 or 9 Amps	RF 2½" GE/Wstg B'Csd	3.49
750 Ma	RF 2½" Csd & couple Weston	3.49
15 Amp	DC 2½" Csd Hoyt	2.95
240 Amp	DC 50 MV mvt 2½" B'Csd AN	2.49
30 Volt	DC AN 2½" B'Csd Westinghs	2.49
10000 V	DC 10000ohms/v 3½" B'Csd	12.95
150 Volt	AC 25-125 cyc 2½" Wstg & G E	3.95
7.5 Volt	AC 3½" Bklt Sq. RA35 Wstg	4.49
15 Volt	AC 3½" Bklt Sq. Weston 476	4.95
I-82 360°	Bendix Autosyn	4.95
Test Leads & Clips 8 ft Insul 30 amps		49¢
Test Leads & Red & Blk insltd Prods Hi		49¢

ANTENNAS

AN-30 Telescopic Whip Adj 9"—12 ft NEW ea $1.49; 2 for $2.49
AT5/ARR1 AT1/APN2 30am/12" &/coax conn &wtpf gask & flange for mobile .... 98¢
AN130B Spring Swiv'ld Whip END Loaded 33" ea $1.25; 2 for 1.98
P108/LU3 12cm coax fitting ANT 1.98
AS23/AP w/coax fitting 2.98
MS49/54, 18 ft whip 3.98

SWITCHES MICRO, TOGGLE, ETC.



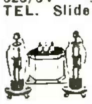
A) MU/Leaf Sw 3½" DPNO&NC/15A ½"@.... .98
B) MICROSWITCH Pin Plunger SPDT 10A@ .54
C) MICROSWITCH Plunger SPDT/10A @.... .59
D) MICROSWITCH Plunger SPNO/10A @.... .69
E) ARROW H & H PLUNGER SPNO/6A @.. .39
F) MICROSWITCH ROLLER SPNC 10A @..... .89
G) AH & H Toggle 6A/DPDT 30¢ @ 4 for.... 1.00
H) MICROSWITCH PLUNGER SPNO'NC @.. .59
H) MU & MICROSWITCH SPDT w/reset..... .65
I) MICROSWITCH PLUNGER Button SPDT @ .69
J) MICROSWITCH SPNC/30 Amp/Cased @.... 1.25
K) SWITCHETTE DPNO&NC 30¢; SPNO @.... .25

LAMPS, PILOT LIGHTS, SOCKETS

TUNGAR* BULBS		Aviation Lgts		SOCKETS for	
20x672"	2.95	C1249/12VGR 25 for	1.00	2X2HV	.30
199698*	2.95	Sealed Beam		705/715	.69
289881*	2.50	4522/250W	1.49	803/304T	.90
MAZDA PL**		4560/600W	3.50	807	.27
46** Box 10	.50	NEON BULBS		829/832	.25
47** Box 10	.50	NE2 — 100 Qty	4.50	866	.24
49** Box 10	.60	NE16/991	.25	872/211	.49
64** @	.07	NE51/NE20	.08	Diheptal	.69
S6/T4**	.15	Qty 100— NE20	6.00	Magnal	.54
10 for	1.39	Acorn Sockets 5 for	1.00	Loktal 49SSL	.24
100W/20V**	.25			Octal 78S8	.06
313/28V**	.10			Octal 49SS8	.15
323/3V**	.10			Min 59500	.12
				Min & SH	.25

TEL. Slide Lamps 6, 24, 30V@18¢; 100 for $15

Kit 886A's & Xformer



115VACin 2.5VCT/10A out 10KV insul & Tubes & sockets, only **$5.95**
Similar 872A kit 12.95

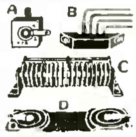
Blowers—Cool That Tube!

40CFM/28VACDC 2.98
100CFM/12FACDC 5.95
100CFM/28VACDC 4.95
Xfmr 12/28V to 115V AC 1.60
250CFM/28VACDC 8.95
250CFM with 28-115 Xfmr 10.95

Dynamic Microphone & Xfmr Special! A Terrific Bargain! Combination high gain dynamic mike transformer (UTC/Super Elec 3 wdg. 600CT & 4000 ohms tapped 250 & 150 ohms. Fully shielded H'sld plus excellent fidelity dynamic microphone. While they last.....$1.49

COBALT BAR MAGNET. Wide Hysteresis (hi-retentivity) charged COBALT bars 3⅞x½x¾". Pair for.......... **79c**

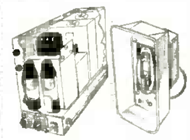
Rectifiers, Bridge (C)



In	Out	Amps	Each
18V	14V	1.35	$2.49
18	14	3.5	3.49
18	14	5.	4.85
36	28	.32	1.49
36	28	3.5	6.75
36	28	5.	7.50
90	75	.15	1.49

A. Selen FED 100 dia 79¢: 200 ma.......... 98¢
B. Bridge 210Vin/190out/40 ma.......... 79¢
D. Selen C.T. 36Vin/28 out/1.5 amps.......... 1.49

BASIC FOTOFLASH KIT



—Complete Pwr Suply Incl cndsrs, tubes, xfmrs, circ diag, all instructions & FOTOFLASH lamp & reflector. For 115 VAC. Only.... **$29.95**

STUDIO KIT—Famed Air Corps 1503 Set for 115V AC or battery w/2 lamps & refls. A terrific buy at..........$53.95

FOTOFLASH Cndsrs 8mfGE660VAC/3000DC intermitnt 4/$11.95; 16mf/660AC/3000DC 7.95; 15mf/330AC/2000DC 4.50; 28mf/330AC/2000DC int. 7.95
16mm PAN50 film GSAP camera 54 rolls..... 5.49
16mm PAN film GSAP camera 10 rolls.......... 1.49

SNOOPERSCOPE INFRARED

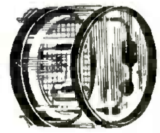
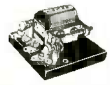


Image-Converter Tube HiSensitivity simplified design 2" dia., Willemite screen—Resolution up to 350 lines/in. Complete data & Tube.
"TAB" SPECIAL $10.98
G.E. GL434A similar 7C29/1KW. JTF RF..........$7.95

RELAYS—FAMOUS MAKERS



AUTOMATIC RA74 Remote Control Reset Stepping Twin Coil 24to30V D?10 Circuit $8.95
W.E.263A Telephone 275ohm dual coil 2 section each 25 pole DPNO palladium cts, $10.95
CLARE A12280/115V—60cy/3SPDT & 3SPNC, $2.98
CLARE Octal based 115VAC/DPNC & SPNO. $3.98
CH/B8/operates7to24VDC/200to1200 Amps.....$2.98
S'DUNN 32AXX10 Reset&o'load 10ma&115VAC.$4.95
KURMAN 4maSens650ohm/DPINO&INC/5Amp,$2.25
A Bradley 702/110VAC/3PSTD break 25Amp, $4.49
ADVANCE 4001B Antenna DPDT&SPNO 15Amp. Ceramic HF ins 75to110V $2.75 @ Rec115VAC. $3.25
A Bradley Overload adj18.1/15.2/12/9&5.3A. $3.98
CLARE VAC Nitrogen sld SK5010/DPDT/18-28V 2Amp Cts octal base @ $1.49; w/115VAC rect. $1.98
GE Inst V'Rel Calib 70,85,110,160Vfor115VAC. $9.95
A'Bradley 110VAC/3PST/30A dbl b k..........$4.49
GE CR2792B 117A3/28V/50A/SPNO Dbl'Bk. $1.98

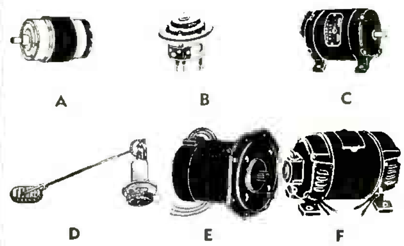
"TAB" MONEY BACK GUARANTEE $3 MIN. ORDER F.O.B. N.Y.C. ADD SHIPPING CHARGES AND 25% DEPOSIT. PHONE WO. 2-7230

THAT'S A BUY "TAB" THAT'S A BUY

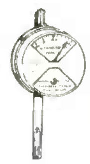
"TAB" MONEY BACK GUARANTEE $3 MIN. ORDER F.O.B. N.Y.C. ADD SHIPPING CHARGES AND 25% DEPOSIT. PHONE WO. 2-7230

DEPT. 1E, SIX CHURCH ST. NEW YORK 6, N.Y., U.S.A. - CORNER CHURCH & LIBERTY STS. ROOM 200

Selsyns, Motors, Generators



A. NEW SERVO AUTOSYN BENDIX BUILT TO RIGID ORDNANCE & NAVY SPECIF. Removed from New Unused MI Gun Directors. TYPE SYNCHROTRANSMITTERS AC 115V/60 cy. operation continuous heavy duty. PRECISION accuracy made for gun-fire control. Cost gov't $90 each. Wgt 5 lbs.—Dimensions 4½x3¼" Dia. Shaft 5/16 dia. ⅞" mfgrd by Bendix, Diehl, Electrolux, Hobart. Complete diagrams included. SPECIAL per PAIR $12.95. Write for Quantity Prices—SYNCHRO-DIFFERENTIALS TYPE 5/115V/60cy $7.95
SYNCHRONOUS REPEATER TYPE II 115V/60cy BRONZE UNITS per PAIR 20.00
AUTOSYNS TYPE 5/50V/60cy per PAIR 9.95
SYNCHRO DIFFERENTIAL TYPE 5/50V 4.95
B. AUTOSYNS AY115/28V—400cy can be used 24V60cy & instructions TWO for 4.50
GE SELSYN 2155VI/110V/60/cy $7.95
C. GE SYNCHRONOUS INDUCTOR MOTOR 5SMY50H36 115V/60cy TORQUE 40oz" RPM 75. 14.95
GE SELSYSN TANK GAGE & SELSYN LEVEL XMTTR indicates qty liquid in one to 3 tanks operates 24VDC/AC or 110VACDC 9.95
D. GE SELSYN TJ SERVO LIQUID XMTTR Pr .98
C. DIEHL 3 phase MOTOR operates 1 phase 110V/60cy with capacitor cont duty 1/40 HP/5/8 shaft/1¾"L/3450RPM & capacitor used LN* ... 4.95
E. HOLTZER CABOT 3 phase/1HP/115V/60cy/3450 RPM MOTOR BALL bearing/cont. duty/removed from gun control LN* 12.95
KOLLSMAN SERVO 403-28775 .... 9.95
F. Telephone INVERTER & CONVERTER inpt 43-47VDC, Outpt 90V/20cys W.E 18.00



WESTERN ELECTRIC GE 8K5A3 THERMOTEL

Accurately indicates percentage of transformer capacity in use for steel or cast TANK transformers 5 to 100KV/2300, 4600, 6900, 13800 volts. Easy to install & read.
NEW USN SPECIAL 7.95

TOP TRANSFORMER BUYS

POWER TRANSFORMERS—115V/50-60 cps input
500VCT/60ma; 6.3V4A Herm Csd $1.29
700VCT/150ma; 10V/3.25A, 6.3VCT/2A, 5V/3A and 2.5V10A HV insul Csd 5.95
700VCT/120ma; 2x6.3V/2A and 5V/2A; 115V Isol/100ma; Csd HiV insul 2.95
880VCT/125 to 250ma; 6.3V/3A, 6.3V/2A, 5V/3A 3.98
1100VCT/150ma; 6.3V/3A and 5V/3A HVins ... 4.50
2500V/10ma; 2.5V/1.75A, 6.3V/.6A KENYON S13336 or equiv. 8.95
PLATE TRANSFORMERS—115V/50-60 cps input
700V or 15000V Dblr/35ma 15.95
1200VCT/300ma 4.50
1800V/4ma 3.49
3000V/10ma 4.50
5000V/10ma 6.95
10800V or 21000V Dblr/95ma 19.95

FILAMENT TRANSFORMERS—115V 50-60 cps inpt

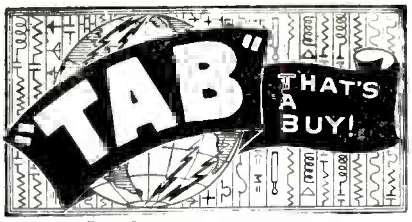
2.5V/40A GE 25KVins $7.95	6.4/12A. 6.4V/10A. 3x5V/3A. 2.5V/1.7A $4.95
2.5V/10A/10KV 3.95	7.5VCT/6.5A, 6.3 VCT/3A 3.75
2.5V/10A/20KV 4.95	
5V/60A KENYON HVins 6.95	7.5V/12A/HV/insul .4.95
	10V/8A/12KV 6.95
5V/115A 10.95	12VCT/.7A, 10VCT/10A, 2x6V/2A. 3x 6V/1A 7.95
4x6.3V/4A 3x5V/4A 4.50	

SPECIAL TYPES

Input	Output	Each
110 or 220V	10VCT or 5VCT/10A	$ 4.95
110 or 220V	5VCT or 2.5VCT/20A	5.95
6, 12, 24, 115VCT	420VCT/85ma. 6.3V/3A	
115 or 230VAC	Univ. Vibra. Xfmr	2.49
110V	110 to 220V/250Watt	
220V	220 to 440V/250Watt	4.95
115 or 230V	AutoXfmr 1.8KW	16.95
115 or 230V	AutoXfmr 2KW	19.95
208 to 251V	6800V or VCT/1A/17KVins	59.50
107 to 126V	3400V or VCT/1A/17KVins	59.50
105 to 250V	2210VCT/500ma; 19V/2.5A. 12V/4.5A. 2.5V/10A	24.95

FILTER CHOKES

13.5Hy/1Amp/42ohm/17KVinsl $49.00
5-29Hy/150ma Swinging Cased 2.95
12Hy/300ma $3.95; 3Hy/40ma .... 3 for 1.00
15Hy/400ma or 20Hy/300ma/12KV ins 7.95
8Hy/150manewUTCcrckdBklteT'Bd2 .... 2.25
50Hy/125ma Csd 1.95
8Hy/100ma/$1.10; 12Hy 275ma 3.29



PRECISION RESISTORS

"NO MFGRS CHOICE, We ship types in stock"

.116	182	689	2700	14400
.42	199	697	2850	14440
.425	200	700	2860	14460
.607	209.4	733	2900	14500
.7	216	750	3000	15000
1.3	220	800	3100	15500
1.75	220.4	806	3290	16500
2.5	225	854	3384	17000
3.75	230	900	3500	17500
3	235	910	3509	18000
3.83	240	917	3700	18380
4	245.4	946	3730	18500
5.35	250	978	3760	19000
5	260	1000	4000	19500
6.025	271	1030	4200	20000
6	275	1056	4280	20520
7.25	280	1060	4300	21008
7	286	1100	4314	21500
7.5	289	1110	4440	22000
7.8	299	1150	4444	22500
8.9	300	1155	4500	22990
10	310	1162	4720	23000
10.38	311.5	1175	4750	23150
10.48	320	1200	4850	23325
11.25	325	1225	4885	23400
12	340	1250	4900	24000
13.52	350	1260	5000	24600
14.2	366.6	1322	5100	25000
14.5	370	1350	5210	25200
15	375	1355	5235	25400
16	380	1400	5200	26600
16.37	390	1495	5500	27500
17	400	1500	5600	29000
20	410	1510	5730	29500
21	414.3	1518	5910	29900
25	418.8	1600	6000	30000
36	425	1640	6140	31000
20	426.9	1646	6200	33000
37	427	1650	6300	35000
48	440	1670	6495	37000
50	450	1680	6500	38140
51.78	452	1710	6840	38500
55	470	1740	6990	39500
60	475	1770	7000	40000
63	478	1800	7500	43000
68	480	1818	7700	47000
71.4	487	1830	7930	47500
74	500	1865	8000	48000
75	520	1900	8250	48660
80	525	1910	8500	49000
81.4	540	1960	8700	50000
89.8	550	1980	8800	52000
90	575	2000	8992	54000
95	580	2045	9000	56000
100	600	2080	9445	60000
101	607	2095	9500	61430
105	612	2145	9710	62000
105.7	625	2160	10000	64000
107	633	2195	10430	65000
113.1	640	2200	10500	68000
120	641	2250	10600	70000
121.2	649	2300	11000	72000
125	650	2400	11400	75000
147.5	657	2450	11500	77000
150	665	2463	11690	80000
160	669	2485	12000	84000
165	670	2490	12600	90000
170	675	2500	13220	91000
175	680	2600	13500	95000
179	681	2635	14000	

ABOVE SIZES EACH 30¢ @ ... TEN FOR $2.50

100000	166750	240000	380000	620000
110000	169360	245000	400000	621000
115000	180600	250000	402000	654000
120000	185000	265000	422000	750000
125000	198000	268000	458000	761300
130000	200000	275000	478000	800000
135000	201000	294000	500000	900000
140000	220000	307500	520000	930000
145000	225000	314000	521000	950000
147000	229000	330000	570000	
150000	235000	333500	575000	
155000	238000	353500	600000	

ABOVE SIZES EACH 40¢ ...... TEN FOR $3.50

1 Meg	2.5 Meg	2.673Meg	5 Meg	19.5 Meg
1.2	2.855	3.9	9.05	20
1.5	3	4	10	
1.8	3.673	4.23	11.5	
2	3.5	4.5	12.83	

ABOVE SIZES EACH 75¢ ...... TEN FOR $6.50

Vacuum Precision Hivolt Resistors (C)

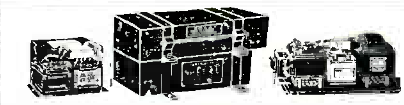
.12, .25, .6, .75, .83, .99 megohms
1, 1.5, 2, 3, 3.75 megohms 0.5% accuracy
SPECIAL $1.00@ .... TEN FOR $7.50
SEALED .... 12Meg/10KV/9W $1.35@10for 10.00
MVZ8/20 Watt/30 Megohms/25KV $1.98@6for 10.00
MFB105/1Meg/.5% accy/Jan.R-29 $1.98@6for 10.00
Type 2/20megJAN R29/20KV/0.5%accy 29.95

Attenuators—100K & 250K Ohms

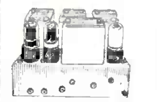
IRC 100000 ohms 20 position $2.98
IRC 250000 ohms 20 position 4.98
Write Qty Prices ½,1&2 Watt insltd Resistors
Resistor Kit, asstd ½ & 1 W. 100 for 98c

XTAL DIODES & THERMISTORS

IN34 .... $1.08; 2/$2.10; 10/$9.85
IN21, 21A, 22, 23, 23A ea .... $1; 12/$10
IN21B. IN26 .... $2 10 for $17.50
IN35 Dual Diode $2.29
D168391. Therm Compensator .... $2; 3/$5
D170396 HF pwr meas .... 90¢; 3 for $2.50
IC Bulb Time Delay .... 90¢; 3 for $2.50

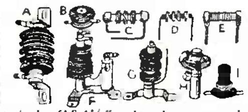


CONSTANT V'REGULATOR NEW RAYTHEON In 95-130V/60 cy; Output 115V/60 cy Csd $10.95
RAYTHEON in 198 to 242 Vinpt/50-60 cys; Output 220V/500 Watts/0.5% Rgltn Rack mtg .. $36.00
SOLA CONSTANT V'REGLTR USN Cased in 95 to 190V/50-60 cys; Output 115 or 220V 2KW/17.4 Amps/Constant Duty 1% Regulation LN* $130
Same Unit NEW. USN Cost $369. Only 162



Collins Art-13 Speech Amplifier

Dynamic or Carbon Mike or line inpt. Audio Driver to PPG & Monito tube. Less Tubes .. 4.50
SAME & CLIPPER KIT & TUBES & Data. NEW 8.25



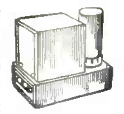
RF CHOKES

(A) HAMMARLUND CH500/2.5 MH8ohms500ma98c
(A) 20MH/500ma/14.75 ohms DCR 8mmf dist Cap w/mtg ft&4¼" mtg ctrs. ceramic core 98c
(B) SICKLES 85MH/250ohms/ceramic form 70c
(C) NATIONAL R300/mh/300ma/10ohms@28c,4/98c
(C) Two 2.5MH/125ma&.01&.002cdsr&Resist 45c
(D) 5MH/300 ma, pi wound 29c
(E) MILLER2½&5mtr/2.5MH/.27ohms/1A@25c,5/98c
(F) Nat'l R152/80&160 mtrs/4MH/600ma/10 ohms 98c
(G) SICKLES HF 20MH/200ma75ohms 49c
(H) Hash Chokes for MercuryVaporRec@25c; 5/98c
(I) SICKLES 1.5MH/200ma. ea. 25c; 5 for 98c

IF TRANSFORMERS

IF XFORMERS 456 Kc Double slug tuned. Shielded .... ea. 39c; 3 for $1.00
FM & TV IF Xformer 10-14 Mc double slug tuned. Shielded .. ea. 59c; 2 for 98c

VIBRAPACKS



VIBRAPACK 6VDC input & 425V/110ma output ... $10.95
VIBRAPACK PE157SP KR BAT&CHGR p/oSC R593 & SPHR 8.95
VIBRAPACK 12VDC Input & 190V/85 ma outpt 3.49
VIBRAPACK PP/18AR inpt 12-13V output 24VDC 6.95

HIPOWER VARIABLE ANTENNA MATCHING NETWORK 1001A 1 KW RF NEW 1.5 to 7 mc's convertible to Hi-freqs. PiNetwork adjustable IN & Output CASED 15 x 15 x 23" RACK MTG Ribboncoil & 250mmf/7000V V-condsr RFmtr. Insltrs Techmanual will match most ANTS. NEW requires recementing coil turn SPECIAL Cabinet alone worth the price! $9.95
Same Unit NEW $12.95
SAME UNIT, NEW, broken coil 8.95

Famous USN W. E. BEACHMASTER SOUND SYSTEM

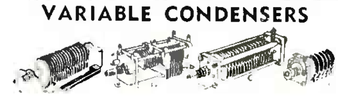
250 Watts—Tremendous Coverage!

COMPLETE 250-Watt 14-tube Power Amplif & PreAmp Unit, dynamic mike & 700 Watt Pwr Supply for 115V60cycACoper & Reproducer Assy of 9 Drivers & Trumpets in projective array for most effective sound distribution. System powerfully built to take heaviest rain or snow. Blast & Humidity proofed. Excellent response. Perfect for Industrial Marine & Harbor installations. Units contained in waterproof chests. COMPLETE SYSTEM & SPARES NEW USN READY TO OPERATE. Only $695

SPECIAL! Gtd Famous Make!

EP Electrolytic 50mfd/350WV only 39c: 10 for $3.50; 100 for $25.00
Write for larger Qty Quotations.

VARIABLE CONDENSERS



(A) 150mm/3000VcapHF 1.00
(B) 15 mmf per Sect/3000V nap .... .79
(B) 75mmf/sec/1000V gap/HF 1.49
(C) 70H30/74mmf/3000V nap/ 1.29
(D) ZT/12mmf/5000 Vna&locknut .... .93
PHASING CONDSR 90° Quadrants/4taps, 360°
SINEWAVE GENERATOR Variable 2.39
2½ MTR Butterfly Cndsr 30 mmf w/RF tank & choke. SPECIAL 75c: 2 for $1.25

Write for your FREE TABOGRAM

"TAB" MONEY BACK GUARANTEE $3 MIN. ORDER F.O.B. N.Y.C. ADD SHIPPING CHARGES AND 25% DEPOSIT. PHONE WO. 2-7230

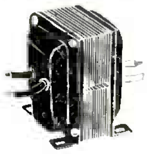
THAT'S A BUY • "TAB" THAT'S A BUY •

DEPT. 1E SIX CHURCH ST. NEW YORK 6, N.Y., U.S.A. - CORNER CHURCH & LIBERTY STS. ROOM 200

"TAB" MONEY BACK GUARANTEE $3 MIN. ORDER F.O.B. N.Y.C. ADD SHIPPING CHARGES AND 25% DEPOSIT. PHONE WO. 2-7230

SAVE MONEY!

BY BUILDING YOUR OWN HIGH QUALITY LABORATORY TEST EQUIPMENT



TRANSFORMER

24 Volts @ 10 amps. Will deliver 18 Volts DC from full wave selenium rectifier @ 10 amps — good quality 110V 60 cy imput... **$4.95**

SELENIUM RECTIFIER

2 amps—18 to 24 Volts input—18 to 12 Volts output. Your cost...... **$2.49 ea.**

1000-1000 Mfd FILTER

Cond.—upright can at 15 Volts—Perfect filter for low Voltage DC Supplies. **$1.95 ea.**

DUMONT 164 E SCOPE

A popular 3" scope for the discriminating user—

- Freq. response Horiz. & Vert. amplif. from 5 to 100,000 CPS. Uniform within 7½%
- Deflection factor, Vertical. .7 RMS Volts per inch Max.
- Deflection factor, Horiz. .55 RMS Volts per inch Max.
- Sweep freq. continuous from 15 to 30,000 cycles
- Primary input 110 Volts—40 to 60 cy.

Only a few left at this amazing price **$75.00**

THE NEW 900A VTVM VOMAX

Accurate AC-DC & RF voltage measurements of Laboratory caliber:

- 5" giant meter providing 45 ranges fused
- 24 Volt DC Voltages thru 3000 Volts
- AC, AF, IF, RF Ranges 20 cycs. thru 10 megacycles
- DB ranges from +10—10, +30+50, 0-DB=1MW in 600 ohms impedance
- Current ranges—6 ranges from 1.2 ma to 12 amps. + or —2% absolutely stable.

Complete with test leads tubes & all accessories.. **$68.50**

GOING MOBILE?

Here is a Rig for 80 or 10 meters—Will deliver 8 watts output Modulated — Fits in Glove Compartment or under dash only 4×5×5½" designed for T17 B Mike or equivalent Less Tubes, Mike, Xtal & Power Supply—Requires 3—6AG7 and 350V DC @ 110Ma

Model 129—27 to 29.7 MC
Model 175-3750 to 4000 KC
Your Cost **$23.95**
Set of Tubes...... **3.84**

BUTTERFLY CONDENSER

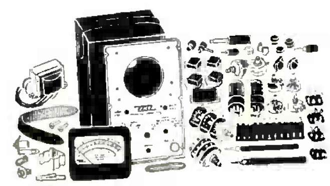
This cond. has the tank circuit built in—just plug in a tube. (Designed for W.E. 368AS.) Operates from 200 to 1000 mcs. Can be used with any high frequency triode **$1.98**

RG 22U-TWIN COAX.

Nominal impedance 95 ohms—Perfect for television or where Shielded Balanced Transmission Lined is Needed .... **.15 per ft.**

BUILD YOUR OWN TEST EQUIPMENT

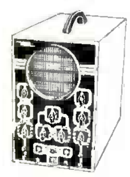
MODEL 221K VACUUM TUBE VOLTMETER KIT



Comes complete nothing else to buy.

- DC and AC ranges 0-5, 10, 100, 1000 Volts
- Ohmmeter ranges .2 to 100 megohms 5 ranges R×1—R×100, R×1000, R×10,-000 R×1 megohm
- DB scale from —20 to +16 DB
- DC input resistance 25 megohms constant on all ranges
- AC input impedance over 1½ megohms constant on all ranges
- Large 4½" linear movement 2% accurate with minimum friction
- Size 9 7/16×6"×5" WHT. 10 lbs.

Your cost kit **$23.95**
Above unit completely built **49.95**



MODEL 400-S" 5" OSCILLOSCOPE KIT

Easy to read assembly instructions & diagrams:

- Horizontal Sweep Freq. 15 to 30000 cycles
- Graph screen for measuring peak to peak voltages
- Internal & External Synchronization
- Deflection sensitivity .65 volts per inch Full gain
- Amplifier freq. response from 50 cycles to 50 KC
- Input impedance 1 meg. and 50 MMF
- Z axis intensity modulation provided
- Size 8½×13×17" WHT 38 LBS

Your cost complete........ **$39.95**
Above unit completely assembled & tested.......... **69.95**

HIGH FREQUENCY F.F. PROBE FITS MOST V.T.V.M's.

A handy addition to your laboratory. Will measure R. F. Voltage to over 200 mc, with a minimum of circuit loading. An excellent method of signal tracing for Television, F.M., and amateur radio. Contains the 1N34 crystal. This highly accurate and dependable crystal makes a small compact unit that is easy to use. Fits the Model 221 and Model 113A as well as most other V.T.V.M.'s.

Kit form **$3.75**
Completely built and tested **7.50**

VOLT-OHM MILLIAMETER KIT

Easy to assemble—Easy to use

- 3" meter
- DC 0/5/50/250/500/2500 volts
- AC 0/10/100/500/1000 volts
- Output 0/10/100/500/1000 volts
- DC mils 0/1/10/100 ma
- DC amps 0/1/10
- Ohmmeter 0/500/10,000 and 0/1 meg
- DB 8 to 55
- Size 5⅛×8⅝×3⅛

Complete kit nothing else to buy **$14.95**
Wired & factory tested.... **17.95**

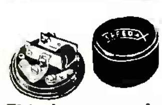
DO YOU OWN AN SCR-522?

We have a complete power supply, including a separate voltage regulated bias supply chassis and schematic—all in kit form. This kit will supply all voltage necessary for operation of the set. All parts guaranteed. Complete at the amazingly low price of..... **$14.95**

IT'S SENSATIONAL

Hottest Item Out! Make your SCR-522 receiver operate on 144 to 148 MC with ONE DIAL control, in less than 1 hr. Parts and instructions.. **$3.00**

Model 200-EA. 5-ELEMENT 2 METER BEAM KIT. Folded di-pole driven element. All-aluminum construction. Feed with low impedance coaxial cable. Amateur net price.......... **$8.40**



HI FREQUENCY BUZZER

This buzzer and a key will get your code speed up for that ticket.... **.88**

K200-TWINEX

Mfd. by Federal. Will handle 3 KW of R. F.; very heavy Poly base—Unaffected by moisture—Get all of that R. F. up to the Ant. Sample on request .... **.08 per ft.**

ATTENTION

Amateurs-Industrials-Experimenters-Inventors

Cut your cost on radio supplies and equipment in half. Clip coupon today.

Hundreds of "hard to get" war surplus items along with the best in standard brand equipment—all at great savings to you. Let us know your particular requirements.

IMMEDIATE DELIVERY.

PLEASE PUT MY NAME ON YOUR MAILING LIST FOR SPECIAL BULLETINS.

NAME...

ADDRESS..............................ZONE......

CITY ....STATE............

NIAGARA RADIO SUPPLY CORP.
160 Greenwich St., New York City 6, N. Y.

20% DEPOSIT WITH ORDERS UNLESS RATED

NIAGARA RADIO SUPPLY CORP.

160 GREENWICH STREET NEW YORK 6, N. Y.

Phone
DIgby 9-1132-3-4
All Prices F. O. B. N. Y. C.

MAGNETRONS

2J41 Magnetron-Magnet-Stabilizer Pkg. 9290-9330MC, 1.25 KW Pk. Pulse Output Power. 100MC Tuning Range. Refer Rad. Lab. Series Vol. G, Pg. 766.... ....(as shown) $75.00

Tube	Frq. Range Pk.	Pwr. Out	Price
2J31	2820–2860 mc.	265 KW.	$25.00
2J21-A	9345–9405 mc.	50 KW.	$25.00
2J22	3267–3333 mc.	265 KW.	$25.00
2J26	2992–3019 mc.	275 KW.	$25.00
2J27	2965–2992 mc.	275 KW.	$25.00
2J32	2780–2820 mc.	285 KW.	$25.00
2J38 Pkg.	3249–3263 mc.	5 KW.	$25.00
2J39 Pkg.	3267–3333 mc.	87 KW.	$25.00
2J55 Pkg.	9345–9405 mc.	50 KW.	$25.00
2J61	3000–3100 mc.	35 KW.	$65.00
2J62	2914–3010 mc.	35 KW.	$65.00
3J31	24,000 mc.	50 KW.	$55.00
5J30			$39.50
714AY			$25.00
718DY			$25.00
720BY	2800 mc.	1000 KW.	$50.00
720CY			$50.00
725-A	9345–9405 mc.	50 KW.	$25.00
730-A	9345–9405 mc.	50 KW.	$25.00

Klystrons: 723A/B $12.50 707B W/Cavity $20.00

MAGNETRON MAGNETS

Gauss	Pole Diam.	Spacing	Price
4850	3/4 in.	5/8 in.	$12.50
2500	1 5/8 in.	1 11/16 in.	$12.50
1500	1 5/8 in.	1 1/2 in.	$12.50
D161392*	1 5/8 in.	1 5/16 in.	$12.50

*Mfr's Number.

TUNABLE PKGD. "CW" MAGNETRONS

QK 61 2975-3200 mc. QK 62 3150-3375 mc.
QK 60 2800-3025 mc. QK 59 2675-2900 mc.
New, Guaranteed ....Each $65.00

VARISTORS W.E.

D-171631	$.95	D-168549	$.95
D-167176	$.95	D-162482	$3.00
D-170225	$.95	D-99136	$1.65
D-168687	$.95	D-166271	$2.50
D-171812	$.95	D-162356	$1.50
D-163298	$.95	D-161871A	$2.85
D-171528	$.95		

THERMISTORS—W. E.

D-167332 (bear).....$.95 D-164699 FOR MTG. in
D-170396 (bead) ....$.95 "X" Band Guide...$2.50
D-167613 (button) ..$.95 D-167018 (tube) ....$.95
D-166228 (button) ..$.95

COAX CABLE

RG 17/U. 52 ohms imp.....................$.48/Ft.
RG 57/U. Twin Cond. 95 ohms..............$.35
RG 18/U. 52 ohm im. armored..............$.51/Ft.
RG 23/U. twin coax, 125 ohm imp. armored...$.50/Ft.
RG 28/U. 50 ohm imp. pulse cable. Corona min. starting voltage 17 KV..............$.50/Ft.
RG 35/U. 70 ohm imp. armored.............$.50/Ft.

COAX CONNECTORS

831SP	$.35	UG 254/U	$.75
831AP	$.35	UG 255/U	$1.25
831HP	$.15	UG 146/U	$1.00
UG 21/U	$.85	UG 85/U	$1.25
UG 86/U	$.95		

D-166366—BABY "N"..............................$.85
ADAP. CABLE ASSY: Type "N" Male to Type "N" Female $2.25
ADAPTER CABLE ASSY: Sperry Male to Type "N" Male $2.25
Homedell male to type "N" male adapter........$1.25

MISCELLANEOUS

"PPI" ROTATING YOKE TYPE. Complete with all necessary oscillator circuits, CR tube 5FP7, complete with tubes. Used with SO radar..............$100.00
SPERRY KLYSTRON TUNER Mod. 12...........$2.00
SINE POTENTIOMETERS. GE#251x96 or W.E. #KS 15138 LO1 ....$3.50
PH-SHIFTING CAP, 180 deg. W.E. #D-150734..$2.50
KLYSTRON SOCKETS for 723 A.B. and similar types 2 for $1.00
LINE INSERTION ATTENUATOR, type OAX-1, 20 Db. attenuation, with 3-contact plug and socket (amphenol 16S-5) $2.25
LIGHTHOUSE TUBE CAVITY, 500 mc..........$7.50
0-15 lbs PRESSURE GAUGES.....................$3.50
CONNECTOR for RG18/U, Navy type 4957......$3.75

MICROWAVE ANTENNAS

AN MPG-1 Antenna. Rotary feed type high speed scanner antenna assembly, including horn parabolic reflector. Less internal mechanisms. 10 deg. sector scan. Approx. 12'L x 4'W x 3'H. Unused. (Gov't Cost—$4500.00) $250.00
APS-4 3 cm. antenna. Complete. 14½" dish. Cutler feed dipole directional coupler, all standard 1" x ½" waveguide. Drive motor and gear mechanisms for horizontal and vertical scan. New. complete...$65.00
AN/TPS-3. Parabolic dish type reflector approx. 10' diam. Extremely lightweight construction. New, in 3 carrying cases $69.50
RELAY SYSTEM PARABOLIC REFLECTORS: approx. range: 2000 to 6000 mc. Dimensions: 4½' x 3', rectangle, new $85.00
TDY "JAM" RADAR ROTATING ANTENNA, 10 cm. 30 deg. beam. 115 v.a.c. drive. New..........$100.00
SO-13 ANTENNA. 24" dish with feedback dipole 360 deg. rotation, complete with drive motor and selsyn. New............$120.00 Used...........$45.00
DBM ANTENNA. Dual, back-to-back parabolas with dipoles. Freq. coverage 1,000-4,500 mc. No drive mechanism $65.00
AN/128A ANTENNA. Two Vertical dipoles working against a square reflector apx. 3' x 4'. Range: 140-200 mc......................................NEW $40.00
AS 125/APR Cone type receiving antenna, 1000 to 3200 megacycles. New $4.50
140-600 MC. CONE type antenna, complete with 25' sectional steel mast, guys, cables, carrying case, etc. New $49.50
ASD 3 cm. antenna, used, ex. cond..............$49.50

MICROWAVE PLUMBING

10 CENTIMETER

MAGNETRON TO WAVEGUIDE coupler with 721-A duplexer cavity, gold plated..........................$45.00
10 CM WAVEGUIDE SWITCHING UNIT, switches 1 input to any of 3 outputs. Standard 1½" x 3" guide with square flanges. Complete with 115 vac or dc arranged switching motor. Mfg. Raytheon. New and complete $150.00
721-A TR CAVITY WITH TUBE. Complete with tuning plungers $12.50
POWER SPLITTER: 726 Klystron input, dual "N" output $5.00
10 CM. McNALLY CAVITY Type SG...............$3.50
WAVEGUIDE SECTION, MC 445A, rt. angle bend. 5½" ft. OA. 8" slotted section.....................$21.00
10 CM OSC. PICKUP LOOP, with male Homedell output $2.00
TS115/APS-2F 10 CM ANTENNA in lucite ball, with type "N" fitting...................................$4.50
OAJ NAVY TYPE CYT66ADL. ANTENNA in lucite ball, with Sperry fitting..............................$4.50
10 CM FEEDBACK DIPOLE ANTENNA, in lucite ball, for use with parabola.............................$8.00
10 CM END FIRE POLYRODS..............$1.75 ea.
"S" BAND Mixer Assembly, with crystal mount, pickup loop, tunable output.............................$3.00

⅞" RIGID COAX—⅜" I.C.

SLOTTED SECTION, 10" L, 4" Slot..............$8.50
RIGHT ANGLE BEND, with flexible coax output pickup loop $8.00
SHORT RIGHT ANGLE bend, with pressurizing nipple $4.00
RIGID COAX to flex coax connector.............$3.50
STUB-SUPPORTED RIGID COAX, gold plated 5' lengths. Per length.....................................$7.00
RT. ANGLES for above...............................$3.75
⅞" COAX, ROTARY JOINT.............................$8.00
RT. ANGLE BEND 15" L. OA.........................$4.50
FLEXIBLE SECTION, 15" L. Male to female...$4.25
MAGNETRON COUPLING to ⅞" rigid coax, with TR pickup loop, gold plated $7.50
⅞" RIGID COAX. Bead Supported........$1.20 per ft.

⅞" RIGID COAX—¼" I.C.

Short right angle bend...............................$3.00
Rotating joint, with deck mounting..................$6.00
Rigid coax slotted section CU-60/AP................$5.00

3 CM. PLUMBING

(STD. 1" x ½" GUIDE UNLESS OTHERWISE SPECIFIED)

CU 105/APS 31 Directional coupler 25 db.......$15.00
CU 106 APS—33 Directional coupler, 25 db.......$15.00
CG 176/AP Directional coupler, 20 db..........$18.00
APS-10 TR/ATR duplexer section with additional iris flange $10.00
Flexible waveguide ....$4.00 per ft.
THERMISTOR: D-164699 for mtg. in "X" Band Guide $2.50
45 DEG. TWIST, 6" Long..............................$6.50
12" SECTION, 45 deg. twist. 90 deg. bend.........$6.00
11" STRAIGHT WAVEGUIDE section choke to cover. Special heavy construction, silver plated.......$4.50
15 DEG. BEND, 10" choke to cover.................$4.50
5 FT. SECTIONS, choke to cover, silver plated..$14.50
18" FLEXIBLE SECTION..............................$17.50
"E" or "H" PLANE BEND..............................$12.50
BULKHEAD FEED THRU...............................$15.00
WAVEGUIDE SECTION, CG 251/APS-15A. 26" long choke to cover, with 180 deg. bend of 2½" rad. at one end $6.00
ROTARY JOINT with slotted section and type "N" output pickup $8.50
WAVEGUIDE SECTION, 12" long choke to cover, 45 deg. twist & 2½" radius, 90 deg. bend.........$5.00
SLUG, TUNER/ATTENUATOR, W.E. guide, gold plated $6.50
TWIST, 5" 90 deg. choke to cover...................$5.00
WAVEGUIDE SECTIONS 2½ ft. long, silver plated, with choke flange $7.25
WAVEGUIDE, 90 deg. bend E plane, 18" long..$5.00
ROTARY JOINT, choke to choke.......................$6.00
ROTARY JOINT, choke to choke, with deck mounting $6.00
S-CURVE WAVEGUIDE, 8" long cover to choke..$3.50
3" FLEX SECTION. Sq. flange to circ. flange adapter $7.50
"X" BAND WAVEGUIDE, 1¼" x ⅝" OD, 1/16" wall aluminum ....per ft. $ .75
TR CAVITY for 724-A TR tube.......................$3.50
724-A TR tube (41-TR-1)..............................$2.50
APS-15 DUPLEXER SECTION using 1B24.....$10.00
3 CM WAVEGUIDE, 1" x ½" I.D. per ft.........$1.50
CIRCULAR CHOKE FLANGES, solid brass......$ .55
SQ. FLANGES, flat brass........................$ .55 ea.
"T" SECTION (TR-ATR) choke to choke, supplied with circ. or sq. flanges....................................$4.50
"X" BAND PRESS. GAUGE SECTIONS, with 15 lbs. gauge and press. nipple............................$18.50
TRANSMISSION LINE PRESS GAUGE..............$3.50
2" FLEXIBLE SECTION, cover to cover...........$5.00
MOUNTING SECTION for Absorp. Wavemeter and Thermistor Mount, Silver Plated, Sq. Flanges..$6.50

1.25 CENTIMETER

MITRED ELBOW cover to cover.....................$4.00
TR/ATR SECTION choke to cover.....................$4.00
FLEXIBLE SECTION 1" choke to choke.............$5.00
KBAND Rotary joint.....................................$45.00
ADAPTER, rd. cover to sq. cover....................$5.00
MITRED ELBOW and S sections choke to cover..$4.50
"K" BAND FEEDBACK TO PARABOLA HORN, with pressurized window $30.00

MICROWAVE GENERATORS

AN/APS-15A "X" Band compl. RF head and modulator, incl. 725-A magnetron and magnet, two 723A/B klystrons (local osc. & beacon), 1B24 TR, rcvr-ampl, duplexer, HV supply, blower, pulse xtmr. Peak Pwr Out: 45 KW apx. Input: 115, 400 cy. Modulator pulse duration .5 to 2 micro-sec. apx. 13 KV Pk Pulse. Compl with all tubes incl. 715-B, 829B, RKR 73, two 72's. Compl pkg, new..........................$210.00
APS-15B. Complete pkg. as above, less modulator $150.00
"S" BAND AN/APS-2. Complete RF head and modulator, including magnetron and magnet, 417-A mixer, TR, receiver, duplexer, blower, etc., and complete pulser. With tubes, used, fair condition $75.00
10 CM. RF Package. Consists of: SO Xmtr.-receiver using 2J27 magnetron oscillator, 250 KW peak input. 707-B receiver-mixer...............$150.00
Modulator-motor-alternator unit for above $ 75.00
Receiver-rectifier power unit for above.......$ 25.00
Rotating antenna with parabolic reflector for above. New $75.00

PULSE EQUIPMENT

APQ-13 PULSE MODULATOR. Pulse Width .5 to 1.1 Micro Sec. Rep. rate 624 to 1348 Pps. Pk. pwr. out 35 KW. Energy 0.018 Joules...................$49.00
TPS-3 PULSE MODULATOR. Pk. power 50 amp. 24 KV (1200 KW pk); pulse rate 200 PPS. 1.5 microsec: pulse line impedance 50 ohms. Circuit—series charging version of DC Resonance type. Uses two 705-A's as rectifiers. 115 v. 400 cycle input. New with all tubes...$49.50
APS-10 MODULATOR DECK, Complete, less tubes $75.00
APS-10 Low voltage power supply, less tubes...$18.50

MODULATOR UNIT BC 1203-B

Provides 200-4,000 PPS. Sweep time: 100 to 2,500 microsec. in 4 steps, fixed mod. pulse, suppression pulse sliding modulating pulse, blanking voltage, marker pulse, sweep voltages, calibration voltages, fil. voltages. Operates 115 vac. 50-60 cy. Provides various types of voltage pulse outputs for the modulation of a signal generator such as General Radio #804B or #804C used in depot bench testing of SCR 695, SCR 595, and SCR 535. New...$125.00
MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power: 114 KW (12 KV at 12 amp). Duty Ratio: .001 max. Pulse duration: .5 1.0, 2.0 microsec. Input voltage: 115 v. 400 to 2400 cps. Uses 1-715-B, 1-829-B, 3-'72's, 1-'73. New.........................$110.00

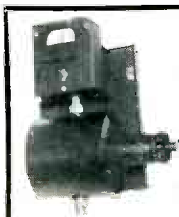
PULSE NETWORKS

G.E. #25E5-1-350-50P2T, 25 KV, 5 sections, "E" circuit, 1 microsecond pulse length, 350 PPS, 50 ohms impedance $45.00
G.E. #6E3-5-2000-50P2T, 6KV, "E" circuit, 3 sections, .5 microsecond, 2000 PPS, 50 ohms impedance $6.50
G.E. #3E (3-84-810; 8-2.24-405) 50P4T: 3KV, "E" CKT Dual Unit: Unit 1, 3 Sections, .84 Microsec, 810 PPS, 50 ohms imp.; Unit 2, 8 Sections, 2.24 Microsec, 405 PPS, 50 ohms imp. $6.50

PULSE TRANSFORMERS

W.E. #D166173 HI-Volt input transformer, W.E. Impedance ratio 50 ohms to 900 ohms. Freq. range: 10 kc to 2 mc. 2 sections parallel connected, potted in oil $12.00
W.E. KS 9800 Input transformer. Winding ratio between terminals 3-5 and 1-2 is 1.1:1. and between terminals 6-7 and 1-2 is 2:1. Frequency range: 380-520 c.p.s. Permalloy core..............................$2.00
G.E. #K2731 Repetition Rate: 635 PPS. Pri. Imp: 50 Ohms, Sec. Imp: 450 Ohms, Pulse Width: 1 Microsec. Pri. Input: 9.5 KV PK, Sec. Output: 28 KV PK. Peak Output: 800 KW. Bifilar 2.75 Amp. $19.50
W.E. #D169271 Hi Volt input pulse Transformer..$9.95
G.E. K2450A Will receive 13KV. 4 micro-second pulse on pr., secondary delivers 14KV. Peak power out 100KW GE $15.00
G.E. #K2748A Pulse Input, line to magnetron..$12.00
#9280 Utah Pulse or Blocking Oscillator XFMR Freq. limits 790-810 cy-3 windings turns ratio 1:1:1 Dimensions 1 13/16 x 1⅛" 19/32...................$1.50

MICROWAVE TEST EQUIPMENT



TS-238 GP. 10 cm. Echo box with resonance indicator and micrometer adjust cavity. 2700 to 2900 Mcs calibrated $85.00
TS- 108-AP dummy load $65.00
"X" Band calibrated attenuator $75.00
Shielded klystron tube mounts with rough attenuator outputs $90.00
W. E. I 138. Signal generator. 2700 to 2900 Mc range. Lighthouse tube oscillator with attenuator & output meter. 115 VAC input, reg. Pwr. supply. With circuit diagram...................................$50.00
3 cm. wavemeter: 9200 to 11,000 mc transmission type with square flanges..............................$15.00
3 cm. stabilizer cavity, transmission type...$20.00
3 cm. Wavemeter, Micrometer head mounted on X-Band guide. Freq. range approx. 7900 to 10,000 Mc $75.00

RADAR SETS

RC 145 IFF SET. Consists of BC 1267 xmtr-rcvr, remote antenna controller and indicator I-221, power supply RA 105-A. 1 kw. pulse oscillator operates on 154-186 mc. Operates from 117 v., 60 cy. New $190.00
SN RADAR-GE, low power, 5 and 25 miles ranges. Uses GL446 as pulsed oscillator, 5" "A" scope, "S" band. Extremely compact, ideal for demonstration and laboratory work. 115V 60C operation. Used. Excel. cond. $600.00
SE 10 CM SURFACE SEARCH RADAR, 20,000 to 80,000 yds. range. 250 KW. pk. power input to 706 magnetron. Thyratron modulator, variable pulse rate. Complete set including spare parts, tubes, waveguide and fittings. Send for price and additional information.
R85TPL-1 RADAR RCVR, Sperry......................$85.00

ALL MERCHANDISE GUARANTEED. MAIL ORDERS PROMPTLY FILLED. ALL PRICES, F.O.B. NEW YORK CITY. SEND MONEY ORDER OR CHECK. ONLY SHIPPING CHARGES SENT C.O.D. RATED CONCERNS SEND P.O.

Prices Subject to Change Without Notice

COMMUNICATIONS EQUIPMENT CO.

131-E Liberty St., New York, N. Y. Cable "Comsupo" Ph. Digby 9-4124, Mr. Chas. Rosen

AUTOMATIC CODE EQUIPMENT

TAPE PULLERS, (McEllroy) TP 890, 110-120 v. AC-DC .... $12.50 ea.
TAPE BRIDGES: (McEllroy) TG 815, complete $3.50
TAPE LOOPS: For TG-8 and TG-9 .... $1.00
BLANK CODE TAPE: 4" rolls, ¼" wide. Per roll .... $.15

AN/ARC—3 AUDIO TRANSFORMERS

T-102, #55545 T-104, #55547
T-103, #55546 T-105, #55554
T-206, #55530
Price, each .... $.95

XMTR TUNING UNITS

For BC 610: TU 47 (2-2.5 mc); TU 48 (2.5-3 mc); TU 53 (8-12 mc). Each $1.75
For BC 223AX: TU 17 (2-3 mc); TU 18 (3-4.5 mc). Each $1.95
6-Section Ceramic Stack: 10-460 mmf, for Collins Art-13 .... $.69

ROTARY BEAM COMMUTATOR

6 Slip rings 3" dia. ½" wide each mounted in low loss form. Each ring brought out to pin at base bearing inside dia. 1½". New $5.45

QGB-1, ECHO RANGING DRIVER-RECEIVER, underwater sound signal transmission and reception unit with range of 200 to 600 yds. and freq. range of 16 to 27 kc. New, with battery box in chest, less projector $125.00

VIBRATORS

TR 1210, 12 vdc, 5 pin $1.00
OAK V-6675, 24-32 vdc, 7 pin 1.00
Mal. Type G534C, 12 vdc, 5 pin 1.00
Mal. Type G629-C, 12 vdc, 4 pin 1.00
Radiaart VR2, 6 v. DC, 6-pin special 1.00
Mfrs. quantities available.

Typewriter Desk Wells Mounted on Steel Panel for Standard Rack Mtg. 10½" H x 19" W x ⅛" Thick. Well is 22" Wide, 20" Deep, Affording Full Working Space. Grey Crackle Finish. New .... $9.90 ea.

AN/CPN-6, 3 CM RADAR BEACON INSTALLATIONS

CERAMICON CONDENSERS
$7.50 per 100

3 mmf	±5%	67 mmf	±20%
5 mmf	±5%	100 mmf	±5%
4 mmf	±5 mmf	115 mmf	±2%
8.5 mmf	±5 mmf	120 mmf	±5%
11 mmf	±5%	240 mmf	±3%
15 mmf	±2.5 mmf	250 mmf	—
48 mmf	±2%	500 mmf	+15 —30%
50 mmf	±20%	1000 mmf	±5%
60 mmf	±3%		

*Silver-Mica Button Capacitors (Erie, Contralab) $9.50 per 100

185 mmf .... ±2.5 mmf
175 mmf .... ±2.5 mmf
500 mmf .... ±10%

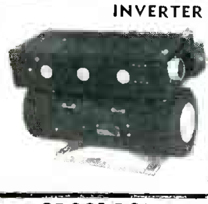
HEADSETS

Dynamic mike and headset combination. A high quality, efficient unit, used in B-19 tank Xmtrs. Mike and phones complete, new $2.75
R-15 headsets: 8000 ohms impedance, rubber cushions. Comes with 8" cord and plug PL 55. New 2.95
HEADBANDS: HB-1, HB-4, HB-30. New .... .25 ea

MINE DETECTOR

Model AN/PRS-1 Detector will detect buried Metallic and Non Metallic objects, such as: rocks, pipes, water pockets, etc. Ideal for home owners, campers, prospectors. Uses meter and phones for visual and aural indication. Price: New, including detector, amplifier, phones, resonator, and all cables $12.75
With Batteries $21.65

INVERTER PE 218



Input: 27.5 V DC, 90 AMPS
Output: 115V. AC, 400 CY, 13 AMPS
1500 Volt—Amperes .9 PF
New. Original Packing $49.95
Used, Ex Cond. .$25.00
Also Available: PE 206, 80V, 400 CY, 500 V.A. New $12.50

CROSS POINTER INDICATOR

Dual 0-200 microamp. movement in 3" case. Each movement brought out to 6-term. Receptacle at rear. Originally used in ILS equipment. New $5.50

CARBON PILE VOLTAGE REGULATORS

Type "A" Coil current .105 to .115 amp, 80 volts, Leland Electric $3.00
Type "C" Input: 22-30 v. coil, 30 amps. Output: 19 v, 5.7 amps Spec #VR9000-2c. Leland Electric.... $3.00
#35X045B: 22v, .1 to 3 amps, for K-14B Gunsight, Webster $3.00

PRECISION CAPACITORS

D-160270: 1 mfd @ 200 vdc, —40 to plus 65 deg C $12.50
D-161859: 4 mfd @ 400 vdc, —50 to plus 85 deg C $2.00
D-163707: 0.4 mfd @ 1500 vdc, —50 to plus 85 deg C $2.00
D-163035: 0.1 mfd @ 600 vdc, 0 to plus 65 deg C $2.00
D-170908: 0.152 mfd, 300 v, 400 cy, —50 to plus 85 deg C $2.50

DYNAMOTORS

Type	Input Volts	Input Amps	Output Volts	Output Amps	Radio Set	Price*
BD 77KM	14	40	1000	.350	BC 191	$20.00N 14.00LN
PE 73	28	19	1000	.350	BC 375	24.50N
DM 21	14	3.3	235	.090	BC 312	3.45N
DM 21CX	28	1.6	235	.090	BC 312	3.45N
DM 25	12	2.3	250	.050	BC 367	2.49LN
DM 28R	28	1.25	275	.070	BC 348	8.95N
DM 33	28	7	540	.250	BC 456	5.50N
DM 42	14	46	515 1030 2/8	.110 .050	SCR 506	6.50LN
PE 86	28	1.25	250	.060	RC 36	3.95
PE 101C	13/26	12.6/ 6.3	400 800	.135 .020	SCR 515	5.25N
BD AR 93	28	3.25	375	.150		4.95N
23350	27	1.75	285	.075	APN-1	3.50N
35X045B	28	1.2	250	.060		3.50N
ZA .0515	12/24	4/2	500	.050		3.95N
B-19 pack	12	9.4	275 500	.110 .050	Mark II	9.95N
D-104	12		225 400	.100 .200		14.95N
DA-3A*	28	10	300 150 14.5	.260 .010 .5	SCR 522	8.95N
#5053	28	1.4	250	.060	APN-1	3.95N
DA-7A	26.5		1100	.400	TA-2J	25.00N
CW 21AAX	13 26	12.6 6.3	400 800 9	.135 .020 1.12		17.50
PE 94	28	10	300 150 14.5	.260 .010 .5	SCR 522	15.00

N—New. LN—Like New.
*For PE 94 Power Supply less Filter Box & Starting Relays

POWER EQUIPMENT

STEP DOWN TRANSFORMER: Pri. 440/220/110 volts a.c. 60 cycles. 3 KVA. Sec. 115 v. 2500 volt insulation. Size 12" x 12" x 7" $40.00
PLATE TRANSFORMER: Pri: 117 v. 60 cy. Sec. 17,600 @ 144 ma. with choke. Oil immersed. Size: 26" x 29" x 13" American $120.00
FIL. TRANSFORMER: Pri: 220 v.a.c., 60 cy; .05KVA. Sec. 5 v.c.t., 34,000 v. test $24.50
FIL. TRANS. UX6899. Pri: 115 v. 60 cyc. Sec: Two 5 v. 5.5 amp wdgs. 29 KV test $24.50
PLATE TRANSFORMER: Pri: 115/230 v.a.c., 50-60 cy. Sec: 21,000 v, 100 ma $145.00
VOLTAGE REG. Transtat. Amertran type RH 2 KVA load, input: 90/130 v. 50-60 cy. output 115 v. .$40.00
ITE CIRCUIT BREAKER, 115 A, 600 v $15.00
KS 9668: Pri: 115 v. 60 cy 1 phase, tapped to give 2750/2470/2240 v. on sec. at 750 ma., no CT. 7,000 v. ins. $34.50
UX 6801 (Raytheon): Pri: 110 v. 60 cy, 1 ph. Sec: 22,000 v, 234 ma, 5.35 KVA, Dim: 23"x24"x10¾".
31911 (Amertran): pri: 115 v. 60 cy, 3 ph, 4 KVA. Sec: 105/125 v. Dim. 20"x14½"x12½".
Plate Xfmr: Pri: 198, 22, 240 v, 60 cy, 1 ph, 16.7 KVA. Sec: 3650 v, 30 KV test.
Fil Xfmr: Kenyon: Pri: 210/215/220/225/230/235/240 vac, 60 cy. Sec: 11v, 35 amp: 10 v, 35 amp ct; 7.5 v, 35 amp ct: 5 v, 35 amp ct #S-10768 .... $37.50
Fil Trans. KS8767: Pri: 115 v. 60 cy. Sec: 2 wdgs: 5 v @ 5 amps. 15 KV Test $15.00

OIL CONDENSER
STANDARD BRANDS

.1 mfd. 10 KVDC #14F191 .... $15.00
.06 mfd. 15 KVDC, 25F585-G2 .... $ 8.70
1.5 mfd. 6000 vdc $12.50
.25 mfd. 20,000 vdc $17.50
10 mfd. 1000 vdc .... $ 1.79
3x10 mfd. delta connected synchro-capacitor, 90 v, 60 cycles .... $ 4.95
.1 mfd. 6000 vdc. 25F509G2 .... $ 6.50

400 CYCLE TRANSFORMERS

352-7070: Pri: 118 v, 440 cy. Sec: 2.5 v, 2.5 amp: 2.5 v, 2.5 amp; (2000 v ins.): 6 3 v, 2.25 amp; 1200 v tapped at 1000 and 750 v. p/o AN/APS 15..... $4.95
#7469105: Pri: 115 v, 400 cy, Sec: Tapped to give 742.5 v, 50 ma; 709 v, .0477 amp; 671 v, .045 amp $2.95
M-7474319: Pri: 115 v, 400 cy Sec: 6.3 v, 2.7 amp: 6.3 v, .66 amp; 6.3 v, 21 amp $2.95
32332: Pri: 115 v, 400-2400 cy. Sec: 400 vct, 35 ma; 6.4 v, 2.5 amp: 6.4 v, .15 amp $2.25
352-7138M: Pri: 115 v, 400-2400 cy. Sec: 640 v, .5 ma. 2.5 v, 1.75 amp $3.85
352-7179: Pri: 115 v, 400-2400 cy. Sec: 6.5 v, 12 amp ct. 250 v, 100 ma; 5 v, 2 amp $3.50
#9069: Pri: 115/80 v, 400-2600 cy. Sec: 650 vct. 50 ma: 6.3 vct, 2 amp; 5 vct, 2 amp $2.15
352-7096: Pri: 115/80 v, 400-2400 cy. Sec: 2.5 v, 1.75 amp, 3 KV ins; 5 v, 3 amp; 6.5 v, 6.5 amp: 6.5 v, 1.2 amp $3.95
KS 9607: Pri: 115 v, 400-2400 cy. Sec: 734 vct, 177 ma, 1710 vct, 177 ma $5.95
D-166333: Pri: 115 v, 400-2400 cy. Sec: 6.3 v, 0.9 amp, 7.7 v, 0.365 amp $2.79
GE #7471957: Pri: 100/110/120/130 v, 400-2400 cy. Sec: 2.5 v, 20 amp, HV ins. $4.85
D-163254: Pri: 115 v, 400 cy. Sec: 6.3 v, 12 amp; 6.3 v, 2 amp: 6.3 v, 1 amp. P/O AN/APQ-5 .... $5.85
KS-9685: Pri: 115 v, 400-2400 cy. Sec; 6.4 vct. 7.5 amp: 6.4 v, 3.8 amp; 6.4 v, 2.5 amp $4.35
PLATE XFMR: Pri: 115 v, 400 cy. Sec: 9800 v. or 8600 v. @ 32 ma dc $12.50
#12033. Plate Xfmr, Pri: 115 v, 800 cy. Sec: 4550 vct. 250 ma. $7.95
KS 9445, Pwr Xfmr: Pri: 115 v, 400-2400 cy. Sec: 592 vct, 120 ma, 6.3 v, 8 amp; 5 v, 2 amp $3.50

TBX-19 500 WATT NAVY TRANSMITTERS, 2 - 18 mc. AVAILABLE 10 NEW TRANSMITTERS, 5 MOTOR GENERATOR SETS, 220/440 VAC.; 3 MODULATOR UNITS FOR PHONE OPERATION; 50 SPARE OSCILLATOR UNITS. SEND FOR INFORMATION.

30' SIGNAL CORPS RADIO MASTS

Complete set for the erection of a full flat top antenna. Of rugged plymold construction telescoping into 3 ten-foot sections for easy stowage and transportation. A perfect set-up for getting out. Supplied complete: 2 complete masts, hardware, shipping crate. Shipping wt. approx. 300 lbs. Sig. Corps #2A289-223-A. New .... $39.50 per set

SCR 610 11-10 METER PORTABLE/MOBILE XMTR-RCVR.

SCR 610 portable transmitter-receiver, 27 to 38.9 mc. crystal controlled, using FM for efficient operation. Unit consists of Xmtr-rcvr BC 659 and power supply PE 97 . . . operating from 6 or 12 vdc. Slightly used, excellent condition. Less xtals $25.00

GREAT TUBE VALUES

O1-A	$.45	7C4	1.00	836	1.15
1B24	4.85	7E5	1.00	837	1.95
1H5	.55	7E6	.72	843	.59
1N5	.69	10Y	.60	860	15.00
1T4	.69	12A6	.35	861	40.00
2C21	.69	12K8Y	.65	874	1.95
2C22	.69	12SF7	.49	876	4.95
2J21-A	25.00	12SR7	.72	1005	.35
2J22	25.00	15R	1.40	1613	.95
2J26	25.00	28D7	.75	1619	.21
2J27	25.00	30 (Spec)	.70	1624	.85
2J31	25.00	45 (Spec)	.59	1629	.35
2J32	25.00	39/44	.49	1961	5.00
2J38	25.00	35/51	.72	9002	.65
2J39	25.00	227A	3.85	9004	.47
2J55	25.00	225	8.80	CEQ 72	1.95
3J31	55.00	268-A	20.00	EF 50	.79
2X2/879	.69	255-A	19.50	E-1148	.75
3BP1	2.25	417A	25.00	F-127	20.00
3C24	.60	530	90.00	FC 258A	165.00
3C30	.70	531	45.00	FC 271	40.00
3D6	.79	532	3.95	GL 562	75.00
3CP1/S1	3.50	559	4.00	GL 623	75.00
3D21-A	1.50	562	90.00	GL 697	75.00
3DP1	2.25	615	.89	ML 100	60.00
3EP1	2.95	703-A	7.00	OK 59	65.00
3FP7	1.20	704-A	.75	OK 60	65.00
3GP1	3.50	705-A	2.85	OK 61	65.00
5BP1	1.20	707-B	†20.00	OK 62	65.00
5BP4	4.95	714AY	25.00	RCA 932*	.65
5CP1	3.75	715-B	12.00	VR 91	1.00
5FP7	3.50	720BY	50.00	VR 130	1.25
5JP2	8.00	721-A	3.60	VR 135	1.25
5J30	39.50	723-A/B	12.50	VR 137	1.25
6AC7	1.00	724B	1.75	VU 120	1.00
6C4	.58	725-A	25.00	VU 134	1.00
6G	2.00	726-A	15.00	WL 532	4.75
6J6	1.00	800	2.25	WN 150	3.00
6K7	.55	801-A	1.10	WT 260	5.00
6L6GA	1.00	804	9.95	†With Cavity.	
6SC7	.70	815	2.50	*Photocell.	

FT&R 101-A APPLIQUE

Provides necessary balancing facilities for four wire repeater when used on two wire lines which may be voice-frequency telephone lines of open wire, or non-loaded or loaded cable. Std. 19" channel iron rack mtg. Price, new, complete with tech manual $54.00

SB-19/GT CONSOLE

Provides facilities for patching and monitoring network of lines for telephone intercom, radio reception, telegraph reception, recording, etc. Complete central office supervising position $350.00

EE-89A REPEATER

Extends range of field telephone apparatus, such as EE-8 up to 25 miles, when inserted in a line. New, with spare tube and instruction manual, less standard type batteries $21.50

BC 686 LINE AMPLIFIER

With magneto ringer, 3-tube 25L6 amplifier. For local point-to-point telephone operation, remote operation of Phone Xmtr, remote reception of receiver output, monitoring facility. Requires only 24 vdc for tube "B" plus supply for full operation.
New, less tubes, in wooden chest $18.50
Per pair for 2-way pt-to-pt operation $35.00

F.T. & R. 102-B REPEATER EE-99

May be used as Terminal or Intermediate Repeater. 20 cycle ringing & DC Telegraph. Applicable on simplex operations. Monitoring facilities, equalizing facilities. Dry or storage battery operation. New $55.00
Telephone switchboard lamp holders: 10 lamp holders per strip $4.25

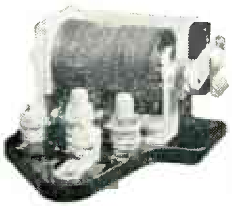
COMMUNICATIONS EQUIPMENT CO.

131-"E" LIBERTY ST., NEW YORK, N. Y. DIGBY 9-4125

RELAYS FOR IMMEDIATE SHIPMENT

IN PRODUCTION QUANTITIES

OR IN SINGLE LOTS FOR LAB EXPERIMENTS

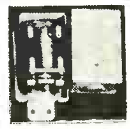


#88 — STRUTHERS DUNN CX 1535-A

S. P. S. T. Normally open. Makes at 12 volts 50 M.A.; breaks at 6 volts 25 M.A.; 240 ohm coil; Contacts rated at 20 ampere; Power relay. Price.......69¢ each

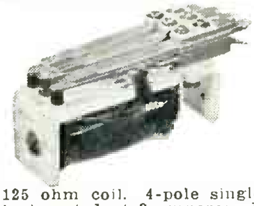
#34—G.E. CR2791-B106C44

S.P.D.T. Double Break. Makes at 11 volts 60 M.A. Breaks at 6 volts 36 M.A. 180 ohm coil. Contacts rated at 10 amperes. Priced at only ....39¢



#92—Clare Bk-13

S. P. S. T. Double break relay. Makes at 8 volts 100 M.A. Breaks at 6 volts 80 M.A. 80 ohm coil. Contacts rated at 10 ampere. This relay comes mounted in a very handsome enclosed, two-piece metal case, as shown in photograph (aluminum case) dust-proof and simple to mount. Priced at only ....49¢

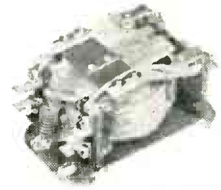


#28 — R.B.M. 452-1312

Dual Coil telephone type relay. Coils can be used singly, parallel or series, according to voltage available. Singly makes at 15 volts 120 M.A. In parallel makes 7½ volts 60 M.A. Can close with both coils and hold with one coil. 125 ohm coil. 4-pole single throw; normally open. Contacts rated at 2 amperes. Priced at only........49¢ each.

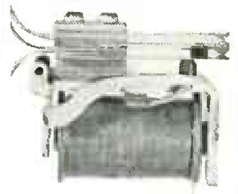
#23 — SOUNDER D. T. Thompson & Co.

Type T44. 600 ohm coil. D.C. operating voltage 10 to 50 volts, according to gap desired. Has no contacts. Could be used to operate small magnetic valve on an electro pneumatic control system. Makes a very good 110 volt A.C. buzzer. Priced at only ....29¢



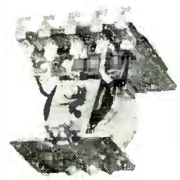
#40 — LEACH TYPE 1025 SNBF

D.P.S.T. Normally closed. Makes at 17 volts 50 M.A.; breaks at 2 volts 3 M.A. 425 ohm coil. Contacts rated at 10 amperes. Priced at..49¢ each



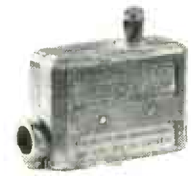
#26 — 5587

D.P.S.T. — Makes at 11 volts 38 M.A. Breaks at 4 volts 10 M.A. — Normally open. 375 ohm coil.—Contacts rated at 3 amperes. Priced at only, each ....39¢



#32 — CR2791-B106J3

3 P.D.T. Makes at 11 volts 58 M.A. Breaks at 5 volts 26 M.A. 180 ohm coil. Contacts rated at 3 amperes. Priced at ....49¢



#28A — Polarized D.C. Micro Switch

Normally closed operation. Heavy contacts, quick, wide break. Has magnetic blowout to suppress arc. Contacts good for 8 amperes 110 volts D.C. Can be used on A.C. also. Special Price........69¢ each

#37 — G.E. CR 2791-B109P36

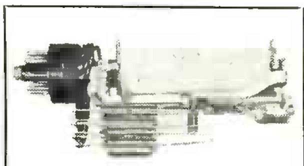
10000 ohms S.P.D.T. Makes at 90 volts 9 M.A. Breaks at 70 volts 7 M.A. Sensitive relay for high voltage. Operates very satisfactory up to 220 volts D.C. Contacts rated at 3 amperes. Priced at only........79¢. Bargain

Bank of 10 Midget telephone relays. These are attached to rack with knurled thumb screws, thus easily removed from rack.

Prices:
Rack of 10-300 ohm coil make one—break none..$3.25
Rack of 10-300 ohm coil make two—break one...$3.75
All operate at much lower than rated 24V.

Allen Bradley B5A Aircraft starting relay. Rated 24V 50 amp. 100 ohm coil. Totally enclosed solenoid action. $1.35 each

Midget Guardian relay with ceramic insulation for high voltage on contacts. Coil operates at 4V 100 M.A. Rated at 6V one normally open 3 amp. contact. Special..39¢



Very special Clare plug—in 110V.A.C. 60 cycle. Makes two breaks one. Fast make and break ....$2.45 each
Similar relay 6500 ohm D.C. same contrast.....$1.65 each

#25—G.E. 55530

Makes 4 contacts; breaks 1 contact.
Makes at 10 volts 60 M.A.; breaks at 8 volts 50 M.A. 300 ohm coil. Contacts rated at 3 amperes. These relays are priced so low, a 24 volt power supply could be provided just to utilize them.

Other miniature telephone type relays in stock as follows:

GE 55530—150 ohm makes 3 breaks one..................Price .59
GE 55251—300 ohm makes 1 breaks none..................Price .39
Clare 16280—300 ohm makes 4 breaks none..................Price .59
Clare 13415—120 ohm makes 2 breaks none..................Price . 9
Guardian 73A71—5 ohm makes 1 breaks none..................Price .39
Guardian 73A63—300 ohm makes 3 breaks two..................Price .59
Guardian 73A69—300 ohm makes 2 breaks one..................Price .49
Guardian 73A67—300 ohm makes 1 breaks none..................Price .39
Cook—555226—300 ohm makes 2 breaks one..................Price .49
Cook 55340—300 ohm makes 1 breaks one..................Price .39

Write Us Your Relay Requirements

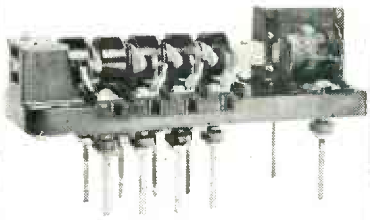
TERMS Net 30 days to rated mfgrs and to schools. All shipments F.O.B. New York. 20% deposit on C.O.D. orders.

EXCESS INVENTORY CORP.

ELECTRONICS DEPT.

56 LISPENARD ST. *Tel. Walker 5-9135—9136* **NEW YORK 13, N. Y.**

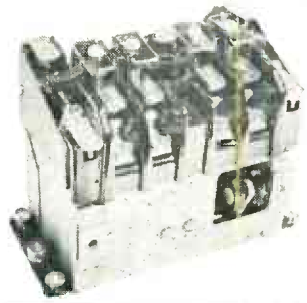
MORE RELAYS AND OTHER LAB. COMPONENTS



G.E. SOLENOID CONTACTOR

440 V. A.C. or 110 D.C. Makes 3-15 amp contacts and breaks one. G.E. number CR 2820-1746.

Special Value, $3.45



G. E. CONTACTOR
No. CR 5181

4 normally open 20 amp contacts *Plus two SPDT 5 amp hold any contacts,* coil 110 VAC. 60 cy (solenoid type) size 5"x3"x4" high. Adaptable for many power applications where fast make and break is desired. Packed one to original GE carton.

$4.80 each

#28D — LEACH 7220

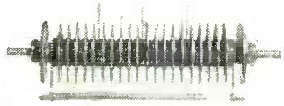
The champ. Incredibly good. Pulls in at 12 volts 1 amp, holds in at 12 volts 46 M.A. Dual, automatically changed coils. Rated 24 volts 200 amperes.

$1.95

Special: Lab Assortment

Any 10 relays at 10% discount from prices shown

SELENIUM RECTIFIER, FULL-WAVE BRIDGE



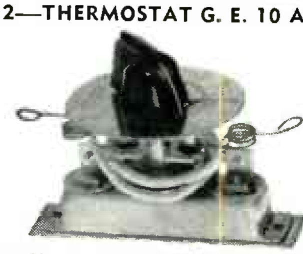
Up to 90 volt A. C. input, 20 plate, output, 150 m.a. continuous duty. Special $1.35 each.

WESTERN ELECTRIC #UR 1068

Sensitive telephone relay 2500 ohm coil. Makes 3 and breaks 2 contacts. Rated 48V. Minimum oper. voltage 16V. 9 M.A. Price........................**$1.45**
Similar relay VR1066—600 ohm...**$1.15**

#1 — This is a full wave bridged selenium rectifier. Input 115 to 130 A.C. Continuous duty. Output 15 milliamperes at 25 volts drop. Less than 25 volt drop if less current is drawn. For instruments, relays, etc. 39¢ each.

#2—THERMOSTAT G. E. 10 AMP.



Adjustable to within 1°F. in range 135°F. to 185°F. with scale and knob. Contacts 110 volt. Good for heating wax, compound, in tanks also oven control, etc. Priced at 59¢ ea.

Priced at 10¢ each.

TERMINAL STRIP, 6 TERMINAL

5 x 1" by 1" high overall, hard black bakelite moulded, 8 x 32 brass studs. 12 heavy, brass hex nuts, 6 lockwashers. Heavy or light wiring. Mounts flat, insulated for 5000 v. 14 bakelite finger separate wires to each terminal allowing wires to enter either side without danger of shortening. Suitable for transmitters, indus. equip.; may be cut shorter cheaply.—Price 11¢ each.

#89—CANNON SOLENOID

This item just must be seen and tested to be appreciated. At 6 volts, draws 1 1/3 ampere, has ½ pound pull at ¾ in. stroke; 2 pound pull at ⅜ in. stroke. At 12 volts, draws 2-2/3 amperes, has 1 1 pound pull at ¾ in. stroke; 4 pound pull at ⅜ in. stroke. At 24 volts (rated voltage), draws 5 amperes, has 2 pound pull at ¾ inch stroke; 8 pound pull at ⅜ in. stroke. Very compact, easily mounted Tapered shaft that goes clear through the back of the case when energized protruding ⅛ of an inch which would be sufficient to close a micro switch in addition to the mechanical functions above described. 69¢ ea.

#79A—HEATER VULCAN D5

Ring 2" O.D., 1" I.D., ¼" thick, fully armored, with upstanding porcelain bushing insulators ¾" high for two terminal leads, 35W, 55V; designed for two in series on 110V. Excellent for small compound heaters, wax heaters, small enough to hold and pour from. Liquid-proof design, easily installed in any pot or ladle, small tank, stamping die. Priced at 10¢ each.

#85—G. E. THYRITE K-522332 (M)

Diameter 3 in. Thickness ⅛ in. Hole ½ in.
Good voltage regulator, 3rd harmonic generator.
Current:
5 ma. at 18 volts; 10 ma. at 23 volts.
20 ma. at 29 volts; 40 ma. at 36 volts.
Rating: 3 watts maximum in air.
Priced at 25¢ each.
We have sold these at $1, right along.

#82—G. E. THYRITE K-8396832-1

Diameter 1⅞". Thickness ⅛". Hole ¼".
Good voltage regulator, 3rd harmonic generator.
Current: 5 ma. at 21 volts
10 ma. at 24 volts
20 ma. at 28 volts
40 ma. at 33 volts
Rating 1½ watt maximum in air..15¢ ea.

#80—EDISON FIXED THERMOSTAT

Hermetically sealed. Explosion proof. 135 degrees Fahrenheit, normally closed. Opens above 135 degrees. Sealed in glass. One ampere contacts. Fine for fire alarm system. Another 29¢ bargain. Lists for over $3.00.

#76—60 DEGREE FAHRENHEIT THERMOSTAT

Fixed thermostat. Closes at 60 degrees and opens at 65 degrees. 10 ampere contacts. Snap action. Made by Klixon. Excellent for auto heater control. —We are closing these out at 22¢ each, less quantity discounts.

EXCESS INVENTORY CORP.

ELECTRONICS DEPT.

56 LISPENARD ST. Tel. Walker 5-9135—9136 NEW YORK 13, N. Y.

SURPLUS BARGAINS — — NOW!!

L & N—INDICATORS—CONTROLLERS—RECORDERS

STANDARD D.C. POTENTIOMETER TYPE — MICROMAX — SERIAL NUMBERS IN 4000 GROUP SERIES

REBUILT . . . THOROUGHLY RECONDITIONED ELECTRICALLY & MECHANICALLY

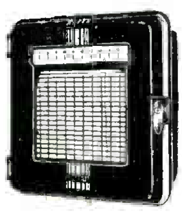
Model R INDICATING & RECORDING CONTROLLER

Single Point - Curve Drawing, Continuous Line Chart speed — one revolution in 24 hours, One set adjustable High & Low Contacts, 115 V AC Motor.

RANGES:

0— 800° F C/A
700—1400° F C/A
200—2000° F C/A

Model S INDICATING & RECORDING CONTROLLER



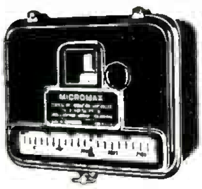
Single Point-Curve Drawing, Continuous Line One set adjustable High & Low contacts, 115 V AC Motor.

RANGES:

0—1000° F C/A
0—1500° F C/A
0—1800° F C/A
200—2000° F C/A
1000—2000° F C/A

Model C SINGLE POINT CONTROLLER

Non-Indicating, Non-Recording, Open type contacts for use with External relay, High-Common-Low Contacts for controlling, 115V AC Motor.



RANGES:

0—1500° F I/C
0—1600° F C/A
0—1800° F C/A
0—2000° F C/A
200—2000° F C/A
800—2000° F C/A

CAN BE CONVERTED FOR OTHER APPLICATIONS . . . A NUMBER OF SPECIAL TYPES ALSO AVAILABLE.

SINGLE & TWO POINT BROWN RECORDER/CONTOLLERS . . . IN VARIOUS RANGES . . . NEW & REBUILT . . . ARE ALSO IN STOCK

INQUIRIES INVITED!

GE TYPE DO 50 DC AMMETER

50 MV FULL SCALE RECTANGULAR 3¼" x 3". Barrel 2¾" DIAM. x 1½" DEEP, MOUNTING HOLES 2⅝" x 2⅜" c. to c.

SPECIAL SCALE, CAN BE USED WITH EXT. SHUNT FOR ANY RANGE, BAKELITE CASE

A BUY! Price . . . . . . **10 for $27.50**

GE TYPE DO 50 DC VOLTMETER

3 VOLTS FULL SCALE, 100 OHMS 1V, SPECIAL SCALE, SAME DIMENSIONS AS ABOVE, BAKELITE CASE

A BUY! Price . . . . . . **10 for $27.50**

A SCOOP ON A 'SCOPE DUMONT Model 164-E

3" CRT operates at accelerating potential of 1100 V—brilliant well-defined trace. Vert amp voltage gain approx 43, horiz amp voltage gain approx 55, Freq. range vert. & hor. amp both uniform ±3 DB from 5-100,000 CPS Input impedance 1 megohm vert, .8 megohm hor. Operates 115 V, 40-60 cycles.

Price New $115.00

Your Cost $77.50

MICROVOLTER—FERRIS Model 20B

.2 to 100,000 microvolts output, continuously variable . . . operates on 115 V. 60 cycle AC . . . push button selector for 18 frequencies from 455 K.C. to 22 M.C. . . . with or without 400 cycle 30% modulation . . . frequency may be varied ±2% by screwdriver adjustment.

Your Price $100.00

BC 403E OSCILLOSCOPE

Made for Signal Corps by RCA for use in SCR-270D Radar—Can be converted to other uses — A Gold Mine for Parts — Shipping Weight: 400 lbs—Without Cathode Ray Tube 5BP4. . . . . **NEW! $57.50**

HIGH VOLTAGE CAPACITORS

• 1 MFD 20 KV DC 18"x13½"x5" $25.00
.1 MFD 25 KV DC-13"x7"x4" 9.85
.001 MFD 50 KV DC-5⅛"x7¾"x"4" insulators 4" dia. x 7" high 12.50

Cap Mfd.	Volts D.C.	Height Width Length	Price
10	1000	5-7/8 x 1-3/4 x 3-7/8"	$1.85
4	1000	5-7/8 x 2-3/4 x 1-1/4"	.85
1	1000	3-5/7 x 2 x 1-1/16"	.50
1	500	2" x 1-1/4" x 1-1/16"	.25
.25	1000	1-1/2 x 1" x 3/4"	.25

RHEOSTAT

Ohms	Amps	Size-Diam.	Price
.87	13	3½"	$2.50
6	2	1½"	1.75
10	9.2	14"	5.95
22	4.5-3.1	6"	6.50
30	1.7- .9	2½"	1.50
32	2.4	3½"	4.95
40	1.12	2"	2.50
50	1.11	2"	2.50
75	3.5	6"	7.50
100	1	3"	2.95
200	.25	1½"	.75
250	2.5- .51	6"	7.50

HEINEMAN CIRCUIT BREAKER

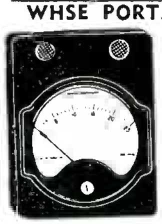
For use with low voltage, D.C., 100 Amps. Dimensions: 3¼" H x 4" D x 1" W

$1.75

15 Amp, 115 V AC, as is, Curve U-40, CAT 0411 . . . . **$1.75**

35 Amp, 120 V AC, Curve 2, CAT. AM 1510R-35 . . . . **$1.75**

WHSE PORTABLE GALVANOMETER



Type PX-12, Movement 7 MA, special scale, solid connecting terminals, contains a 1 Volt internal cell which can be easily removed for conversion to DC AMMETERS & VOLTMETERS, with leather case and canvas carrying strap.

A buy at $4.95

AGASTAT TIME DELAY RELAY

Type ND-21, Diagram type, 24 V. mom. coil. SPDT, 0-5 sec. cont. duty, up to 15 sec. intermittent duty.
Dimensions 2¼" x 2¼" x 4¾" for 24 V. DC operation.

Price $4.50

STRUTHERS-DUNN RELAYS

D.P.S.T., Normally open, 115 V, 60 Cycle, AC coil, 30 Amp. contacts, fibre base with 4 holes for mounting. Dimensions, 4½" L x 3" W x 3¾" H.

A Real Buy At $2.50

HIGH VOLTAGE TRANSFORMER

GE Cat #7470609, can be enclosed with insulators

PRI—115/230 V. 50/60 CYCLES
SEC—14000 V., RATING 1.4 KVA
Dimensions: 16" H x 12" W x 10" D.
Shipping weight: 178 lbs.

A buy at $45.00

R. C. A. POWER TRANSFORMER

PRI—440/220 V. 60 CYCLES
SEC—125/115/105 V. at .8KVA
Bracket mounted, pri & sec terminal board. Dimensions: 5¾" H x 7½" W x 8" D. Shipping weight: approx 40 lbs.

Your price $12.50

STEP DOWN TRANSFORMERS SPECIAL

Made by GE, heavy duty, considerable over-design, open frame, ideal for rectifier application, size: 3½" x 3½" x 4".

PRI—115 Volts 60 Cycles
SEC—15 V at 12 Amps

$3.75

Also available: SEC—10V at 18 Amps

$3.75

POWER TRANSFORMER

PRI—440/220 V. 60 Cycles
SEC—125/115/105 V., RATING .8KVA
RCA Open construction. Bracket mounted, pri & sec terminal board. Overall dimensions: 5¾" H x 7½" W x 8" D. Mounting dimensions: 6⅞" x 5⅞".

Price $12.50

GE POWER TRANSFORMER STEP DOWN

GE Type M Cat #61021. Enclosed. Size: 4-9/16" H x 4⅞" W x 12¼" L.
PRI—460 V 60 Cycles; SEC—115 V
RATING—750 Watts

$9.00

TRANSTATS—.25KVA

Type RH Input: 115 V ±10%. Output: 115 V. Made as a line voltage corrector ±10% of input voltage, or can be connected to give ± 20% of input

Your price $6.50

RATING 3KVA, MAX AMPS 26

same as above, can also be reconnected to be used as an isolation type step down with variable secondary, Input: 115V. Output: 0-30V. at 30 Amps.

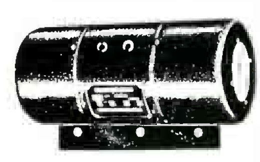
Your price $18.00

RATING 1.85 KVA, MAX AMPS 16

same as above, can also be reconnected as isolation type transformer above Input 115 V. Output: 0-30 V, at 16 Amps.

Your price $17.00

DYNAMOTOR MADE BY G. E.



INPUT 28 V D.C. OUTPUT 1000 V D.C. CAPACITY 350 MA With voltage regulator box on top. Approx dimensions: 12" L x 6" Diam. Weight: 30 lbs.

A buy at $5.75

ALL PRICES INDICATED ARE FOB OUR WAREHOUSE NYC. SHIPMENTS WILL BE MADE VIA RAILWAY EXPRESS UNLESS SUFFICIENT POSTAGE IS INCLUDED OR OTHER INSTRUCTIONS ISSUED. WE WILL REFUND EXCESS POSTAGE IN STAMPS.

POWERTRON Electrical Equipment Co.

117 LAFAYETTE STREET   *Phone:* WOrth 4-8610   NEW YORK 13, N. Y.

SURPLUS NEW EQUIPMENT

PORTABLE TACHOMETER

Multiple Range Continuous Indicating

This unit is of the centrifugal mechanical type and is designed to show **INSTANTANEOUSLY** and **CONTINUOUSLY** the speed or change in speed of any revolving shaft or surface. No stop watch or other mechanism required.

- Three ranges in R.P.M. and three in F.P.M.
  Low Range 300-1,200 (Each division equals 10 R.P.M.)
  Medium Range 1,000-4,000 (Each division equals 10 R.P.M.)
  High Range 3,000-12,000 (Each division equals 100 R.P.M.)
- Large open dial 4" diameter.
- Ruggedly constructed for heavy duty service.
- Ball bearing and oilless bearings—require no lubrication whatsoever.
- Readily portable—Fits neatly into hand.
- Gear shift for selecting low, med., high ranges.

Made by Jones Motorola, Stamford, Connecticut. Comes complete in blue velvet lined carrying case: 7⅛"L x 4"H x 5"W. Your cost............$24.50.

PORTABLE A. C. AMMETERS WESTON MODEL 528

DUAL RANGE 0-3 Amp. and 0-15 Amp. full scale for use on any frequency from 25 to 500 cycles. The ideal instrument for all commercial, industrial, experimental, home, radio, motor and general repair shop testing. Comes complete with a genuine leather, plushlined carrying case and a pair of test leads. A very convenient pocket sized test meter. Priced your cost..**ONLY $12.50**

PORTABLE A.C. VOLTMETER
WESTON MODEL 528

DUAL RANGE 0-15 and 0-150 Volts for use on any frequency from 25 to 125 cycles. Complete with plushlined leather carrying case and a pair of test leads. This Voltmeter, with the matching model Ammeter as illustrated above, makes an ideal pair of test meters for any mechanic to carry around in his tool box........**ONLY $9.50**

Combination Offer: 528 Voltmeter
528 Ammeter

BOTH For $21.00

COMBINATION OFFER

150 VOLT A.C. METER
Triplett 331-JP, 3½" Rd flush case

30 AMP A. C. METER
Triplett 331-JP, 3½" Rd flush case

Both meters for $7.95

PORTABLE (CHRONOMETRIC) TACHOMETER

Jaeger Watch Co. Model #43A-6

- Can be used for speeds up to 20,000 R.P.M.
- Can be used for lineal speed measurements to 10,000 F.P.M.
- Ideally suited for testing the speeds of motors, particularly of fractional horse power, generators turbines, centrifugals, fans, etc.
- Very small Torque—requires practically no power to drive.
- Unequalled Readability 2" Open face dial—each division on large dial equals 10 R.P.M.; each division on small dial equals 1,000 R.P.M.
- Greatest Accuracy—meets Navy specifications—guaranteed to be within ½ of 1%.
- Results of test reading remain on dial until next test taken.
- Push button for automatic resetting.
- Complete with the following accessories.
  1—Large pointed rubber tip
  1—Large hollow rubber tip.
  1—6" circumference Wheel tip
  1—Operating instructions.
  1—Temperature Correction chart.

The combination of the above features will give accurately, within a few seconds, by direct reading, the R.P.M. of shafts or the lineal speeds of surfaces without any accessories or timing of any kind. Each unit comes complete in a red velvet lined carrying case 5"x3½"x1½". Net List Price..........$70.00
Your Cost $24.50

SPECIAL
JUST RECEIVED

In addition to those panel meters listed in our December 'ad', we now offer the following items from stock:

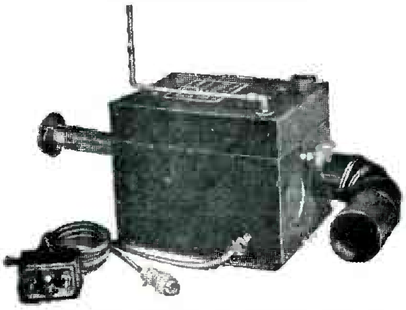
DECEIBEL METER—Weston 301 type 61, — 10 to + 6, 3½" rd fl bake case, 6 MW 600 ohms, Zero DB = 1.9 volts. High speed type .29 — .35 Seconds to final reading. Only 2-6% overthrow, 5000 ohms at Zero DB, 16-50 Damping factor. Complete with external wire wound precision resistors to extend the range to any or all of the following ranges:
— 20 to + 16 DB
— 30 to + 26 DB
— 40 to + 36 DB

Ideal for sound and broadcasting applications (Quantity Available). Total List Price...$37.50
Your Cost Only $11.50

DECEIBEL METER—G.E. DO-46, — 10 to + 6 DB, 3½" rd fl bake case. Zero DB = 1.9 volts.
Your Cost Only $8.95

0-500 MA R.F., **Weston** 425, 3½" rd fl bake case with ext thermocouple..............$ 9.50
0-1 Amps R.F., **GE DO**-44, 3½" rd fl bake case ....$ 7.50
0-2 Amps R.F., **Weston** 425, 3½" rd fl bake case ....$ 8.50
0-2.5 Amps R.F.. **Weston** 425, 3½" rd fl bake case ....$ 8.50
0-3 Amps R.F., **Weston** 425, 3½" rd fl bake case w ext thermocouple................$11.50
0-5 Amps R.F.. **Weston** 425, 3½" rd fl bake case ....$ 8.50
0-5 Amps R.F.. **GE DO**-44, 3½" rd fl bake case ....$ 7.50
50-0-50 **Microampere** DC, Gruen 3½" rd fl bake case, 570 ohms resist...............$ 6.50
0-200 **Microampere** DC, WH NX-35, 3½" rd fl bake case, 230 ohms resist MR35W200 DCUA ....$ 8.50
0-1 **Milliamperes** DC, WH NX-35, 3½" rd fl bake case, 53.7 ohms resist MR35WOO1 DCMA ....$ 7.50
.1-0-1.25 DC M.A., Aircraft type G-1 **miniature meter**, black sc, 500 MV mvt., Bulova Watch Co., 1¾" sq fl bake case...........$ 3.95

Gasoline Heater Motorola Model GN-3-24



An internal combustion type heater which will give 15,000 B.T.U. of heat per hour. Ideally suited for use with equipment, farms, boats, bungalows, cabins, trailers, work sheds, darkrooms, mobile equipment, transmitter stations, etc., and any place where a quick heat is required in volume.

Very economical in operation—tank holds one gallon of gasoline which is sufficient for 6 hours operation. Uses any grade gasoline.

This unit is designed primarily for aircraft installation, 24-28 volts d.c., but it can be readily adapted for a 115 or 230 volt 60 cycle power supply by use of a transformer and rectifier. Simple circuit diagram for adaption to 115 or 230 volt 60 cycle use supplied with each unit. Can be used on 32 volt farm or boat systems as is without the installation of additional transformers, etc. Power consumption approximately 75 to 100 watts.

Takes very little space—can be readily stored when not in use—measures approximately 12 long x 9⅛" high x 9½" wide, weighs only 30 lbs complete with all accessories.

These units are complete with exhaust pipe, 3" air duct elbow, control switch and cord, as illustrated, and are supplied with Technical Manual and Parts Catalog.

SIMPLE TO INSTALL—SAFE TO USE—NO ODORS
BRAND NEW—IN ORIGINAL CARTONS—READY TO USE
Made by Galvin (Motorola) Mfg. Company.

NET PRICE................ **$22.50**

INSULATION TESTER

0-20 and 0-200 Megohms, full scale
0- .5 and 0-5 Megohm, center scale

The original unit. The Weston Model 796 Insulation Tester operated at a 500 volt test potential supplied by eight 67½ volt batteries. This has been modified by us to utilize two 1½ volt standard No. 6 dry cells and a vibrator power supply for the 500 volt test potential thereby eliminating the high replacement cost of batteries. Enclosed in a hardwood carrying case 8⅜"x9⅛"x8". The Weston Model 801, 4½" Rectangular 0—50 microampere meter guarantees extreme accuracy on all ranges. Surplus—New—Guaranteed.
NET $39.50

PORTABLE CURRENT TRANSFORMER

Weston Model 461 Type 4. This unit can be used with any precision 5 Amperes A.C. Meter to extend the ranges of the meter to 50, 100, 200, 250, 500 or 1000 Amperes A.C. Accuracy within ¼ of 1%; Normal Secondary Capacity = 15 VA; Binding Posts for 50 Ampere tap; Inserted primary for 100, 200, 250, 500 and 1000 Amperes; Insulated for use up to 2500 volts. List Price $98.00.
NET $35.00

ROTARY CONVERTER

230 V. 1.5 Amps DC.
110 V. 2.5 Amps 1 ph AC 100 P.F.
.225 KVA 3600 R.P.M.
Janette # CA-16-F. @ $55.00

MOTOR GENERATOR

230 V. 6.8 Amps DC Input
1.25 KVA 120 V. 60 cycle Output
3600 R.P.M. Allis Chambers
@ $100.00

All items are Surplus—New—Guaranteed. C.O.D.'s not sent unless accompanied by 25% Deposit.
Orders accepted from rated concerns, public institutions, etc., on open account.
The above is only a partial listing of the many items we have in stock. Send for free circular.
MANUFACTURERS, EXPORTERS, DEALERS—we invite your inquiries.
NOTICE—We Repeat—all items are Surplus—New—Guaranteed. All prices FOB, NY

MARITIME SWITCHBOARD

336 Canal Street Worth 4-8217 New York 13, N. Y.

We carry a complete line of surplus new meters suitable for every requirement, such as portable, panel, switchboard, laboratory standards, etc.

OVER 50,000 METERS IN STOCK

We also have in stock various surplus components, tubes, code keying and recording units, code training sets, tachometers, analyzers, tube testers, converters, precision resistors, current transformers, transmitters, receivers, condensers, and other electronic units, parts and accessories.

Finest of surplus at a fraction of cost

PEAK ELECTRONICS CO.

Industrials Schools - Labs

SALE Inventory Clearance Many Items Below Our Cost • *ORDER NOW AND SAVE* • Drastic Reductions. Prices Return to Normal on Feb. 1st **SALE**

MISCELLANEOUS "99" BARGAINS

.004 1000 WVDC Micas ..... 9 for $.99
.01 600 v Micas ..... 9 for .99
24 v DC Relays ..... 5 for .99
.02 400 VDC Tubulars ..... 15 for .99
1000 Mfd 25 VDC Electrolytic ..... 2 for .99
25 Mfd 25 Volt Electrolytic Tub. ..... 6 for .99
Jan 6 C 4 Tubes ..... 4 for .99
1000 Ohm 200 Watt Resistor ..... 3 for .99
2 Mfd 250 Vac Oil ..... 5 for .99
Shielded Littlefuse Holders ..... 11 for .99
3:1 PP Input Trans, Hermetic Seal ..2 for .99
.05 600 Vdc Oil Tubular ..... 10 for .99
Ceramic Beehive Insulators ..... 25 for .99
705A Sockets Ceramic ..... 5 for .99
10 Mmf Midget Variable Cond ..... 4 for .99
.002 3500 Vdc Micas ..... 2 for .99
50 Ohm 20 watt Adjustable Slider ..... 5 for .99
10K, 15K Potentiometers ..... 6 for .99
½ Meg Potentiometers ..... 4 for .99
Ceramic Grid Caps for 866 ..... 6 for .99
Jan 807 Tubes ..... .99
GE 1/25 Watt Neons ..... 10 for .99
Ceramic 4, 5 Prong Sockets ..... 9 for .99
Butterfly Cond. 2-11 Mmf Ball B'rngs..2 for .99
6.3 V 10 Amp Trans.. 110v/60 Pri., Hermetic Seal 1.99
10 x 10 x 10 V 7 Amp Each. Pri 110/60. Amertran 3.99
4300 V 4 ma pri 110/60 Hermetic Seal 7.99
WE Silvered Adjustable Cap. .5-2.5 Mmf ..... 6 for .99
Weston 507 Rf Meters Less Thermo ..... .99
Allen Bradley ½ Meg Pots with Switch ..... 2 for .99
1/40 Amp (250 ma) Littlefuses ..... 15 for .99
Ohmite 10 Ohm 20 Watt Resistors ..... 12 for .99
CD 16 Mfd 450 WV Elect. in can ..... 3 for .99
50 Mfd 50 Volt Electrolytic Tubular..5 for .99
5v at 4A x 6.3v at 3A. 110/60 Pri 2.99
4 Mfd 300 WV Oil Cond ..... 4 for .99
Corning Glass Slug Form and Variable Cap ..... 5 for .99
CD 1 x 1 x 1 Mfd 1200 VDC ..... 2 for .99
I R C 220 Ohm 100 Watt Resist ..... 4 for .99
BZRS Micro Switches S P D T 10 Amp 4 for .99
Midget Closed Circuit Jacks ..... 7 for .99
.0015 5% Silver Micas ..... 9 for .99
Heineman 5 Amp 110 Vac Circuit Breakers. .99
Trimm Commercial Headphones Hi Imp 3.99
GE Solenoid with Micro Switchs 24 v DC ..... 3 for .99
HS 30 Earphones ..... 2 for .99
Solar .02 600 Vdc Dominoes ..... 9 for .99
Interlock Switch Spst 15 Amp 125 Vac ..... 4 for .99
1 Mfd 450 VDC Oil Tubular ..... 9 for .99
.25 Mfd 600 VDC Tubulars ..... 9 for .99
.01 Micas 300 VDC ..... 12 for .99
Erie .0005 N 750 D Ceramicons ..... 15 for .99

HIGH CURRENT PLATE TRANS.

This plate transformer built to rigid Signal Corps spec. Input 118 volts, 25 to 60 cycles. Has 2 separate 118 volt primaries and can be used on 110 or 220 volts. Secondary 800 volts center tapped at 775 mills. Exceptional regulation even when loaded to 900 mills! Fully cased—4 mtg holes. 37 lbs. net wt. 6½ x 6½ x 7⅛. Sale price. $5.95.

FILAMENT TRANSFORMER

Two separate 118 volt, 25 to 60 cycle primaries. Can be used on 110 or 220 volts. Secondary 5 volts at 15 amps. Built to Signal Corps specs. Fully encased. 5 x 4¼ x 5⅝. Net wt. 10 lbs. Now only $2.95.

RECTIFIER TRANSFORMER

2 separate 110 v primaries. Sec 70-75 v at 3 amps. 35-37 v (pri in series). Fully cased. Now only $1.69 ea.

GENERAL PURPOSE TRANSFORMER

Ideal for Bias, Filament, Isolation Stepdown, etc., 2 Isolated 110v pr. sec. 110v at 900 ma plus 6.3 @ 2 amp. Fully cased. Now $1.49 ea. Same as above but 6.3v 5 amp, 110v at 500 ma. $1.49 ea.

CHOKE BARGAINS

6 Henry 45 MA 300 ohms ..... 3 for .99
8 Henry 75 MA 230 ohms ..... 2 for .99
8 Henry 160 MA 140 ohms ..... 2 for .99
10 Henry 200 MA 150 ohms 1.99
1.5 Henry 250 MA 72 ohms ..... 2 for .99
10 Henry 350 MA 60 ohms 3.99
6 Henry 550 MA 30 ohms 4.99
4.3 Henry 620 MA 42 ohms 5.99
10 Henry 750 MA 95 ohms 10.99

35 WATT WIRE WOUND RESISTORS

100-1500-4K-5K-10K-15K-40K. Your choice 6 for .99

1% PRECISION WIRE WOUND RESISTORS

2500, 5000, 8500, 50,000, 95,000 ohms. Your choice ..... 6 for .99

U. H. F. COAX. CONNECTORS

831AP-UG12U-UG21U-UG-14U-UG146U-UG-206U. Any type. 5 for .$99.

METERS BARGAINS

2" Gruen 0-3 v DC (1 ma Basic)
2" GE 0-1 Amp RF
2" GE 0-1 ma (volt scale)
2" GE 0-30 volts DC (1 ma basic)
2" GE 0-5 ma (amp scale)
2" Westinghouse 0-250 volts DC
2" Gruen 0-100 ma
2" GE 0-30 amps DC

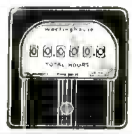
1.99 ea *ANY TYPE*

2" Weston 150-0-150 micro amps
2" GE 0-500 ma
3" Triplett 0-75 amps AC
3" WE 0-80 ma DC
3" Westinghouse 0-2 ma
3" Westinghouse 0-20 ma
3" GE 0-15 ma
3" Dejur 0-100 ma

2.95 ea *ANY TYPE*

3" Westinghouse 0-150 volts AC
3" Westinghouse 0-50 amps AC
3" GE 0-200 ma DC

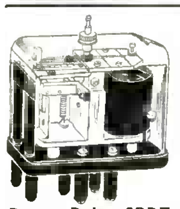
3.95 ea



WESTINGHOUSE RUNNING TIME METER

0-99,999.9 hours. 3½" Square Bakelite Case, 110V 60 Cycle, Brand New. $7.95

WESTINGHOUSE



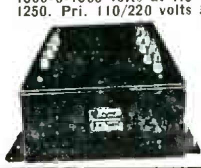
Type MN Overcurrent Relay, Adjustable Form 250 ma to 1 amp. External Push Button Reset. Enclosed in glass case. Hand calibrated adjustments, only $7.95

Dunco Relay SPDT 6vac Coil 1.59

Voltage Regulated Power Supply—Input 110 v. 60 cy. Delivers 150 v. DC—Well filtered (3 chokes).

H.V.-H. CURRENT PLATE TRANS.

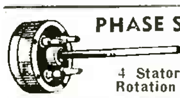
1500-0-1500 volts at 1.5 amps. Tapped at 1350 and 1250. Pri. 110/220 volts 50/60 cycles in 2 Separate windings. Built to rigid Navy specs by Amertran. Suitable for broadcast transmitters, induction heating, etc. Continuous duty. 10 x 10 x 7. Swt 125 lbs. Now $39.95.



MEDIUM CURRENT PLATE

As illustrated above. 1500-0-1500 volts at 600 ma. Pri. 110/220 v. 50/60 cycles. 8 x 8½ x 7 s.w.t. 78 lbs. ..... now $27.50

PHASE SHIFT CAPACITOR



4 Stator Single Rotor, 0-360 Degrees Rotation ..... Now Only $2.45 each

1-196-B SIGNAL GENERATOR 175-220 Mcs. With Tube and Carrying CASE, $5.95.

STEPDOWN TRANSFORMER

220/110 volts, 110 watts. Fully encased. 5⅛ x 4¼ x 5⅛. 110V. 60 cycle ..... $2.49 each

Precision 15 Meg. 1% Accuracy Resistor. Non-inductive, 1 watt, hermetically sealed in glass. 10 for $2.50.

VARIABLE CONDENSERS—CERAMIC INSULATIONS

Midget		Transmitting	
35 MMF	$.39	73 MMF .3 SA	5.95
250 MMF	.49	150 MMF .07SA	.95
325 MMF	.59	Dual 250 .051	2.75
APC 100	.29	Dual 250 .1	2.95
APC 140	.35	125 MMC .07	.89

CWI 60 AAG range calibrator and power supply book, cables, etc. 29.50

AMERTRAN RECTIFIER FILAMENT

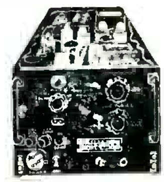
Trans, 2.5 V 10 A Pri. 110 v. 60 cy. H.V. Insulation. Cased 3.95

FILAMENT TRANSFORMER

6.3 v 21 amps. Hermetically sealed, 110 v 60 cy. Pri $4.75

AMERTRAN FILAMENT TRANS.

5.25 volts at 21 amps. plus 2 x 7.75 v at 6 amps. Pri. 110 v 60 cy. H.V. Ins. 6" x 5½" x 4½". 5.95.



AN/APT 2 Radar Jammer

425-750 mcs. Contains 10 tubes: (1)—807 (2)—703A (2)—6AC7 (2)—6AG7— (2)—5R4GY (1)—2x2 (1) 981A Unit has blower motor and 400 cycle Pwr supply complete with all tubes, etc.. BRAND NEW, Now 12.95 ea.

50 Megohm 80 watt Resistor, IRC Type Mve. .$1.49

Advance DPDT 110v/60 cy Antenna Relay. Ceramic Insulation $2.49

Swinging Choke .1/1 Amp, 11.5/1.7 Hy. 15 Ohms DC, H.V. Ins. Fully cased, Raytheon. Swt 50 lbs. ..... $24.50 ea.

Amertran Voltage Control. 110/220v 60 cy input. Output variable 100 to 130 volts, 8.5 Amps ..... $6.95 ea.

WIRE WOUND RESISTORS

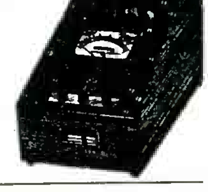
5 Watt type AA, 20-25-50-200-470-2500-4000 ohms ..... .09 ea.
10 watt type AB, 25-40-84-400-470-1325 1900-2000-4000 ohms ..... .15 ea.
20 watt type DG. 50-70-100-150-300-750 1000-1500-2500-2700-5000-7500-10000-16000-20000-30000ohms ..... .20 ea.
30 watt type DI, 100-150-2500-3000-4500-5300-7500-18000-40000 ohms ..... .24 ea.

HIGH VOLTAGE MICAS**

XR .0001 MMF 5 KV	.75
F2L .0005 MMF 5 KV	.85
F2L .001 MMF 5 KV	1.39
F2L .0015 MMF 5 KV	1.69
F2L .003 MMF 5 KV	1.90
XS .005 MMF 5 KV	2.50
F3L .007 MMF 5 KV	2.75
GI .00024 MMF 6 KV	4.50
GI .001 MMF 6 KV	4.75
F3L .002 MMF 6 KV	3.50
F3L .0025 MMF 6 KV	3.60
F3L .003 MMF 6 KV	3.75
*MX .004 MMF 6 KV	4.95
F3L .0005 MMF 8 KV	2.99
F3L .0006 MMF 8 KV	3.00
*PL .001 MMF 8 KV	4.95
F3L .0015 MMF 8 KV	3.50
F3L .002 MMF 8 KV	4.00
F3L .0025 MMF 8 KV	4.50
F3L .003 MMF 8 KV	5.00
F3L .01 MMF 8 KV	6.50
F3L .004 MMF 8 KV	5.50
F3L .005 MMF 8 KV	6.00
*G2 .005 MMF 10 KV	5.95
*G2 .002 MMF 10KV	6.95
*G2 .001 10 KV	5.95
XA .0005 MMF 12 KV	4.90
*G4 .008 MMF 12 KV	26.50
*G4 .0033 MMF 20 KV	22.50
*G4 .004 MMF 20 KV	24.50
*G4 .001 MMF 25 KV	32.50

** All ratings "working-voltage."
* Tolerance ±5%. Ceramic case. High current.

MEGOHM METER



Industrial Instruments Model L2AU 118/220 volts 60 cycle input. Direct reading from 0-100000 megohms on 4" meter. Can be extended to 500000 megohms with external supply. Sloping hardwood Cabinet 15"x8"x10". Brand new with tubes plus running spare parts including extra tubes. Great value Now only $59.50.

OIL CONDENSERS

1 mfd 250 vac— .85
5 mfd 150 vac— .49
1 mfd 600 vdc— .29
2 mfd 600 vdc— .39
4 mfd 600 vdc— .59
3/3 mfd 600 vdc— .79
10 mfd 600 vdc— .95
14 mfd 600 vdc—1.25
2 mfd 1000 vdc— .79
4 mfd 1000 vdc— .95
15 mfd 1000 vdc—2.95
2 mfd 1500 vdc—1.25
1 mfd 2000 vdc—1.45
2 mfd 4000 vdc—5.50
3 mfd 3000 vdc—3.95
1 mfd 5000 vdc—4.50

.1/.1 mfd 7000 vdc—2.25
.1 mfd 7500 vdc—1.95
1 mfd 7500 vdc—9.25
4 mfd 8 kv dc—19.95
.01/.01 mfd 12 kv dc—5.75
.005/.01 mfd 12 kv dc—5.50
.03 mfd 16 kv dc—5.75
.65 mfd 12,500 vdc—12.95
.75/.35 mfd 8/16 kv—12.95
.02 mfd 20 kv dc—7.95
2 mfd 18 kv dc—59.50

AMERTRAN 500 VOLT PLATE

5½" x 4½" cased 6.95

Tremendous stocks on hand. Please send requests for quotas. Special quantity discounts. Price f.o.b. N. Y. 20% with order unless rated, balance C. O. D. Minimum order $5.00.

PEAK ELECTRONICS CO.
188 Washington St., New York 7, N. Y.

PHONE CO-7-6443
DEPARTMENT EA
SEND FOR BULLETIN

TRANSTAT VOLTAGE REGULATOR

Max KVA Output..............11.5
Single Phase............50-60 Cycles
Fixed Winding............115 Volts
Commutator Range......0-115 Volts
Max. Amperage 100
With reconnection for 220 V. Operation: Max. Amperage.............50

This Transtat has wide application to control temperature, motor speed, illumination, rectifier output, filament supply, voltage compensation, instrument calibration, and general testing and laboratory use

Net weight 134 Lbs. Dim. 25" W x 16" D x 17½" H (Exclusive 8" shaft extension)

Brand New $75.00

MOTOR GENERATORS

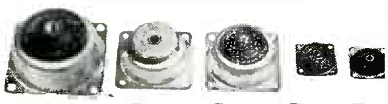
Brand New War Surplus Machines Built by Allis Chalmers Co. to U. S. Navy Specifications.
Input: 115V. D.C. at 14 amps., 3600 rpm.
Output: 120V A.C., 60 CY. 1 ph. at 10.4 amps. 1000 Watts continuous duty. Ball bearings.
Splashproof: Fully enclosed. Centrifugal starter.
Frequency adjustable to load.
Length 26"; Width 12⅞"; Height 13".

Price $97.50

Same machine but for 230V. D. C. input.

Price $125.00

SHOCK MOUNTS



A. Lord #20, 3" x 3" x 1¾"............ .40
B. U. S. Rubber #5150 C 2⅜" x 2⅜" x 1⅛"................ .30
C. Lord #15 2⅜" x 2⅜" x 1⅛"........ .25
D. Lord #10 1¼" x 1¼" x ⅝"......... .10
E. Lord #3 1¼" x 1¼" x ⅜"......... .10

BRAND NEW

DYNAMOTORS—500 Watts
Navy Type CAJO-211444

Input: 105-130 Volts D.C., 6 amps. Output 13 or 26 Volts D.C. (26 V. at 20 amps. in series or 13 V. at 40 amps. in parallel). Designed for radio use, fully R.F. filtered, complete with separate Square D line switch box.

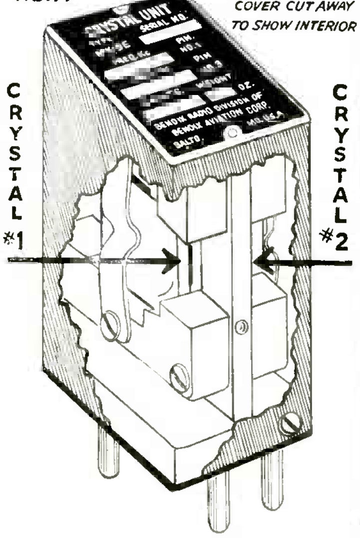
BRAND NEW $59.50

"TWO-IN-ONE" CRYSTAL UNITS

TYPE MX-9E

BRAND NEW!

ACTUAL SIZE COVER CUT AWAY TO SHOW INTERIOR



Each unit contains two ¾" sq. crystals differing in frequency by 455 k.c. The following combinations are available:

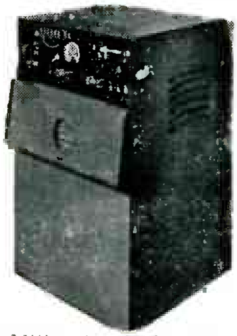
Kilocycles	Kilocycles
(1183.0 and 1638.0)	(4287.5 and 4742.5)
(2407.0 and 2862.0)	(4310.0 and 4765.0)
(2457.0 and 2912.0)	(4360.0 and 4815.0)
(2481.0 and 2936.0)	(4435.0 and 4890.0)
(2530.0 and 2985.0)	(4702.5 and 5157.5)
(2539.0 and 2994.0)	(4713.0 and 5168.0)
(2560.0 and 3015.0)	(4930.0 and 5385.0)
(2562.5 and 3017.5)	(4935.0 and 5390.0)
(2915.0 and 3370.0)	(4975.0 and 5430.0)
(2945.0 and 3400.0)	(5080.0 and 5535.0)
(3820.0 and 4275.0)	(5217.0 and 5672.0)
(3860.0 and 4315.0)	(5235.0 and 5690.0)
(4002.5 and 4457.5)	(5490.0 and 5945.0)
(4175.0 and 4630.0)	(5835.0 and 6290.0)
(4205.0 and 4660.0)	(6485.0 and 6940.0)
(4242.5 and 4697.5)	(6515.0 and 6970.0)

All above units are brand new, individually packed with frequencies marked on containers and with manufacturer's inspection tags attached.

Priced at a fraction of the cost of the holder alone. Brand new..... $1.95

3 prong Micalex sockets for above crystal units ....50c each

Raytheon RECTICHARGERS



Input: 115 volts AC, 60 cy., 1 Ph. . . . Output: 48 v. DC at 3 amperes regulated and adjustable. Charges 23 to 24 cell battery or may be used direct as battery eliminator.

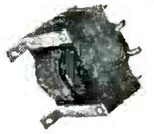
The Raytheon Recticharger is designed to supply current at constant voltage to any load within its rating, and in addition to supply current to a storage battery connected across its load, of sufficient amount to maintain full charge. The function of the battery is to supply surge current due to sudden changes in load and to supply current above the rating of the Recticharger for temporary overload, and to act as a "stand-by" source of power in event of commercial power failure.

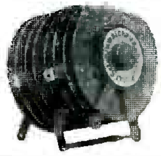
BRAND NEW $69.50

STEPDOWN TRANSFORMERS

Input: 115 V. 60 cycles.
Output: 20 V., at 10 amps.
Also tapped at 6V., for pilot light. Ideal for Selenium Rectifier Applications, etc.

Brand New $2.45





SELENIUM RECTIFIER

Bridge Type

Input: 36 V. AC.
Output: 28 V. DC., 1.1 Amps.

Brand New $2.75

LINEAR SAWTOOTH POTENTIOMETER
W.E. No. KS 15138

The d-c potentiometer consists of a closed type die-cast aluminum alloy frame consisting of a continuous resistance winding to which electric power is supplied through two fixed taps 180 degrees apart. Two rotating brushes (180 degrees apart and bearing on the resistance winding) and two take-off brushes are provided for the output voltage. Varying the position of the brushes varies the output voltage in accordance with a linear sawtooth wave. The potentiometer is excited with 24-volt direct current, is arranged for panel or bracket mounting, is approximately 3-11/16 inches in diameter, 3 inches deep, 4¾ inches long, and has an approximate weight of one pound. External connections are made through a standard AN type connector.

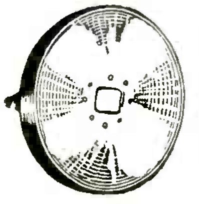
Brand New $5.75

ACME HI-VOLT TRANSFORMERS

Primary: 115 V., 60 cycles.
Secondary: 8000 V., C.T., 800 V.A.

Brand new in sealed cans.... $27.50

PARABOLOIDS



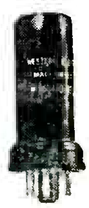
Ideal for microwave experimental work.
Spun Magnesium dishes
Reinforced Perimeter
17½" Diameter x 4" Deep
Two sets mounting brackets on rear
Open center hole 1½" x 1⅝"

Per Pair, Brand New... $8.75

MERCURY CONTACT RELAY
Western Electric D-168479

For applications in all types of high speed switching devices. Long service life, high operating speeds. Large current and voltage handling capacity, uniform and constant operating characteristics under adverse atmospheric conditions. Hermetically-sealed mercury-wetted contacts in gas-filled glass envelope. Free from moisture, dirt, corrosion and atmospheric pressure. Single pole double throw contacts.
7000 hours life at 60 operations per second. Two coils of 700 ohms, and 3300 ohms. Operating current, coils series aiding—6.6 mils. Release current, coils series aiding—5.2 mils. Four page Technical Data on request.

Brand New in Original Cartons, $4.75



All prices indicated are F O B Tuckahoe, New York. Shipments will be made via Railway Express unless other instructions issued.

ELECTRONICRAFT
INC.
5 WAVERLY PLACE TUCKAHOE 7, N. Y.
PHONE: TUCKAHOE 3-0044

All merchandise guaranteed. Immediate delivery, subject to prior sale.

All Prices Subject to Change Without Notice

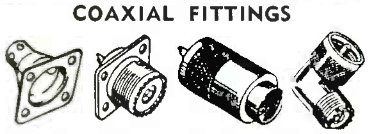
HARD-TO-GET PARTS AT *REAL* SAVINGS!

RG 8/U NEW-UNUSED
52 OHM COAXIAL CABLE
4c A FOOT

500-2,500 feet	$40.00 per M
3,000-5,000 feet	35.00 per M
5,500-10,000 feet	30.00 per M
10,500-20,000 feet	27.50 per M
over 20,000 feet	25.00 per M

No charge for reels.

COAXIAL FITTINGS



Hood 10¢ — Socket 40¢ SO-239 83-1R — Plug 40¢ PL-259 83-1SP — Angle Adapter 20¢ M-359 83-1AP

PL259A, 83-1SPN, 83-1J, UG21U, UG22U, UG13U, UG27U, UG281 U assembled with short piece of RG 58U .... 40¢ each
UG85U Baby "N" Plugs .... 40¢ each

STEEL JUNCTION BOX

Water-tight, 14 ga. steel. 17"x25"x6½". Screw type brass hinge on lid. 50 lb $2.95

CHOKE

400 MA. 12 Henry 90 Ohms, 6,000 V.D.C. Test. Hermetically Sealed. 4½" x 5⅜" x 4¼", 12 lb. $3.85

PRECISION RESISTORS

1% OR BETTER

Any Order For
100 pieces .... 10% Off
1000 pieces .... 20% Off

¼ WATT—25c

6.68Ω	12.32Ω	16.37Ω	123.8Ω	414.3Ω
10.48	13.02	20.	147.5	705
10.84	13.52	62.54	220.4	2193
11.25	13.89	79.81	301.8	10,000
11.74	14.98	105.8	366.6	59,148

½ WATT—25c

.250Ω	11.1Ω	235Ω	4,451Ω	15,000Ω
.334	13.15	260	5,000	15,750
.502	46	270	5,900	17,000
.557	52	298.3	6,500	20,000
.627	55.1	400	7,000	25,000
.76	75	723.1	7,500	30,000
1.01	97.8	2,500	8,000	100,000
1.53	125	2,850	8,500	150,000
2.04	180	3,427	10,000	
2.25	210	4,000	14,825	

1 WATT—30c

1.01Ω	5.21Ω	1,250Ω	9,000Ω	55,000Ω
2.58	10.1	3,300	18,000	65,000
3.39	10.9	5,000	20,000	70,000
5.05	270	7,000	50,000	75,000

1 WATT—40c

100,000Ω	128,000Ω	180,000Ω	470,000Ω	525,000Ω
120,000	130,000	250,000	500,000	600,000
125,000	160,000	320,000	522,000	700,000

1 Megohm, 1 Watt, 1%—65c; 5%—40c

CAPACITORS

OIL FILLED

MFD	V.D.C.	Price	MFD	V.D.C.	Price
.1	25,000	$17.95	2	750 V.A.C	
.012	25,000	6.20		(2,200 V.D.C.)	.49
.03	16,000	5.75	1	2,000	.95
.375@16,000 and			10	1,000	1.75
.75@ 8,000(dual)		14.95	8	1,000	1.50
1	7,500	12.50	4	1,000	1.00
1	7,500	1.95	3	1,000	.80
.1-.1	7,000	2.45	2	1,000	.65
.1	7,000	1.85	.05	1,000	.29
.02-.02	7,000	1.65	.1	800	.40
.1	6,000	1.75	10	600	1.35
.03-.03	6,000	1.65	4	600	.69
1	6,000	8.50	2	600	.39
.01	5,000	1.35	1	500	.29
.25	3,000	1.75	.5	500	.24

POSTAGE STAMP MICAS

5mmf	62mmf	220mmf	525*mmf	.0015mfd
8.2	66*	300*	560	.002*
10	68	360	650	.0022*
22	70	390*	680*	.0027*
30*	82*	400	750	.003*
33	90	430*	800	.0033*
39	100	470	820*	.0039*
47	110*	488*	.001mfd	.0068*
50	120*	500*	.0012	.01
56	150*	510*	.0013*	
60	180*			

*Silver Mica

Price schedule

5MMF to .001MFD	5¢—Silver Mica	10¢
.0012MFD to .0027MFD	7¢—Silver Mica	20¢
.0029MFD to .0068MFD	12¢—Silver Mica	50¢
	.01MFD	18¢

PULSE TRANSFORMERS

X 143T 2, UTAH, core—⅝" x ⅜" x ¼", 3 windings, open frame, capable of shortest pulses **$1.50**

X 124 T2, UTAH, marked 9262 or 9280, small gray case 1⅞" high x 1⅛" x ⅝" with two 6-32 mtg. studs. Ratio 1:1:1, hypersil core **$1.50**

Spec.—10, 111, Chicago Transformer equivalent of 9262 .... **$1.50**

134-BW, Westinghouse, core—1½" x ⅜" x ⅞", 4 windings open frame **$1.50**

7472407, GE. core ⅝" x 1⅜" x 3/16", 2 windings (0.6 ohm and 0.08 ohm DC) **$1.25**

80G16, GE **$1.25**

D161310. Western Electric, cased 1¾" dia. x 1⅞" high, impedance ratio 120 to 2350 ohms, molybdenum Permalloy tape core. Frequency response 50 Kc to 4 Mc **$2.00**

D166638, W. E., cased 1¾" x 1¼" x 2¼", 2 semitorridal windings, 150 turns ea. of two windings, used in portable oscilloscope .. **$1.25**

352-7250-2A, cased 15/16" dia. x 1⅝" high, DC 10 ohm, 3½ ohm sine wave response 140 cy. to 175 Kc **$1.25**

352-7251-2A, similar to above but for shorter pulses **$1.25**

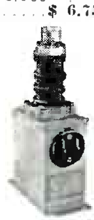
300 KVA GE 7557296, 50 ohm pulse cable connection; 3,850 V. in 17,300 V. out. (250 KVA @ ¼ micro second) **$15.00**

800 KVA GE 7710417, 50 ohms pulse cable connection. 450 ohm output. 9500 volt input, 28000 volt pk. output, Bifilar **$19.50**

TRANSFORMERS

Pri. 115 V., 60 Cyc. Sec. 24 V., 10 A. encased **$4.75.** Lots of 10 .... **$45.00**
Pri. 115 V., 60 Cyc. Sec. 5 V., 60 A., 5,000 V. insulation .... **$ 6.75**

FILAMENT TRANSFORMER
WESTINGHOUSE #6D4298



Tested at 34,000 volts
Pri. 115 V. A. C., 60 Cyc. Sec. 5V @ 6.5 Amp.
ONLY $8.50

DELAY NETWORKS. 1400 ohm, in small cans (look like I.F.) made up with ceramicans and R.F. chokes. Ideal for making pulse generators, etc.
T113—approx. 1.2 micro second delay .... 85¢
T114—approx. 2.2 micro second delay .... 85¢
T115—similar to T114 with tap brought out .... 85¢

POWER RESISTORS

200 WATT—55c

10,000Ω	400Ω	250Ω
2,000	300	150

160 WATT—47c

200Ω

150 WATT—44c

25,000Ω	1,500Ω	400Ω
8,000	600	40

100 WATT—95c
Ohmite Non-inductive

5,000Ω	3,500Ω	2,500Ω	1,500Ω	250Ω
4,000	3,000	2,000	750	200

BLEEDER RESISTOR

Two 200 Watt Ohmite in series, total res. 18,000Ω. Res. between taps, 4,500Ω, 2,200Ω, 10,700Ω, 600Ω **$1.75**

TUBE SOCKETS

Octal (SS8) .... 8¢
7 pin miniature .... 14¢
Acorn ceramic .... 14¢
829 ceramic .... 29¢
14 pin cathode ray .... 40¢

BC 1072 A IFF X'MITTER in MAPLE CHEST

150 to 200 Mcs.
115 V. 60 Cyc.

POWER SUPPLY gives: 0-5000 v.d.c. (variac control) 312 v.d.c., 700 v.d.c., 6.3 vac. (Also contains; 11 tubes 6J5, 826, 6SN7, 5U4G, etc.), 5 KV. meter. Blower, Condensers and many other useful parts too numerous to list. Shipping Wt. 245 lbs.

Only ...... (slightly used) $22.50

Vernier dials, 2⅝" dia. 0-100 in 360°, black with silver marks, thumblock. For BC221 .... **$.85**

UNIVERSAL JOINT
ALUMINUM

1⅛" long x ½" O.D. ¼" ID
35c

ALLEN SET SCREWS

4-40x1/8	8-32x1/8	10-32x1/4
4-40x3/16	8-32x3/16	1/4-20x1/2
6-32x1/8	8-32x5/16	

All sizes .... $1.50 per C

Wrapped—BALL BEARINGS—New

Mfg.	ID	OD	Width	Price
Fafnir 33K5E	3/16"	1/2"	5/32"	25¢
Fafnir 38K	5/16"	7/8"	9/32"	45¢
Timken	1/2"	1 3/8"	7/16"	85¢
ND5202C13M	1/2"	1 3/8"	1 3/8" (dual)	1.25
ND 88503	43/64"	1 37/64"	21/32"	1.00
MRC 206SF	1 5/32"	2 7/16"	5/8"	1.25
Fafnir 545	2 1/6"	2 5/8"	15/32"	1.00

NEEDLE BEARINGS

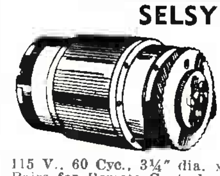
B88 1/2" wide	1/2"	11/16"	25¢
B108 1/2" wide	5/8"	13/16"	30¢
GB34X 1/4" wide	3/16"	11/32"	25¢

Glyptal—cement, 1 quart cans GE #1286 .... $.75
Gallon cans .... $ 2.50
5 gallon cans $11.00

HARDWARE ASSORTMENT — (mostly brass) —screws, nuts, washers, solder lugs. 3 lbs. **$1.00**

Mounting Brackets—(Bakelite) for selsyns and differentials shown below .... 25¢ pair

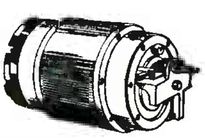
SELSYNS



ONLY $7.25 pair
#C78248

115 V., 60 Cyc., 3¼" dia. x 4½" body. Used in Pairs for Remote Control.
Also 50 V., 50 Cyc., $4.75 pair.

SELSYN DIFFERENTIAL #C78249



ONLY $2.25 ea.

115V., 60 Cyc.
Used between two #C78248's as dampener. Can be converted to a 3600 RPM Motor in 10 Minutes. Conversion sheet supplied.
Also 50 V., 50 Cyc., $1.50 ea.

MINIMUM ORDER $3

All Orders f.o.b. PHILA., Pa.

RELIANCE MERCHANDIZING CO.

Arch St. Cor. Croskey, Philadelphia 3, Pa. *Telephone RIttenhouse 6-4927*

SURPLUS ELECTRONICS — CLEARANCE SALE!!!

FREQUENCY METER TS-69/AP

Frequency range 400 mc to 1,000 mc, continuous. Ideal for labs, schools, or for hams experimenting with eqpt. for civilian phone band. Black-crackle finished metal case, dim: 6"x6""22", contains variable length coax resonating cavity with crystal rectifiers and 0-200 microammeter, Veeder - Root counter and calibration charts insure extreme precision. Telescopic antenna, and coax line probe, with metal carrying case for entire equipment. New equipment.

COMPLETE, EACH **$42.50**

REGULAR STOCK SPECIALS!
5-Meter Walkie-Talkie

Model BC-322 Transceiver; simple, popular communications unit. Freq. range 52-65 mc. Uses only two tubes, types 33 and 30. Includes a 5 mc. crystal in a crystal calibrator circuit. Range 5 to 50 miles, depending upon location and altitude. Operates from single battery block (not supplied) available from mfr., or other sources. Supplied with handset and telescoping antenna. Excellent condition. **PRICE, EACH** **$22.95**

DECK ENTRANCE INSULATORS
Bowl and Flange Type

Manufactured by OHIO BRASS CO. for Army and Navy use. Has heavy galvanized metal flange 8⅞" diameter, porcelain bowl set in rubber gaskets, top bell is 6¼" in diameter. Brass feed-thru rod 11½" long. Insulation distance between top bell and flange is 4½". Individually packed in cartons. Quantities available. **New, price each, $2.75. Spare porcelain bowl, only, each** .... **$.75**

32 VDC TO 110 AC CONVERTER

Mfd. by Kato Engineering, for marine or farm installation. Rotary type, compact and ruggedly built for continuous duty. Rubber shock mounting on filter case, with complete input and output filtering. Output 110 volts, 60 cycles AC, .225 KVA, but will operate efficiently on loads up to 300 watts. New units only. **PRICE, EACH, $39.95. Quantities, 10 or more, each** **$32.00**

AMPLIDYNE MG SET
MOTOR 110/220, 60 C.A.C.

For Automatic or Remote Control of heavy equipment. Mfd. by General Electric. Generator is Type V-5875677, motor 73AB58; Navy type CG-21ABU. Generator delivers 250 volts DC, 375 watts. Motor—115 or 230 volts, 1-phase, 60 cycles AC, rated at ¾ HP RPM-1725. Includes capacitor for starting, and instructions for 115 or 230 volt connections. Generator section can be removed, and entire assembly shortened to make valuable 1 H.P. AC motor. **PRICE, EACH** **$60.00**

MISCELLANEOUS SPECIALS

APQ2 Transmitter, only, with tubes. Almost New. **Each** **$37.50**

SN-APQ5 Synchronizer, with tubes. Almost New. **EACH** **$37.50**

TA-12B 4-Channel Aircraft Transmitters, less dynamotor and accessories, but with tubes. Excellent condition. **EACH** .. **$40.00**

BC-620 FM Transmitter-Receiver. Mobile or portable unit main part of SCR-510. NEW, with tubes and complete crystals but less accessories or power supply (operates from batteries or vibrator power supply). Export packed.
PRICE EACH **$50.00**

BC-603, 604, 683, 684, Transmitters, Receivers. Main components of SCR-508, 528, and 608, 628 FM mobile installations. Dynamotor and tubes supplied.

PRICE. New BC-603 Receiver, w/dynamotor, tubes **$40.00**

PRICE. New BC-604 Transmitter, w/dynamotor, tubes, crystals **$50.00**

BC-683 Receiver, New w/dynamotor and tubes. **EACH** **$40.00**

BC-684 Transmitter, New w/dynamotor, tubes and crystals. **EACH** **$50.00**

SB-23/GTA-2, Large Airport Switchboard. With separate power supply (SB-14/GT) operates from 110V. AC. 50-60 cycles, to charge telephone batteries and operate switchboard. Both in handsome metal cabinets, approx. 50" high, 30" wide and 22" deep. New eqpt.
PRICE, per Switchboard and Power Supply **$300.00**

— RADAR —
TREMENDOUS ASSORTMENT

Hundreds of major radar components, mostly for navy types, includes power transformers, wave-guides, plumbing of all sorts, magnetrons, cavity chambers, echo boxes, connectors, antennas. Complete SF and SF-1 spares in original factory cases. Inspection invited, or write us your requirements.

SF RADAR, NEW and Complete, in original cases with operating spares. **PRICE, Complete** **$2500.00**

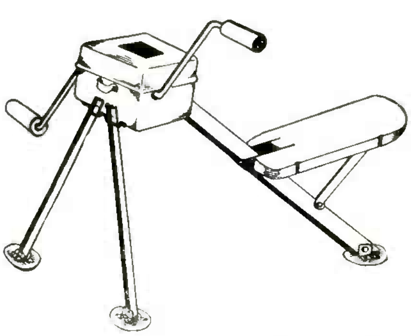
SF-1 RADAR SPARES only, this equipment in addition to above. All NEW major units, with tubes, transformers, capacitors, etc. **PRICE, COMPLETE SET SPARES** **$775.00**

SF RADAR SPARES, all NEW containing all important components for Model SF. **PRICE, COMPLETE SET** **$500.00**

SNOOPERSCOPE INFRA-RED IMAGE CONVERTER TUBE!

This is the tube that enabled our combat men to see in the dark and through camouflage. An infra-red light cast in the direction desired, shows all objects on tube screen in greenish-white color with good detail. No scanning or amplifiers necessary. High-voltage power supply needed, can be built from toy ignition transformer and rectifier tube. Optical lens system only necessary where magnification or long-range viewing is desired. This tube has wonderful possibilities for dark room work, fog-penetration devices, night photography, etc. With complete technical data. All NEW, guaranteed, individually boxed. ***PRICE, EACH*** **$10.00**

NEW, COMPLETE 10 W. HAND GENERATORS



FOR MARK II. Delivers 162.0 volts at .06 amps, and 3.1 volts at .3 amps, completely voltage-regulated and filtered. NEW units, export packed four to the case, with seat pedestals, cranks, carrying bags, cords. Complete, in 1-case.
FOUR, for $30.00

RADIO TRANSMITTERS MODULATORS, AND POWER SUPPLIES
Immediate Delivery from Stock

RADIO TRANSMITTER T-4/FRC, 400 Watts Output. Freq. Range 2 to 18 Mc. Operates from Power Supply PP-1/FRC described below. 12 available, 3 New, balance almost new. **PRICE, EACH** **$600.00**

RADIO TRANSMITTER T-5/FRC, 600 Watts Output, Freq. 150-550 KC. Operates from PP-1/FRC described below. 3 Available, almost new. **EACH** **$650.00**

POWER RECTIFIER PP-1/FRC, Operates from 220 v. ac, 50-60 cycles, current 50 amps max. Supplies all necessary power to above described units, as well as to a 300 watt audio modulator (not available). Four Available, all New. **EACH** **$1,000.00**

BC-325 Transmitter, 400W.-A1, 100 W.-A2 and A3. 1.5 to 18.0 mc. M.O. or X'tal control on 6 frequencies. Operates from 110/220/1/60c. AC. With tubes in excellent condition. **PRICE, EACH** **$400.00**

TCR—Radiomarine Transmitter, 125 watts (conservative) A1, A2, & A3. For ship or shore station radio telephony, 6 channels in 2 to 3 mc band controlled by remote control box supplied. Complete RF, modulator and power supply (for 110 or 220 V. 50/60 cycles AC) in one cabinet. Excellent condition, with tubes and remote control box. **EACH** **$500.00**

BC-319-A Transmitter. CW only 300 watts output. Freq. range 4.0 to 13.4 mc. Operates from 110/220 volts, 60 cycles AC. Excellent condition. Less tubes **PRICE, EACH** **$300.00**

Wilcox, 96-200A 2-KW RF section. Large cabinet with complete RF end containing the VFO, intermediate sections and PA stage. Almost new, but lacks PA inductance only. Power supply separate unit not available, but can be built. Less tubes. **PRICE** **$500.00**

RCA 8023/HF Ship Transmitter. 200 watts output. A1 and A2. Freq. range 4.0 to 20 mc. Operates from mg set (not supplied) in IF main transmitter (RMCA type 8024). With tubes, but no receiver. Excellent cond. **PRICE, EACH** **$350.00**

MACKAY SHIP TRANSMITTERS. The following Mackay ship-radio types are available: 150-AY, 151-A1, 149-A, 136-A, 104-M, 147-M. Some new, most in excellent condition. Write for prices.

LINK FM Transmitter Receiver, 70-100 MC. Model 1498 DC. 50 watts output, wall style cabinet containing transmitter, receiver and 14 V. D.C. power supply, handset. Dim: 34"x21"x11". NEW CONDITION. Complete with tubes, crystals, special telescopic antenna, instruction book. **PRICE, EACH** **$600.00**

RADIO TRANSMITTER BC-339, CW only, 1-KW output. Freq. range 4.0 to 26.5 mcs. Six crystal positions also M.O., four intermediate stages and two 833s final. Operates on 220 volts 50/60 cycles. Reconditioned new. Complete with power supply and one set operating tubes. **PRICE** **$2400.00**

MODEL AT-14A TRANSMITTER. Mfd. by Phillips. Output A1 275 watts; A2, A3 225W. Freq. range 2 to 20 mcs. Four xtal positions & separate M.O. Operates on 110/200/220/240/260 volts 50/60 cycles. **PRICE,** complete with power supply & set of operating tubes... **$900.00** Extra power supply & modulator only for above model AT-14A, complete in cabinet with tubes. Has 1600 Volt D.C. output at 450 mils. for R.F. stage. **PRICE** **$175.00**

MODEL SVC100L/110 TRANSMITTER. Output A1 150 watts, A2-A3 50W. Mfd. by Philips. Freq. 2 to 20 mcs., with 6 pretuned channels. Operates from 90-260 volts 50/60 c. A.C. **COMPLETE,** with tubes **$450.00**

RCA 2-CHANNEL A.F. AMPLIFIER. 250W. per channel, total 500W. Complete with power supply, voltage gain stages for low level input, metering circuits, in one cabinet approx. 6 ft. high. Operates from 110 volts 50/60c A.C. Almost new cond. with tubes. **PRICE** ... **$1,000.00**

NOTICE: Price quoted above does not include crating or packing. Price for packing will be quoted upon specification as to whether export or domestic packing is desired.

All Prices F.O.B. N.Y.C. **All Material Offered Subject to Prior Sale**

Phone—
LOngacre 4-4490-1

TELEMARINE COMMUNICATIONS COMPANY

280 Ninth Ave.,
N. Y. 1, N. Y.

SPECIAL SURPLUS BROADCAST OF OUR SUPER SPECIALS!!!

KATO ROTARY CONVERTERS

Kato type 1206A Model 26/A54 Marine or Farm duty. Ball Bearing. 24 VDC to 115 VAC, 1 ph. 60 cy. 1800 RPM. Compact and ruggedly built for continuous duty operation. Rubber shock mounting on filter case. Input and output filtered. Brand new in original cases. $90.00

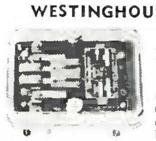
IDEAL SOLDERING TRANSFORMERS

Model 5C. Input 115 VAC 60 Cy. Regulated by toggle switch for high, low, or off position. High heat output 6.5-6.8V @ 1150W. Low heat output 5.2-5.4V @ 875W. Portable. 6½" x 5¾". New. List price $41.40 Our price.............................$12.50

DAVEN SOUND ATTENUATORS

Type 350E, Ladder network, impedance 250/250 ohms. 2 DB attenuation. Type 350A, Ladder network, impedance 30/30 ohms. 2DB attenuation. Compact constant impedance attenuators that will dissipate 10 watts in any position. Linear attenuation. Brand new in original boxes. Your choice............$2.50

WESTINGHOUSE AUXILIARY RELAYS



Type MC, Style PH8082-1. 115 VAC 60 cy. continuous rating. Electromagnet Coil. Contact rating 10 Amps. 4PST. Coil resistance 70 ohms. Used to operate a number of circuits from one control circuit. Used frequently for tripping circuit breakers. Glass top. Dimensions: 6½" x 4½" x 4½". Brand new in original cartons. $7.95

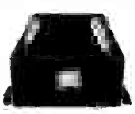
RCA TRACK LIGHTING AND CONTROL PANEL

Model 713-AS. Completely wired ready for immediate operation. Controls the filament voltages on vacuum tubes in the process of being exhausted on rotary turn table equipment. Physical dimensions 7' High 15" Deep and 32" Wide. Unit is complete with meters, variac, distribution transformers, switches, rheostats, etc. Brand new...........................$275.00

HIGH VOLTAGE POWER SUPPLY

Western Electric, D150382, RA50A. Plate Trans. Mfd. by Jefferson which supplies 20,000 VCT @ 750 VA for the anodes of two 705A tubes in the unit. Filtered by C-D capacitor rated .05 mfd @ 12,500 volts. The filaments of the 705A tubes supplied by a Western Electric Transformer of 5 volts at 10 Amps., 15,000 volt test. Dimensions 21½" H 17" W 11½" D. New $49.95

AMERTRAN HEAVY DUTY TRANSFORMERS

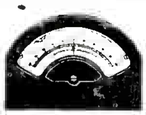


Pri 115/230 VAC 60 cy. Sec 4730/2365. KVA 1.66 RMS 12 KV. Wgt. 150# 11" x 11" x 9" Brand New $27.50

WESTINGHOUSE FLEXARC WELDERS

Type WC-2, transformer type for single operator, Style 36R117. Primary 550/440 volts 60 cy. 1 ph. Welding current output 300 Amps. Continuous for one hour. Load volts 40 at rated load. Rotating handle on top for current adjustment. Self cooling with built in circuit breaker to deenergize the welder and give overload or short circuit protection. 37" H 18" D 26" W. Used but in excellent cond....$125.00

MILLIAMMETERS

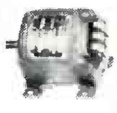


Used as balance indicators on telephone and telegraph circuits but are equally as well suited for the laboratory or anywhere that a vertical scale desk type of meter is desired. Permanent magnet moving coil type. Scale length 4⅛". Wgt. 3½ lbs. 6" x 2½" x 4-5/32". Two ranges available: 150-0-150 MA DC or 50-0-50 MA DC. Accuracy within ½ of 1%. Your choice $2.50 ea 10/$22.50

AMERTRAN HEAVY DUTY TRANSFORMERS

Pri: 55 V. Sec: 10V @ 238 Amps., 2.38 KVA 9½" x 7½" x 8½". Two trans can be put in series to operate on 110V, giving secondary of 20 V, 238 Amps. Brand New....$12.50 each

DIEHL MOTORS

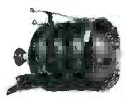


Normally 110V, 60 cy. 3 Ph. unit. Will operate satisfactorily on 110V 60 cy. 1 Ph. by addition of capacitor across one of the other phases. 1/40 HP, cont. duty, 3450 RPM. 1¾" x ⅝" D shaft. Motor dimensions: 4"H x 5"W x 5"D. Wgt. 10 lbs........$4.50

SERVO MOTORS

Mfd. by White-Rodgers, Model 6904X-27, type 3. Voltage 24 DC, 1.1A torque 150 in/lbs. 2½ RPM Int. Duty. Brand New. $9.95
Model 6905X-46 type 3. Voltage 24 D.C. Torque 50" lbs. 0.5 RPM .65 Amps. New $8.95

STANDARD BRAND RHEOSTATS



High shock rheostats, four 13" plates with circular contacts, 100 ohms @ 8-2A connected in series and assembled for back of board mounting or by reversing the supporting brackets for floor or table operation. Brand new in individual cartons. $19.75

SERVO MOTOR

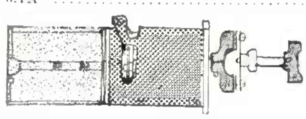
Aircraft Controller, Barber Coleman, Model YLC-2 89. 24V DC. 1.0A, Torque 100 in/lbs. 1.5 RPM. 7"L x 3½"D. shaft ½". Special...............$6.95

MAGNETRON TUBES

2J26	$10.00	700A	$15.00	728BY	$25.00
2J27	10.00	700B	15.00	728CY	25.00
2J31	15.00	700C	15.00	728DY	25.00
2J34	25.00	700D	15.00	728EY	25.00
2J40	25.00	706BY	35.00	728FY	25.00
2J42	35.00	714AY	8.50	728GY	25.00
2J49	35.00	720AY	25.00	725A	25.00
5J23	35.00	720GY	25.00	Klystrons	
5J29	35.00	728AY	25.00	723A/B	12.50
				417A	9.60

PULSE AND SPECIAL TRANSFORMERS

Sprague. 15-E4-.91-400-50P $4.95
Fast. 15-E5-1.33-700-50P2T (Z1743) $3.00
Raytheon. UX7361A, blocking oscillator, 3 windings 2-3 micro seconds, peak pulse 300-400. Repetition rate up to 4000 Cy...................................$1.00
RAYTHEON, INPUT, UX9216A, Pri. 10000 ohms impd. Sec. 2x25,000 ohms..........................$1.00
RAYTHEON, SWEEP, UX8725A, Pri. #1 1600-0-1600 turns. Sec # 2 800-0-800 turns Sec. # 3 & #4 1600 turns.......................................$1.00
RAYTHEON, AUTO, UX7548. Pri. 26V, Sec. 10.8V 400-800 Cy..$1.00
RAYTHEON, INTERSTAGE, UX7587C. Pri. #1 & #2 15,000 ohms impd. Sec. 67,500 ohms.......$1.00
RAYTHEON, PHASING. UX8724, Pri. 115VAC. 60 cy. Sec. 15V 0.5MA $1.00
RAYTHEON, INTERSTAGE, UX8442, Pri. Minus 40V, Sec. plus 40V...............................$1.00
RAYTHEON, AC-RC. UX7358, Pri. 115V AC Sec 6500V .005A 400 Cy.............................$1.00
RAYTHEON, FILAMENT, UX8486A. Pri. 115 VAC 400 Cy. Sec. 5V @ 5A, 13500 WVT..........$1.00
RAYTHEON, OUTPUT, UX7489A. Pri. 3600 Ohms Sec 720 Ohms
RAYTHEON PLATE & FILAMENT, UX8547. Pri. 115V 400 Cy. Sec. 1000V 25MA, Sec. #2 6.15 V @ 0.7A $1.00



BECKMAN HELIPOTS

Model A, 10 turns, 3600° rotation. 20,000 ohms resistance, 5 watt. 0.5 guaranteed linearity 5% resistance tolerance. With aluminum stop as pictured $5.00. Without stop $4.50

RAYTHEON CHOKES

S.M. CHOKE. UX7776. 1.28 Henries 130 MA 57 ohms $1.00
S.M. Choke. UX8678. 15 Henries 28MA 1050 Ohms 50c
S.M. CHOKE. UX9116. .03 Henries @ 2A (Rectifier Choke) $2.25
CHOKE ASSEMBLY, CRP30509. 1.8 Henries 0.384A $1.50
DUAL CHOKE, WX5146. 1.5 Henries 400 MA. 1.5 Henries @ 400 MA..............................$1.75
S.M. CHOKE, (Rectifier), UX9114A. 0.100 Henries 1.4 Amps.......................................$2.00
G.E., #7385576. 87.9 Henries @ .0672 Amps. 7.5 KV DC Test Volts...............................$10.00
AMERTRAN. 20 Henries @ 45 MA..............75c

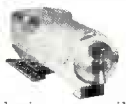
WHEELCO CAPACITROL

Model 221. Volts 230. 50/60 Cy., 50 Watts. Temp. Element C/A. Cont. Cap. 5A. Wiring diagram HCL. 0-2500°F. 9"H x 7"W x 11"D. Brand new....$50.00

BROWN RECORDING POTENTIOMETERS

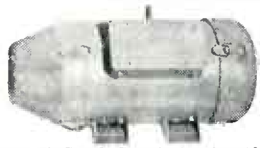
Model 151321-XPD. Range 0-1200°F. Operates on 105-125 VAC 60 cy. Uses chart #14007. Used but like new. $125.00

SELECTOR SWITCHES



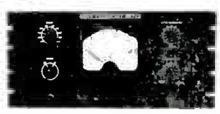
Heavy duty, specially built for the U. S. Navy to control any type of multi-circuit devices. Removable contacts enabling any combination of closed and open circuit. The following are available: 5 section-5 pole: 10 section-20 pole; 15 section-15 pole; 15 section-30 pole. $1.50 ea. Case lot of (5) $5.00 or (5) cases at the special price of $17.50

MOTOR GENERATORS



Built by Allis-Chalmers to U. S. Navy Specifications

Input: 115 Volts. DC at 14 amperes, 3600 speed, ball bearings. Output: 1.25 KVA; 80% P.F.; 120 VAC. 60 Cy. single ph., 10.4 Amperes. With resistive control of voltage output and frequency built-in and with Centrifical automatic controller built-in permitting line-start operation. Fully enclosed, Splash-proof. BRAND NEW! In original Factory Cases Price $100.00. Same machine for 230 Volts, D.C. Operation.........................$120.00
Spare parts kit of brushes, brushholders, ball bearings, field coils, etc. in steel case........Price $10.00

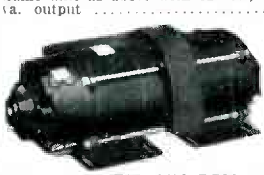


RCA AUDIO FREQUENCY METERS

Type 306A. Direct reading 0-50,000 Cycles in ten ranges. Input voltage 1 to 200 volts RMS. Input impedance 25,000 ohms. Recorder output 5.0 MA 1000 ohms max. Accuracy 2%. Regulated power supply 105-125V, 50-60 cy. Power consumption 70 watts. 6" meter scale. 8⅜"H x 19"W x 13⅝"D, Wgt. 41 lbs. Used but like new...$75.00

MARATHON MOTOR GENERATORS

Rebuilt like new. Two separate units coupled together on a common bed plate. MARINE TYPE with voltage regulator and frequency controller. Operable at 110 volts DC and supplying 110 volts AC, single phase, 60 cycles, 500 va. Special Price $65.00
Same unit as above with 32 volt, DC motor and 300 va. output $54



GENERAL ELECTRIC AMPLIDYNES

Model 5AM45-DB20 INPUT: 115 volts, 1φ, 60 cycles, 5 amps. OUTPUT: 250 volts, .6 amp. 150 watts, cont. duty 40 C.—Temp. Rise 3450 RPM. New Special Price $53.50

GENERAL ELECTRIC ROTARY CONVERTERS

78 Volts. DC input; 110 Volts, 60 cycle. OUTPUT. 1.5 amperes REMARKABLE VALUE AT...$9.95

GENERAL ELECTRIC TYPE IRT 3 PHASE INDUCTION VOLTAGE REGULATOR

1.64 KVA. Outdoor service, filled with 9 gallons oil. Primary Volts; 208; Load Amperes —10.5. Brand New and in original manufacturer's cases. Price $83.50

INTER-COMMUNICATION SETS MANUF. BY DICTOGRAPH

Designed to bring to homes and offices the convenience of two-way conversation without the use of telephone, household electric current, or radio. Operates efficiently up to 800 feet off flashlight batteries. NEW, Pair $9.95

BENDIX AUTOSYN Type AY-101-D: Input: 26 Volts, single ph. 400 cyc. 65 mils, .36 watts, Can be used on 6.3 volts, AC, 60 cycles, with current drain of 75 mils and .3 watts........PRICE $21.50

FORD INSTRUMENT SYNCHRO GENERATORS Type 5G; MK 1 Mod. 3 115/90 Volts, 60 cyc. PRICE $37.50

STEP-BY-STEP MOTORS 65 volts. complete with gear train ....PRICE $65.00

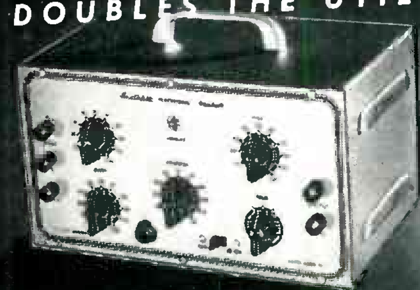
ALL PRICES F.O.B. BOSTON. ORDERS ACCEPTED FOR RATED CONCERNS ON OPEN ACCOUNTS. NET 30 DAYS. WRITE FOR OUR CATALOGUE

ESCO ELECTRO Sales Co.

110 PEARL STREET . . . Boston 10, Mass. . . . LIberty 2-5589 . . . HAncock 6-5069

Build YOUR OWN TEST EQUIPMENT

Heathkit ELECTRONIC SWITCH KIT
DOUBLES THE UTILITY OF ANY SCOPE



Gives two separately controllable traces with individual inputs on any scope.

See both the input and output traces, locate distortion, phase shift, etc., immediately.

Individual gain controls and positioning control. Coarse and fine sweeping rate controls. Complete Heathkit matches others, with 5 tubes, All metal parts are punched, formed and cadmium plated. Complete with tubes, all parts, detailed blueprints and instructions. Shipping Wt. 13 lbs.

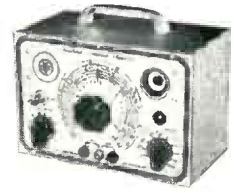
Nothing ELSE TO BUY

$34.50

HEATHKIT CONDENSER CHECKER KIT

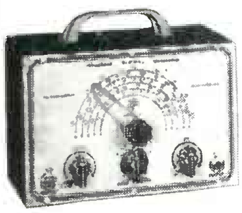
$19.50

Nothing ELSE TO BUY



A condenser checker anyone can afford to own. Measures capacity and leakage from .00001 to 1000 MFD on calibrated scales with test voltage up to 500 volts. No need for tables or multipliers. Reads resistance 500 ohms to 2 megohms. 110V 60 cycle transformer operated complete with rectifier and magic eye indicator tubes.
Easy quick assembly with clear detailed blueprints and instructions. Small convenient size 9" x 6" x 4¾". Wt. 4 lbs.

HEATHKIT SIGNAL GENERATOR KIT



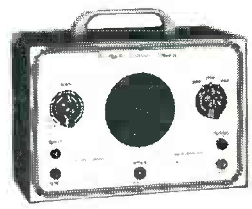
Every shop needs a good signal generator. The Heathkit fulfills every servicing need, fundamentals from 150 Kc. to 30 megacycles with strong harmonics over 100 megacycles covering the new television and FM bands. 110V 60 cycle transformer operated power supply.

400 cycle audio available for 30% modulation or audio testing. Uses 6SN7 as RF oscillator and audio amplifier. Complete kit has every part necessary and detailed blueprints and instructions enable the builder to assemble it in a few hours. Large easy to read calibration. Convenient size 9" x 6" x 4¾". Wt. 4½ lbs.

$19.50

NOTHING ELSE TO BUY

HEATHKIT SIGNAL TRACER KIT



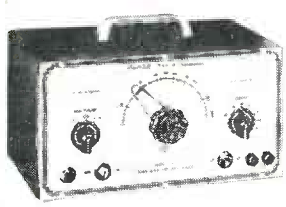
$19.50

Nothing ELSE TO BUY

Reduces service time and greatly increases profits of any service shop. Uses crystal diode to follow signal from antenna to speaker. Locates faults immediately. Internal amplifier available for speaker testing and internal speaker available for amplifier testing. Connection for VTVM on panel allows visual tracing and gain measurements. Also tests phonograph pickups, microphones, PA systems, etc. Frequency range to 200 Mc. Complete ready to assemble. 110V 60 cycle transformer operated. Supplied with 3 tubes, diode probe, 2 color panel, all other parts. Easy to assemble, detailed blueprints and instructions.
Small portable 9" x 6" x 4¾". Wt. 6 pounds. Ideal for taking on service calls. Complete your service shop with this instrument.

HEATHKIT SINE AND SQUARE WAVE AUDIO GENERATOR KIT

The ideal instrument for checking audio amplifiers, television response, distortion, etc. Supplies excellent sine wave 20 cycles to 20,000 cycles and in addition supplies square wave over same range. Extremely low distortion, less than 1%, large calibrated dial, beautiful 2 color panel, 1% precision calibrating resistors, 110 V 60 cycle power transformer, 5 tubes, detailed blueprints and instructions. R.C. type circuit with excellent stability. Shipping weight 15 pounds.

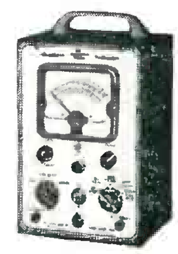


$34.50

Nothing ELSE TO BUY

THE NEW HEATHKIT VACUUM TUBE VOLTMETER KIT

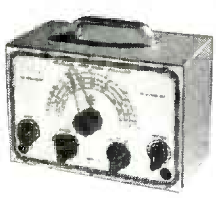
The most essential tool a radio man can have, now within the reach of his pocketbook. The Heathkit VTVM is equal in quality to instruments selling for $75.00 or more. Features 500 microamp meter, transformer power supply, 1% glass enclosed divider resistors, ceramic selector switches, 11 megohms input resistance, linear AC and DC scale, electronic AC reading RMS. Circuit uses 6SN7 in balanced bridge circuit, a 6H6 as AC rectifier and 6 x 5 as transformer power supply rectifier. Included is means of calibrating without standards. Average assembly time less than four pleasant hours and you have the most useful test instrument you will ever own. Ranges 0-3, 30, 100, 300, 1000 volts AC and DC. Ohmmeter has ranges of scale times 1, 100, 1000, 10M and 1 megohm, giving range .1 ohm to 1000 megohms. Complete with detailed instructions. Add postage for 8 lbs.



$24.50

Nothing ELSE TO BUY

HEATHKIT FM AND TELEVISION SWEEP GENERATOR KIT



THE BASIC FM AND TELEVISION SERVICE INSTRUMENT

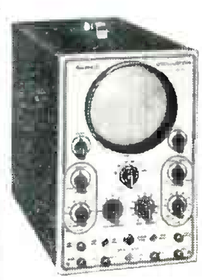
At the lowest cost possible, anyone can now service FM and television receivers. The Heathkit sweep generator kit operates with oscilloscope and covers all necessary frequencies. A few pleasant hours assembling this kit puts any organization in position to share the profits of the FM and TV boom.

Every part supplied — grey crackle cabinet, two color calibrated panel, all metal parts punched, formed and plated. 5 tubes, complete detailed instructions for assembly and use. Shipping weight 6 lbs.

$24.50

NOTHING ELSE TO BUY

The NEW 1948 HEATHKIT 5 INCH OSCILLOSCOPE KIT



$39.50

NOTHING ELSE TO BUY

New improved model of the famous Heathkit Oscilloscope. Building an oscilloscope is the finest training for television and newer servicing technique and you save two-thirds the cost. All the features and quality of instruments selling for $100.00 or more. Supplied complete with cabinet, two color panel, 5BP1 tube, 2 5Y3 tubes, 2 6SJ7 tubes and 884 sweep generator tube. Power transformer supplies 1000V negative and 350 volt positive. Sweep generator 15 cycles to 30 M. cycles. Has vertical and horizontal amplifiers. Oil filled filter condensers for long life. Complete blueprints and instructions included.

The HEATH COMPANY
... BENTON HARBOR 14, MICHIGAN

SELENIUM RECTIFIERS
AND SPECIALIZED ELECTRONIC COMPONENTS

THIS MONTH'S SPECIALS ! !

SILVER CERAMIC TRIMMERS
Type 820-Z 5-20 Mmfd Zero Temp.......24¢ each.
Type N-300 5-20 Mmfd Neg. Temp......24¢ each.

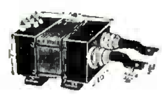
Nat'l Velvet Vernier Planetary Drive
From "AM" Dials 5 to 1...............80¢ each.

COLLINS FILAMENT TRANSFORMER
PRI: 210/220/230/240/250 VAC. 50/60 CPS.
SEC: 7.5 VAC C.T. @ 24 Amps. Herm. Sealed.
Insulation 2500 Volts...............Price $11.95

OIL CAPACITOR
.125 MFD. 27 KV.DC.
With mounting brackets
$17.50

FENWAL THERMOSWITCH
Normally open or closed. Adjustable from —40 to +400° F. each **$1.25**

TRANSFORMER
HIGH CURRENT AMERTRAN



5.1 Volts at 190 Amps.
Primary 105/125 Volts

Can easily deliver 250 Amps. Insulation 35 Kv. Test. Approx. Shipping weight 96 lbs.

Plus $2 crating charge **$17.50**

Full Wave Bridge Types
Input 0–18VAC — Output 0–13*VDC

Type #	Current	Price
B1–250	250 MA.	$.98
B1–500	500 MA.	1.95
B1–1	1 AMP.	2.49
B1–1X5	1.5 AMP.	2.95
B1–3	3 AMP.	3.49
B1–5	5 AMP.	5.95
B1–7X5	7.5 AMP.	7.95
B1–10	10 AMP.	9.95
B1–15	15 AMP.	13.95
B1–20	20 AMP.	15.95
B1–25	25 AMP.	20.95
B1–30	30 AMP.	24.95
B1–40	40 AMP.	27.95
B1–50	50 AMP.	32.95
B1–60	60 AMP.	36.95

Full Wave Bridge Types
Input 0–54VAC — Output 0–40*VDC

Type #	Current	Price
B3–150	150 MA.	$1.25
B3–250	250 MA.	1.95
B3–600	600 MA.	3.25
B3-5	5 AMP.	13.95

Input 0–72VAC — Output 0–54*VDC

Type #	Current	Price
B4–1X2	1.2 AMP.	$7.95
B4–3X5	3.5 AMP.	15.95
B4–5	5 AMP.	17.95

Input 0–115VAC — Output 0–110*VDC

Type #	Current	Price
B6–150	150 MA.	$1.95
B6–250	250 MA.	2.95
B6-600	600 MA	5.95
B6–2	2 AMP.	12.95
B6–3X5	3.5 AMP.	21.95
B6–5	5 AMP.	24.95
B6–7X5	7.5 AMP.	32.95
B6–10	10 AMP.	36.95

Input 0–234VAC — Output 0–180*VDC

Type #	Current	Price
B13-4	4 AMP.	$54.95
B13–7X5	7.5 AMP.	63.95
B13–10	10 AMP.	69.95

Full Wave Bridge Types
Input 0–36VAC — Output 0–25*VDC

Type #	Current	Price
B2–150	150 MA.	$.98
B2–220	220 MA.	1.25
B2–300	300 MA.	1.50
B2–450	450 MA.	2.25
B2–600	600 MA.	2.95
B2–1	1 AMP.	3.95
B2–2	2 AMP.	4.95
B2–3	3 AMP.	6.95
B2–5	5 AMP.	9.95
B2–6	6 AMP.	10.95
B2–7X5	7.5 AMP.	13.95
B2–10	10 AMP.	15.95
B2–15	15 AMP.	24.95
B2–20	20 AMP.	27.95
B2–30	30 AMP.	36.95

Three Phase Bridge Types
Input 0–126VAC — Output 0–130*VDC

Type #	Current	Price
3B7–4	4 AMP.	$32.95
3B7–6	6 AMP.	48.90
3B7–11	11 AMP.	65.00

Input 0–234VAC — Output 0–250*VDC

Type #	Current	Price
3B13–4	4 AMP.	$56.00
3B13–6	6 AMP.	81.50
3B13–11	11 AMP.	110.00

CENTER TAPPED TYPES
Input 12–0–12VAC — Output 0–8*VDC

Type #	Current	Price
C1–10	10 AMP.	$7.95
C1–20	20 AMP.	12.95
C1–30	30 AMP.	17.95
C1–40	40 AMP.	21.95
C1–50	50 AMP.	25.95
C1–80	80 AMP.	34.95
C1–120	120 AMP.	46.95

* Select Proper Capacitor From List Shown Below, to Obtain Higher D.C. Voltages Than Indicated

RECTIFIER MOUNTING BRACKETS
For Types B1 through B6, and Type C1..........$ .35 per set
For Types B13.................................. .80 per set
For Types 3B.................................. 1.20 per set

RECTIFIER CAPACITORS

CF-13	6000 MFD	10VDC	$2.49
CF-14	3000 MFD	12VDC	1.69
CF-15	6000 MFD	12VDC	2.95
CF-1	1000 MFD	15VDC	.98
CF-2	2000 MFD	15VDC	1.69
CF-3	1000 MFD	25VDC	1.69
CF-4	2X3500 MFD	25VDC	3.45
CF-18	10000 MFD	25VDC	4.95
CF-5	1500 MFD	30VDC	2.49
CF-6	4000 MFD	30VDC	3.25
CF-7	3000 MFD	35VDC	3.25
CF-8	100 MFD	50VDC	.98
CF19	500 MFD	50VDC	1.95
CF-16	2000 MFD	50VDC	3.25
CF-17	50 MFD	150VDC	.59
CF-9	200 MFD	150VDC	1.69
CF-10	500 MFD	150VDC	3.25
CF-11	100 MFD	350VDC	2.25
CF-12	125 MFD	350VDC	2.49

Rectifier Transformers
All Primaries 115VAC 50/60 Cycles

Type #	Volts	Amps.	Price
XF15–12	15	12	$3.95
TXF36–2	36	2	3.95
TXF36–5	36	5	4.95
TXF36–10	36	10	7.95
TXF36–15	36	15	11.95
TXF36–20	36	20	17.95

All TXF Types are Tapped to Deliver 32, 34, 36 Volts.

RECTIFIER CHOKES

Type		Amps.	Price
HY2	.03 Hy	2	$2.25
HY3	.03 Hy	3	2.95
HY5	.02 Hy	5	3.25
HY8X5	.02 Hy	8.5	7.95
HY10	.02 Hy	10	9.95
HY12	.02 Hy	12	12.95
HY15	.015Hy	15	13.95

ELECTROLYTIC CAPACITORS

		Lots of 10	Lots of 100
100 MFD	50 VDC	$2.20	$19.00
40 MFD	150 VDC	1.80	17.50
50 MFD	150 VDC	2.00	18.50
8-8-20 MFD	350,150 VDC	4.70	43.00
*20-20 MFD	400,250 VDC	4.50	38.00
10 MFD	450 VDC	2.50	20.00
15 MFD	450 VDC	2.50	20.00
15-15 MFD	450 VDC	3.00	22.00
40 MFD	450 VDC	4.20	36.00

* 4 prong plug-in type.

METERS
O-15 MA.D.C. Weston #506 2" Rd............. $2.95
O-30 A.D.C. Weston W/shunt 2½" Rd., aircraft type............. 2.95
O-50 A.D.C. Weston #301 3½" Rd., Enclosed shunt 5.50
O-60 A.D.C. West., w. shunt, 2½" Rd., aircraft type............. 3.25
O-120 A.D.C. West. w. shunt, 2½" Rd., aircraft type............. 4.95
O-8 V.A.C. G.E. 3½" Round............. 2.95
O-30 V.D.C. West. 2½" Rd., aircraft type....... 2.95

To avoid shipping errors, kindly order by type #. All prices subject to change without notice.

ATTENTION ! ! !
INDUSTRIALS, EXPORTERS, SCHOOLS GOV'T AGENCIES, LABORATORIES
Our engineering staff is at your service to facilitate the application of rectifiers to your specific requirements.
Write for quantity discount on company letterhead.

Minimum order $3.00. No C.O.D.'s under $25.00. 25% deposit on C.O.D. Add 10% for Parcel Post and handling. Terms: Net 10 days to rated concerns only.

Orders Promptly Filled From Our Stocks F.O.B. New York City

OPAD-GREEN COMPANY
71 Warren St. Phone: BEekman 3-7385 New York 7, N. Y.

COMMUNICATION DEVICES CO.
continues to offer
CLEAN ELECTRONIC SURPLUS!

RADIO Point-to-Point Communication with F.M.

We are pleased at the requests for our bulletin describing our SCR-528 radio equipment, which are unused and complete. Each set is packed with transmitter, receiver, tubes, dynamotors for each (in either 12 or 24 volt DC models), xtals, microphone, headset, mounts, connectors, control box, antenna whip with flexible mounting and other accessories. Interphone amplifier and special beam antennas also available. All export packed. Be sure to ask for our bulletin describing its minute completeness!

MARINE, NAVIGATION & SPECIAL ITEMS:

Bludworth, Simplex Marine Direction Finder, standard binnacle type, with tubes and long (shaft) loop. In excellent condition $375.00

AR-8600 Auto Alarm, Mfg. RCA with tubes in excellent condition........ $ 0.00

Mackay 155B Transmitter, 300 watts, CW, 350—500 kcs, with tubes, AND the mate, Mackay 156B Transmitter, 200 watt CW, 5.5—17 Mc., with tubes. Both in excellent condition with one M.G. for both, requiring 115 V. DC input. All for...... $600.00

SL RADAR, Mfg. W.E. Co. New..$1600.00
SD Radar with spares, CLEAN...$ 900.00

CW-3, Mfg. Wilcox, fixed frequency receiver, for 110 V. AC use, with tubes, manual, one set of coils. NEW....$29.50

Gibson Girls (SCR-578-B) UNUSED. Complete, individually packed......... $24.50

High Power **RCA transmitter** in stock, plus other specialized items.

Offerings subject to prior sale.

Catalog on request.

COMMUNICATION DEVICES CO.
2331 Twelfth Avenue at 133rd St.
New York 27, N. Y.
Cable: Communidev Tel: WA-6-6606, 7

TUBES

• TRANSMITTING • RECEIVING • INDUSTRIAL • SPECIAL PURPOSE

Guaranteed by WELLS

Brand new, standard make tubes by the thousands are ready for immediate delivery at the lowest prices in our history. Check this list for exceptional values in magnetrons, cathode ray tubes, voltage regulators, transmitting tubes and also neon, pilot and flashlight bulbs. Be sure to order enough for future needs directly from this ad or through your local parts jobber.

TYPE	PRICE
01A	.50
1B22	5.55
1R4/1294	.85
2J22	14.85
2J31	14.85
2J32	14.85
2J38	18.95
2J48	16.55
2J158	9.85
5J23	14.85
5J29	14.95
2C26	.55
2C26A	.70
2C34	.46
2C44	1.25
2E22	1.35
2X2/879	.75
3C24/24G	.49
3AP1/906P1	2.75
3BP1	2.75
3CP1	2.75
3E29/829B	3.95
3FP7	2.95
3HP7	2.95
5AP1	3.75
5BP1	2.85
5BP4	3.95
5GP1	6.55
5HP4	5.95
12HP7	10.95
6A6	.90
6B7	.99
6C21	19.95
6H6	.52
6J5	.52
6SL7	.65
6U5/6G5	.70
7A7	.70
7C4/1203	.45
7H7	.75
7Q7	.70
10	.52
10Y	.55
12A6	.35
12C8	.35
12SH7	.45
REL21	3.65
FG17	2.95
30/VT67 For	.95
33/VT33 Walkie Talkies	.95
34	.35
RK34	.45
39/44	.34
41/VT51	.55
VT52/45SPEC	.55
46	.85
76	.55
77	.55
78	.55
83	.85
83V	.95
100R	3.45
EF50/VT250	.65
VR78	.62

TYPE	PRICE
VR90	.70
VR92	.65
VR105	.70
VR150	.70
VT127 ENGLISH	.35
VT127A TRIODE	2.55
211	.65
217C	5.95
218	4.45
282B	4.35
250R	7.85
304TH	6.55
304TL	.90
305A	12.45
305B	6.75
316A	.55
350A	2.75
350B	2.55
371A	2.55
371B	2.55
388A	6.45
417A	19.85
GL434	2.95
446A	1.55
446B	1.55
GL471A	2.95
481	4.50
WL530	24.95
WL531	19.95
532A	3.55
GL559	3.75
WL681	19.95
700B	9.95
700C	9.95
700D	9.95
702A	2.95
707B	23.25
708A	6.55
710A	2.15
714AY	9.95
715B	7.95
717A	.90
721A	3.95
721B	3.95
724B	4.25
725A	19.95
726A	19.95
726C	19.95
801A	.80
803	7.75
805	5.75
807	1.20
810	7.95
813	7.85
814	3.75
826	.49
828	4.55
829B	3.95
830B	3.75
832	2.75
832A	3.50
837	1.25
838	3.25
841	.55

TYPE	PRICE
843	.55
860	2.55
861	34.50
864	.55
865	2.55
869	24.95
869B	28.95
872A	2.45
874	2.15
878	2.15
884	1.50
885	.85
930	1.10
954	.55
955	.55
956	.55
957	.55
1005	.45
2050	.75
1148	.40
1201/7ES	.95
1616	1.25
1619	.55
1624	1.25
1625	.45
1626	.45
1629	.45
1641/RK60	.65
2051	.95

TYPE	PRICE
7193	.35
8011	2.55
8012	4.35
8020	3.25
9001	.70
9002	.65
9003	.55
9004	.55
9006	.55
CEQ72	1.55
FG105	10.95
KU610	7.45
RK20A	4.95
12X825	
2 AMP TUNGAR	2.95
RK34	.45
GL471A	.95
EF50	.70
HY615	1.25
704A	1.55
705A	2.15
707A	19.95

NEON BULBS FOR RADIO USE

TYPE	PRICE
NE 15	Price Ea. .06
NE-48	.24
NE-16	.24
NE-51	.06

Pilot and Flashlight Bulbs

Stock No.	Mazda No.	Volts	Watts	Bulb	Base	Each Price
350-40	64	6-8	E 3 CP	G-6	DC Bay	.07
350-50	1820	28	.1 Amp	T3½	Min Bay	.12
350-31	57	12-16	1.5 CP	G4½	Min Bay	.08
350-42	Spec.	12	6 Watts	S-6	Cand Scr	.13
350-20	1446	12	.2 Amp	G-3½	Min Scr	.07
350-14	49	2	.06	T-3¼	Min Bay	.06
350-15	356	120	3 Watts	S-6	Can Bay	.11
348-22	PR-10	6	.5 Amp	B3½	Min Flang	.05
350-18	1477	24	.17 Amp	T-3	Min Scr	.16
LB-101	323	3 (Aircraft)		T-1½	953	.22
350-19	Proj. Bulb	120	500 W	T-20	Med Pf	1.45
LB-103	44 (Ruby)	6-8	.25 Amp	T3½	Min Bay	.04
LB-102	1195	12-16	.50 CP	RP-11	DC Bay	.14
LB-104	313	28	.17 Amp	T-3½	Min Bay	.11
LB-105	1816	13	.33 Amp	T-3½	Min Bay	.12
LB-106	12A	12	.09 Amp 11	T-2	Tel Base	.18
LB-107	24-A2 W E	24	.75 Amp 105	T-2	Tel Base	.18
LB-108	S 14 Argon	105	2½ Watt	Med	Screw	.22

Cut Out This Page for Ready Reference

Distributors: Our standard jobber arrangement applies.

Order directly from this ad.

Manufacturers: Write for quantity prices.

WELLS SALES, INC.

320 N. LA SALLE ST., DEPT. S-L, CHICAGO 10, ILL.

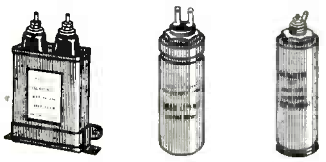
ATTENTION!

MANUFACTURERS
RESEARCH LABS
SCHOOLS
INDUSTRIALS

AMAZING SURPLUS SPECIALS

OIL FILLED CONDENSERS

Complete with mounting & hardware



Mfd.	Volts	Price
.1	7500	$2.25
.01	7500	2.25
.02	7500	2.25
.03	7500	2.25
1	5000	4.75
2	3000	2.75
1	3000	2.25
.5	3000	2.00
.1	3000	1.25
2	2000	2.25
.5	2000	1.25
4	1500	2.00
2	1500	1.75

Mfd.	Volts	Price
1	1500	1.35
.5	1500	.99
4	1000	1.45
2	1000	1.25
1	1000	1.15
.5	1000	1.05
6	600	.99
4	600	.79
2	600	.69
1	600	.59
2x1	400	.39
4	100	.39

RECEIVING TUBES

1LN5	.60	6L7	.85	39/44	.30
2A2 1	.75	6SL7GT	.50	46	.45
2D21	1.93	6SN7GT	.54	50	1.05
3A4	.40	6Y6G	.70	56	.49
3Q5GT	.50	6Z7G	1.05	77	.45
3S4	.31	12H6	.44	80	.41
5R4GY	.90	12SK7	.45	81	1.05
5T4	1.09	12SQ7G	.45	1201	.90
5Y3GT	.40	10	.39	1203A	.91
6AG7	.84	30	.40	1231	.34
6B8	.91	33	.91	1291	.91
6C5	.50	35/51	.45	1299	.60
6C6	.50	36	.45		
6E5	.60	37	.40		

NON-RECEIVING TUBES

2E22	1.40	811	1.39	1625	.37
2x2/879	.30	813	6.25	1626	.25
3B24	.44	826	.44	1629	.50
3C24	.55	829B	2.85	2C30	.70
Hy69	2.15	860	1.88	8020	2.85
371B	1.88	866A	.75	9002	.30
GL434A	7.85	874	.64	9003	.30
446A	.69	876	.54	3FP7	1.10
532A	3.95	905	8.85	3GP1	3.40
705A	1.75	955	.30	5BP1	2.25
725A	15.00	956	.49	5CP1	3.35
801A	.70	957	.30	5FP7	2.50
805	4.39	1616	1.25	872A	1.35

872A $1.35 ea. Large quantities special price on request

GET ON OUR MAILING LIST TO RECEIVE PERIODIC CIRCULARS

Limited quantity subject to prior sale. Send checks with orders unless rated. Shipping charges prepaid on orders $10.00 or over.

Distributors of nationally advertised electronic products. Special attention to industrial accounts.

MILO RADIO & ELECTRONIC CORP.

200 Greenwich St. New York 7, N. Y.

BE 3-2980

Branch:
160-13 Northern Blvd., Flushing, L. I.
Phone: FLushing 8-7425
Cable Address: MILOLECTRIC, New York

Mail orders and inquiries to New York office

APR-1 RADAR SEARCH RECEIVER, range 300-4000 mc, similar to APR-4 Receiver, 110 volts, 60 cps.

TUNING UNITS TN-19, 1000-2000 mc.

TUNING UNITS TN-54, 2000-4000 mc.

10 Cm TEST LOAD TPS-55 PB/T . . **$5.00**

S BAND RECEIVER TRANSMITTER RT-72/UPN-1, less tubes, for battery operation **$100.00**

X BAND VSWR TEST SET TS-12/AP, complete with linear amplifier, direct reading VSWR meter, slotted wave guide with gear driven traveling probe, matched termination and various adapters, with carrying case, new.

X BAND PICK-UP HORN AT-48/UP, with coaxial fitting **$5.00**

X BAND POWER LOAD TS-108/AP, new **$25.00**

SIGNAL GENERATOR MEASUREMENTS 78E, 45-85 MC, 1-100,000 microvolts, calibrated output **$100.00**

TS 155A/UP SIGNAL GENERATOR, 2700-3300 mc pulsed, calibrated output, 110 v. 60 cy. New.

TS 13/18, X BAND SIGNAL GENERATOR pulsed, calibrated output 110 v. 60 cy.

TS 9/APQ5 CALIBRATER.

S BAND MIXER, type N signal output, oscillator output and I.S. **output** connectors, variable oscillator injection. **$17.50**

MICROWAVE TEST CABLE, 15' RG-9U cable with UG-24U connectors. 15 feet long . . . . . . **$4.00** 8 feet long **$3.50**

LOSSY CABLE, 10 db at 3300 megacycles, type N connectors **$3.50**

TYPE N CONNECTORS AND ADAPTERS, UG-10, 12, 21, 22, 24, 25, 27, 29, 30, 58, 59, 83, 86, 167, 190, 201, 245 and UHF Connectors SO-239, PL-259, 83, 1AP, UG-266, complete with center contacts, immediate delivery.

RADAR JAMMER, T-26/APT-2, 435-715 megacycles, 110 volts, 400 cps, new, complete with antenna **$40.00**

COMPLETE SQ RADAR, 10 cm, 300 yards minimum, max. 3, 15, 45 miles, A, B, or P.P. I. presentation, 90-130 volts, 60 cps.

SD-3 SHIPBOARD RADAR EQUIPMENT, complete with all accessories, operates on 115 volts, 60 cps, new.

SA-1 RADAR TRANSMITTER, Receiver and Indicator, 115 volts, 60 cps, new.

RADAR RECEIVER BC 1068-A, 150-200 megacycles, individual tuning for the r.f. stages, band widths 4 megacycles, 115 volts, 60 cps, 14 tubes **$45.00**

GENERAL RADIO PRECISION WAVEMETER, type 724A, range 16 kc to 50 megacycles, 0.25% accuracy, V.T.V.M. resonance indicator, complete with accessories and carrying case, new . . **$175.00**

125/APR ANTENNA **$5.00**

TS 10/AP for APN-1 . . . . **$40.00**

TS 203/AP CALIBRATED SELSYN . **$13.00**

TEST SET I-178 CALIBRATOR **$75.00**

TELEFONE TEST SET EE-65-F **$30.00**

SYNCHRONIZER W.E. BC1043B . . . **$75.00**

SYNCHRONIZER W.E. BC1155-A . . **$50.00**

MODULATOR W.E. BC748-A, 10 kw, 1.3 microseconds, 750-850 PPS, new, less tubes **$25.00**

TRANSMITTER RECEIVER BC800M, new **$30.00**

MODULATOR BC 1007-A **$75.00**

RECTIFIER-POWER UNIT, 110 v, 400 cps, PP-4/APQ-2 . . . . **$15.00**

HI VOLTAGE SUPPLY, RA-90-A, 110 v, 400 cps **$10,00**

GO-9 TRANSMITTER, less tubes . . **$100.00**

TRANSMITTER BC-AR-230, new, less coils **$5.00**

W.E. NETWORKS, D-162630, D-162629, D-161637, D-162634 . . . . **$1.00 each.**

G.E. DELAY LINE, 4 microseconds 1000 ohms, 0-2 mc **$4.00**

TRANSFORMERS, 115 volts, 60 cps primaries:

1. 6250, 3250 and 2000 volts, tapped primary **$14.00**
2. 6250 volts 80 ma, ungrounded, G.E. **$12.00**
3. 2 secondaries at 500 volts 5 amps each, wt 210 pounds **$50.00**

PULSE INPUT TRANSFORMER, permalloy core, 50 to 4000 kc impedance ratio 120 to 2350 ohms **$3.00**

PULSE TRANSFORMER, Utah 9280 . **$1.50**

PULSE TRANSFORMER GE 68G 828G-1 . . . . **$5.00**

HYPERSIL CORE CHOKE 1 Henry, Westinghouse L-422031 or L-422032 . **$3.00**

VARISTORS WE D171528, D171628, D161871-A . . . . **75c** each.

0-350 volts, 1000 ohms per volt meter, Westinghouse **NX-35** **$4.50**

ELECTRO IMPULSE LABORATORY

6 Broad St. Red Bank, N. J.

Red Bank 6-4247

SURPLUS LABORATORY EQUIPMENT

GENERAL RADIO

805-A STANDARD SIGNAL GENERATOR $495.00
(16 Kc-50 Mc 0.1 Microvolt to 2 volts output)

620-A HETERODYNE FREQUENCY METER $375.00
(For frequency measurement between 300 Kc and 300 Mc ± 0.1%)

107-M VARIABLE INDUCTORS ..$ 35.00
(1.5 to 50 Millihenrys—new)

724-A PRECISION WAVEMETER $150.00
(16 Kc to 50 Mc—0.25% accuracy—complete—new)

821-A TWIN-T IMPEDANCE MEASURING BRIDGE $325.00
(460 Kc to 40 Mc—measures capacitance, susceptance, conductance, reactance, resistance ± 0.1%)

583-A OUTPUT POWER METER $ 60.00
(0.1 milliwatt to 5 watts, 2.5 to 20,000 ohms)

222 PRECISION VARIABLE CONDENSER ....$ 35.00
(0-1500 MMF)

775-A FREQUENCY LIMIT MONITOR $125.00
(1.6 to 45 Mc)

FERRIS

34-A U.H.F. CRYSTAL CALIBRATOR $175.00
(1, 5, 10 Mc. Crystals—useful up to 500 Mc.)

HEWLETT PACKARD

P-6255B INTERPOLATION OSCILLATOR ....$ 95.00
(510-1000 and 1280-2520 Cps.)

L & N

4223 REICHSANTALT TYPE PRECISION RESISTORS ....$ 35.00
(0.001 ohm)

7655 SINGLE RANGE PORTABLE INDICATOR AND STANDARD CELL $ 55.00

WESTERN ELECTRIC

TS5/AP RANGE CALIBRATOR..$ 65.00
(SWEEP MARKER GENERATOR) .25, 1. 5, 10 Nautical & Statute Miles—new

RA-90-A H.V. HIGH ALTITUDE POWER SUPPLIES ....$ 7.50
(+4900V, —1000V, Input 110V-400 Cps—New

D-151754 MODULATOR OIL UNIT $ 40.00
(Contains 3B24, 1B3, 6AC7, 6SN7, 3E29—new)

157-A OUTPUT TRANSFORMERS $ 9.95
(10,000 To 500 and 250 ohms—35 To 10,000 Cps ± 1 DB—New)

G. E.

LU RADAR TEST EQUIPMENT $ 50.00

INDUSTRIAL INSTRUMENTS

RN-1 WHEATSTONE BRIDGE...$ 60.00
(.001 ohm To 10 Megohms ± 0.1%)

MB-8 MEGOHM BRIDGE........$ 60.00
(1-100,000 Megohms ± 5%)

SHALLCROSS

621-H RESISTANCE LIMIT BRIDGE $ 80.00
(10 ohms To 10 Megohms ± 1% to 25 %)

WESTON

MODEL 1 (0-300 MA — D.C. ± 0.25%) $ 50.00
MODEL 1 (0-500 V.D.C. ±0.25%) $ 50.00
MODEL 45 (0-75 V.D.C. ±0.5%) $ 35.00
MODEL 45 (0-150 MA D.C. ±0.5%) $ 30.00
MODEL 45 (0-300 MA D.C. ±0.5%) $ 30.00

785 INDUSTRIAL CIRCUIT TESTER $ 80.00
(AC. DC Volts, Ohms, MA., Amps, Resistance. NEW—1-1000 Volts, 50 Microamps—10 Amps, 50 HMS—30 Megohms—Oak Case)

796 MEGOHMMETER (0-200 Megohms) $ 50.00

BOSTON GEAR WORKS

LBT-150 TWINTABLES ....$ 20.00
(Gear Reduction 150-1—New)

BOONTON

140-A BEAT FREQUENCY GENERATOR $550.00
(20 Cps to 5 Mc ± 2% Output 1 MV To 32 volts)

155-A F.M. SIGNAL GENERATOR $350.00
(1 To 11 Mc and 38 To 50 Mc.—0.1 To 1 Volt output—0-225 Kc deviation)

120-A V.H.F. CIRCUIT CHECKER $ 95.00
(3 Ranges—24-210 Mc.)

DUMONT TELEVISION CAMERAS

5027-A IMAGE ORTHICON PICKUP HEADS $2500.00
(with 5047-A Electronic Viewfinders, complete with all tubes, including 2P23 and 90 MM f.35 Ektar Lens, Factory Reconditioned)

ALL PRICES F. O. B. N. Y. C. WAREHOUSE SUBJECT TO PRIOR SALE

THE NATIONAL INSTRUMENT COMPANY

FAR ROCKAWAY, N. Y.

CABLE ADDRESS NATINSTRU, NEW YORK *TELEPHONE* FAr Rockaway 7-1123

GRAIN of WHEAT LAMPS

Used for illuminating meters, compass dials, airplane instruments, etc. Soldering iron removes lamp from base to use in models, doll houses, miniature trains, Xmas trees, etc.

Mazda G.E. 323 3V..19 A

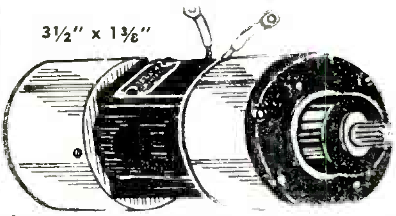
Mazda G.E. 328 6V..2 A

Photo, 3 times actual size. Glass Bulb ⅛" x ⅜"

Either type **$1.50** doz. $75.00 per M.

ALNICO FIELD MOTOR

3½" x 1⅜"



Operates on Flashlight batteries, speed depending on the voltage. Fairly strong on 6 volts, full power and speed on 27 volts. Designed to be used in bombsights, automatic pilots, etc., 250 RPM. FEW MORE AT.......... **$5.00**

A newly Written (1948) Book on Photoelectric tubes (Electric Eye) Circuits and Relays... **$1.00**
10 for $7.50

HAYDON or TELECHRON SYNCHRONOUS MOTOR

to operate switches, etc., 1 Rev. per minute at this

SPECIAL PRICE $3.85

Many other speeds available at $5.25 up

EST. 1923 **BLAN** EST. 1923

Experimenters and Inventors Supplies

64 Dey St., New York 7, N. Y.

NEW YEAR SPECIALS

0-3000 D.C. ammeter, General Electric type DB-12 with shunt ....New $39.00
0-1200 D.C. ammeter, Westinghouse type SX 6½ in. diam. with shunt ....New $19.50

REMOTE CONTROL, RM29A, similar to EE-8 for wall mounting........New $8.75

0-120 R.F. milliameter, Weston 425.....New $5.95

0-800 D.C. milliameter, Dejur 3½" square case ....New $3.95

0-300 A.C. voltmeter, Norton 4½ inch round case with external multiplier........New $7.95
0-50 A.C. ammeter, Westinghouse NA35.New $3.95
0-15 A.C. voltmeter, Roller Smith TAS 3½ inch round ....New $3.95
0-10 D.C. voltmeter, Electro Tectype 350, 3½ inch round ....New $3.95

APN-1 ALTIMETER INDICATOR — Basic movement 0-1 m.a., 5 m.a. shunt, 270° scale. An excellent basic movement for constructing your own meters........New $1.95
METER RECTIFIER, full wave midget Selenium, 10 volts, 30 M.A. ....New $0.29

ID14/APN 1 ALTIMETER INDICATOR, Westinghouse ....New $7.00
Cutler Hammer Safety Switch No. 4121H19, 30 amp., Double Pole, Fuse Mtg........New $7.95

BATTERY CHARGER, G.E. Tungar 6RB6B17, 12 battery 12 amps., 24 battery 6 amps..New $67.50
BATTERY CHARGER, Allen Unitron 2 U. S., 6-65 volts, 6-12 amps........New $49.50

RECTIFIER, General Electric, 230 volts, 3 phase, output 28V.D.C. at 130 amps. Ideal Electroplating supply etc. Used Excellent Tested O.K. $200.00
DYNAMOTOR, PE73 for BC375........New $6.95
DYNAMOTOR, PE94 for SCR522........New $4.95 Used $2.95
INVERTER, Winco PU16/AP 28V.D.C. input, 115 V.A.C. at 6.5 amps. 400 cycle output....New 20.00

WESTON ELECTRICAL TACHOMETER Model 545, for use with MOD. 724 Magneto, Speed 0-2000 RPM, Ratio 2:1...BRAND NEW—GUARANTEED $19.50
WESTON TACHOMETER GENERATOR—Model 724 Type C........Used $22.50

5" P.M. COMPARTMENT SPEAKER, 25 Watt 50-6,000 ohms Waterproof, EXCELLENT CONDITION $8.95

0-20,000 D.C. voltmeter, Weston 506 with 4 type MFA505 precision multipliers.New $49.00
Weston type MFA505 precision multipliers, 5 megohms, 5000 volts........New $12.50

Transformer, 115V.A.C. 60 cycle, output 5 volts at 190 amps., ideal for welding etc. Good condition $12.95

HEADSETS, HS-23 8000 ohms Brand New $3.25
EXTENSION CORD, CD307 with PL-55 and JK-26 ....New $0.59

Headset, HS30 complete with matching transformer, 6 ft. cord and PL-55........New $1.95
SOUND POWERED CHEST SETS......New $5.95
EE-8 TELEPHONE FIELD SETS, New $15.00, pair $28.00, Used good condition $10.00, pair $18.00

IDEAL MOBILE POWER SUPPLY
PE237—Heavy duty vibrator power supply, 6, 12, or 24 volt input, 525v, 95 ma; 105v, 42ma.; 6.5v, 2 amp.; 6v, 500ma.; 1.3v, 450 ma.; small supply—100v, 17ma.; 1.35v, 450ma. with tubes, shock mounted, Brand New........$29.50

HANDSET, TS13 for RM29A........New $3.95

PHOTOFLASH CAPACITOR, 25 mfd, 2000 V. D.C. ....New $10.00
PHOTOFLASH CABLE, 6 cond. plastic, 4000 V.D.C. insulation ....New $0.35 per ft.
TRANSFORMER, 115 V.A.C., 60 cycle, output 2500-0-2500 at 125 m.a........New $16.50

BC375 TRANSMITTER, complete with 7 tuning units, antenna tuning unit, dynamotor, and tubes. New $55.00

SCR522—Accessories, Plugs—Complete set New $4.00
BC631 Jack Box.$0.79 BC629 Jack Box.$0.79
AN104 Antenna, Steel..$1.95 Copper..$2.95
BC602 Control Box........New $1.00

CATHODE RAY TUBES

3AP1	$2.50	5BP4	$2.50
5BP1	$1.15	5CP1	$2.50

TERMS: F. O. B. Pasadena, 25% deposit required on C. O. D.

PHOTOCON SALES

1060 N. ALLEN AVE., PASADENA 7, CALIFORNIA

SPOT DELIVERY
EXCEPTIONAL VALUES

Sound powered Head and Chest Phone Sets, Used, Tested, While They Last
$12.50 per pr.

NOTE: Shipping Weight 10 lbs. Include sufficient mailing charges.

MOTORS

1/40 H.P. 3000 RPM Universal AC-DC 110 volt Shaft ¼" diam. 1¾" long, double shaft ea. $4.50
Small 110 V AC 60 cycle, open frame motor 2700 RPM Shaft ⅛" diam. ¾" long. 1/70 HP mfg. by Barber Colmann Co. ea. 2.00
Synchronous motors, 110 V AC 60 cycles 4/5, 1 1/5 RPM, 2.2 Watts, shaft ⅛" diam. ½" long. mfg. by Hayden Mfg. Co. ea $2.00
(Specify speed desired)

SWITCHES

SPST AN-3022-2B Bat Handle, Lum.Tip 6A-125V, ea. .... .25
DPDT Slide Switch Stackpole 5A 125V .... .20
SPDT Momentary, center-off, 10A 125V Long Bat Handle #8905K710 .... .30
SPDT Center off AN3022-1B Lum.Tip. 6A 125V. Bat Handle .... .30
SPST Bat Handle, 3A. 125V C-H .... .25
SPDT Bat Handle, 6A 125V H-H .... .30
DPDT Momentary, #8905K674, center off long Bat Handle, 20A 125V .... .60
DPST #AN-3023-2, 20A 125V Bat Handle .... .60
DPST Momentary, Push Type, 10A 125V .... .35
SPST Rotary. (enclosed) 6A 125V ¼" shaft H-H .... .25
SPDT Phono Radio Sw. ¼" diam. Shaft .... .15

MICRO SWITCHES

MICRO SWITCH WZ-2RL2TI, normally closed .50
With arm & roller
YZ-2RS normally closed, ea. .... .30
BZ-2RS normally open or norm closed, ea. .... .35
G-2RSTC normally open, ea. .... .30

G. E. SWITCHETTES

CR-1070C103-B3 normally open .... .35
CR-1070123-C3 norm. open or closed .... .35
CR-1070C103-K2 normally closed .... .35

WIRE WOUND RHEOSTATS

1.1 ohm 50 Watt with Switch 1.25
6 ohm 25 Watt .... .65
8 ohm 50 Watt 1.00
250 ohm 50 Watt 1.00
2500 ohm 25 Watt .... .65

PILOT LIGHT ASSEMBLIES

1" Jewel, Red, Green or Clear, with Candelabra Base similar to Drake #75 .... .60
Same as above with Miniature screwbase .... .50
Same as above with Miniature bayonet base .... .50
½" Jewel, Red or White, 6V .... .25

MISCELLANEOUS

Rectifier. Copper Oxide, full wave 110V AC input, 100V DC output at 1A. ea. $3.50
Capacitor. 500 mfd. 200 V DC used in conjunction with above rectifier 1.75
Rectifier and Capacitor. Both for 4.50
Solenoid 6V DC complete with plunger and mtg. bracket 1.25
Condenser 17mfd. 330 V AC 2.50
Shock Mounts (Lord) 75 Lbs .... .45
Lord #6 .... .20
PL-259-A connector & SO-239 socket, silver plated, for RG8U & RG11U coax, pr .... .60
Meter Multiplier, 4 megohms 14 Watts, Sprague, ea. 1.50
Fuse Posts. 3 AG. Littlefuse .... .20
PL-55 Phono Plug wwith 3' cord .... .30
Inverter 24V DC to 110V AC, 10 Watts 1.75
Thermometer 225° F. Base ¾", Standard Thread, Mfg. by Wexler 3.50

SEARCHLIGHT CARBONS

Size .433"x8¾". Spec. No. SGS (66)-122. Mfg. by Nat'l. Carbon Co. Inc. Box of 25 carbons for $1.00
Edwards Food Switch, ea. 1.00

■

No order less than $2.00. All prices F.O.B. N. Y. C. Add 25c to cover postage. 20% deposit required with all orders.

A. M. RADIO SALES CO.
RADIO PARTS

345 CANAL ST. NEW YORK 13, N. Y.
CAnal 6-9442

MARINE EQUIPMENT
Field Telephone Sets

EE-108 Sound powered field telephone sets in leather carrying cases with ringer. Equivalent in size and shape to EE-8 but is sound powered instead of battery operated. Brand new in original packing. Can be used on ships, oil fields, farms, schools, sugar and rubber plantations & etc. **Price $19.45 each**

8511 Radio Marine Corporation of America Broadcast and High frequency Radio Marine Receiver 530 to 1600 K.C. 5 to 23 M.C. 10 watt output 16 tubes 110 V DC operation. New in original export packing with spares.
Price $225.00 each

TRC-109B Western Electric small craft Transceiver 2000Kc to 3500Kc 10 watt output 12 Volt operation New in original packing with spares.
Price $195.00 each

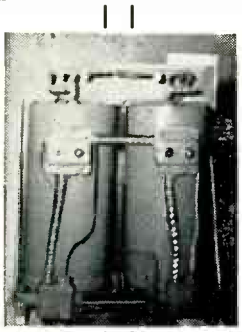
128AZ MacKay Marine receiver 15Kc to 650 Kc 110 V AC-DC 6 Volt Battery operation New with spares. **$160.00 each**

TDE Navy Transmitters 300 kc to 18000 kc complete with tubes and M.G. with output of 125 Watts A-1, A-2, 35 Watts 'phone 230 Volt DC operation. Original packing new with spares.
Price $795.00 each

Other items Bludworth Binnacle and Standard Arrow direction finders.

All material is offered subject to prior sale, F.O.B. our warehouse. Terms: Cash.

EASTERN RADIO SALES
150 Broadway New York 7, N. Y.
Worth 4-2176



The
"KELLOGG DEHYDRATOR"

An all purpose self-reactivating dehydrating unit. To be used for removing moisture from gases. Numerous applications in the fields of Physics, Electronics and Chemistry. Dual insulated tanks with thermostatically controlled heating elements. Complete with 20 lbs. of Silica gel., heating elements, shut-off and safety valves.

$62.50
F.O.B., N.Y.

INTERSTATE Appliance Co., Inc.
Dept. KD, 600 Broadway, NEW YORK 12, N. Y.

CONNECTORS

U.H.F. right angle adapter, amphenol 83-118 10 for $2.50, 100 for $20.00, 1,000 for $120.00.

Type N right angle adapter UG 27/U, 10 for $6.00, 100 for $50.00, 1,000 for $300.00.

Chassis type 4 pin slug 14S-2-10 or five pin slug AN 3102-14S-5P, 10 for $1.50, 100 for $9.00, 1,000 for $60.00.

Electro Impulse Laboratory
6 Broad Street
Red Bank, New Jersey

BARGAIN BUYS

RADAR SETS:
APR/1 with tuning unit, $150.00—also available—3 cm types.
APS/3 and APS/4 complete.
TUNING UNITS:
TN/54 for APR/4—$125.00 (New)
TUBES:

3BP-1	$3.00	723A/B	$5.00
3EP-1	3.50	725	15.00
531	2.50	726A	12.50
827R	$60.00		

METER:
3"—0-150v DC (10 ma movement) $2.50
Minimum order $5.00; F.O.B. New York
Write for listings of other surplus bargains

LERU LABORATORIES, INC.
360 Bleecker St. New York 14, N. Y.

D. C. MICROAMMETERS

0-100 ua. 4" sq. G.E. DO 58 .... $12.00
0-100 ua 4½" round Weston 643 .... 14.00
0-50 ua 4½" round Weston 643 .... 15.00
0-200 ua 3" sq. G.E. DO 50 .... 8.00
0-50 ua 3" sq. G.E. DO 50 .... 12.00

R. F. MILLIAMMETERS

0-100 Ma 3½" r. Weston 425 .... $11.00
0-120 Ma 2½" r. Weston 507 .... 7.00
0-10 Ma 4½" r. Weston (vacuum) 22.00
0-2 Ma 4½" r. Weston (vacuum) 26.00

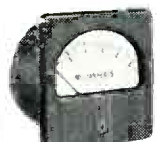
A. C. VOLTMETERS

0-300 v 3½" r. Weston 476 .... $8.00

Precision Electrical Instrument Co.
146 Grand Street New York 13, N. Y.

New "SEARCHLIGHT" Advertisements
received by December 29th will appear in the February issue, subject to space limitations.
Classified Advertising Division
ELECTRONICS
330 West 42nd St., New York 18, N. Y.

SAVE WITH SURPLUS



0-500 Microamps DC; Westinghouse RX 35, 3" Square Bakelite Case, scale 0-25 Watts, depends on ext. circuit for damping .... $4.50 ea.

10 for $40

0-1 MA DC Weston 301, 3" Rd Bake Case, scale for 0-2.5KV or 0-3KV (state first choice) ... $5.95
0-500 MA DC Weston 301, 3" Rd Bake Case ... 4.95
0-800 MA DC Weston 301, 3" Rd Bake Case .. 4.95
0-3A DC Weston 301, 3" Rd Bake Case 4.95
0-5A DC Weston 301, 3" Rd Bake Case 4.95
0-100 V.D.C. Weston 301, 3" Rd Bake Case 4.95
0-8 VAC Weston 476, 3" Rd Bake Case 4.95
0-15 VAC Weston 476, 3" Rd Bake Case 4.95
0-50 VAC Weston 476, 3" Rd Bake Case 4.95
0-200 Microamp DC Simpson 25, 3" Rd Bake Case 4.95
0-200 MA DC; GE. DO 41; 3" Rd Bake Case .. 3.50
0-5A DC; GE. DO 41; 3" Bake Case 4.50
0-800 MA DC Westinghouse, NX35 3" Rd Bake case 4.50
Landing Approach Indicator, Westinghouse, ID-24/ARN9, Dual Movements, Crossed Pointers 2.95

GENERAL RADIO STANDARDS

Type 663 ± 1% Accurate Resistors

663 A	..........1 ohm	663 E	.........20 ohms
663 B	..........2 ohms	663 F	.........50 ohms
663 C	..........5 ohms	663 G	........100 ohms
633 D	.........10 ohms	....	Any Type ... $2.95

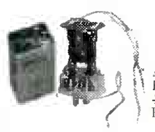
Capacitors ± 1%

505K — 0.005 MFD @ .... $2.95 | 509M — 0.02 MFD @ $3.95
Ohmite Dummy Antenna D250 250 Watt 73 ohm @ $3.95

FUSES — HOLDERS

4AG-3A Littlefuse	$1.25 C	$10.00 M
4AG-10A Littlefuse	1.25 C	10.00 M
SAG-1/33A Littlefuse	2.00 C	18.00 M
8AG-¼A Littlefuse	1.50 C	

Fuse Holder, Littlefuse 441002, 4AG . . 10¢ ea.



IF TRANSFORMER

ALLADIN GA 101 & GA 102 Polyiron Core; Air Tuned; 465KCS; Input & Output IF—Highest Quality ... Pair, $1.00

All material fully guaranteed. Minimum order $2.00. Unrated accts. all or 25% with order. All equipment new surplus. Prices F. O. B. N. Y. C.

STANDARD RADIO ELECTRICAL PRODUCTS

2260 Washington Ave., New York 5, N. Y.

Many other items available.
Send for a complete listing.

FOR SALE

1—ELECTRA VOICE 1000 watt MODULATOR using 1—(807), 3—(845), 2—(250TH), with plate supplies 4—(866A), 2—(866A).

1—ELECTRA VOICE AUDIO AMPLIFIER, 2—(6J5), 2—(2A3), 2—(100TH) with bias and plate supplies.

1—ELECTRA VOICE AUDIO AMPLIFIER 7 tubes with P.P. 807 output.

All above is INDUSTRIAL equipment.

LEA ELECTRIC EQUIPMENT CO.

359 West Chicago Ave., Chicago, Ill.

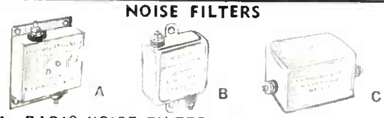
SHEET METAL MACHINERY

NEW and Used — Brakes — Shears
Forming Rolls — Folders — Punches — Di-Acro, Pexto, Niagara & Whitney Equipment.

R. D. BROOKS CO., INC.
Han. 5226
361 Atlantic Ave., Boston, Mass.

TERRIFIC VALUES on BRAND NEW U. S. GOVT. SURPLUS

NOISE FILTERS

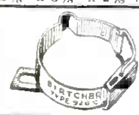


A—RADIO NOISE FILTER: 115 v Malloy #NF12-7. Keeps lash out of power line when connected at source of noise & removes lash from radio when conn. to incoming line: case gnd, lo leg of 115V line goes in term at one end & out of term at other end 3¼" x 3" x 1" .... .98

B—RADIO NOISE FILTER: 10 amp. 6-30 vdc sprague #JX-51 like sprague "Fiteral" type 2. Same lock-up as above item "A" 2⅜ mtg cent; case 2" x 2" x 1¼" .... .69

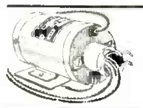
C—BATTERY MOTOR: heavy duty line filter: Malloy #NF1-1 case 3⅞" x 3⅛" x 2⅜" 1.49

BIRTCHER TUBE CLAMPS

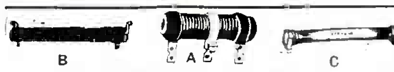


926-A	.14	926-B7	.14
926-B	.14	926-C1	.14
926-B1	.14	926-C24	.14
		929-1	.19
		930-12	.19

ADLAKE MERCURY RELAY



SP contacts normally open: 220 vac 50/60 cy. Operate time: 30 seconds—Release time: .3 seconds. Type 902-72-1 Serial #27405 $8.95



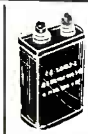
A—50 Ohm—25 Watt Adj. Res. H-H 2"L x 9/16" diam .... 25¢
B—75K Ohm—200 Watt ± 5% Tol. Fixed Res. Ohmite #0924 vitreous enameled core: 10½" x 1⅛" comp. w/clamps $1.19
C—100K Ohm — 120 Watt ± 5% tol. ferrule res sprague #120F Standard style A 9⅝"L x 1 9/64" diam. Outer shell heat treated glass; with mfg. clips $1.98

MICA TRANSMITTING CAPACITORS

Standard Brand

.0015 MFD—500 vdcu Type F2L $1.49
.002 MFD—7000 vdcu Type E .98
.005 MFD—5000 vdcu Type 6. $1.49

OIL CONDENSERS



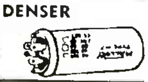
Famous Makes ● All Brands ● Guaranteed New most with ceramic pillar insulators

.1 MFD—3000 vdcu	$.75	4.0 MFD— 600 vdcu	$.69
.25 " —3500 "	1.15	6.0 " — 400 "	.75
1.0 " — 500 "	.28	10.0 " — 600 "	.98
1.0 " — 600 "	.35	14.0 " — 600 "	1.44
2.0 " — 400 "	.35	6.0 " — 600 "	.79
2.0 " — 600 "	.39	15.0 " — 600 "	1.87
4.0 " — 500 "	.59	15.0 " —1000 "	2.25

4-4-4 MFD—400 vdcu 3 section 4 prong plug-in can 4⅛" high x 3" diam $1.49

ELECTROLYTIC CONDENSER

40/40 MFD—300 vdca & 80 MFD —50 vdca, 3 section FP type can 3" high x 1⅜" Standard Brand 59¢



BATHUB CAPACITORS

Famous Makes • ALL Brands Guaranteed New oil filled bathtubs

.033/400V ... 17¢	.25/400V ... 21¢	2x.1/600V ... 29¢
.05/200V .... 13¢	.25/600V ... 23¢	2x.1/1000V .. 31¢
.05/400V .... 19¢	.5/200V .... 20¢	2x.16/600 ... 28¢
.05/600V .... 21¢	.5/400V .... 23¢	2x.25/600 ... 29¢
.1/200V ..... 17¢	.5/600V .... 25¢	2x.5/600 .... 34¢
.1/400V ..... 20¢	1.0/200V .... 22¢	3x.05/600 ... 30¢
1/600V ..... 22¢	1.0/600V .... 30¢	3x.1/600 .... 33¢
15/600V .... 23¢	22.0/600V ... 40¢	3x.25/600 ... 38¢
.25/200V .... 19¢	2x.05/1500V 33¢	3x1.0/100 ... 25¢

ELECTROLYTIC BATHTUBS

4.0/50V ..... 30¢	25/75V ..... 25¢	300/6V ..... 30¢
25/25V ..... 22¢	50/25V ..... 23¢	2x10/25V ... 20¢
25/50V ..... 23¢	200/12V .... 20¢	2x200/9V ... 35¢

Terms: 20% cash with order—balance COD—FOB our warehouse NYC

No Orders Under $5.00
Please All Merchandise Subject To Prior Sale.

ALEXANDER MOGULL CO., INC.

161 WASHINGTON ST., N. Y. 6, N. Y.

FLEXIBLE TUNING and CONTROL CABLES

Brand New — for remote control of Radio Compass Receivers and other types aircraft radio equipment.

Two series available:

MC124 Series for control of R5/ARN7, SCR269 (BC433), MN31, MN26, RA1, RA10, ARB, etc.

MC215 Series for control of SCR274N, ARC-5, RL42, etc.

Cables cut and assembled to lengths other than shown, $2.00 extra.

"T" Drive for MC124 Cable @ $3.90
Right Angle Drive for MC124 Cable @ $2.50
Right Angle Drive for MC215 Cable @ .... $.75

SPECIFICATIONS

Sub-Assembly	Series MC124	Series MC215
O. D. Flexible Casing	29/64"	11/32"
O. D. Flexible Shaft	5/32"	5/32"
Aluminum Ferrule w/flange		
O. D. Ferrule	1/2"	3/8"
O. D. Flange	9/16"	7/16"
Knurled Coupling Nut		
Length	1/2"	3/8"
Outside Diameter	25/32"	21/32"
Inside Diameter	5/8"-27thrd.	1/2"-28thrd.
Female Spline w/tapered pin-hole		
Number of teeth	12	15
O. D. Collar	27/64"	23/64"
O. D. Shoulder	15/64"	15/64"
Overall length	61/64"	61/64"

MC124 Tuning Cables Stocked in the following lengths at **$3.50** each: 4", 72", 100", 124", 139", 161", 164", 166", 168", 175", 189". 306" @ **$6.00** and 480" @ **$7.50.**

MC215 Tuning Cables in the following lengths at **$3.00** each: 36", 45", 56", 77", 79", 81", 82", 86", 91", 115", 117", 120", 127", 132", 135", 140", 154", 214", 221", 240".

War Surplus Material-Prices Net FOB Flushing, New York.

LONG ISLAND RADIO Co.

164-21 NORTHERN BLVD. FLUSHING, N. Y.

FLASH SPECIALS

FOR IMMEDIATE DELIVERY

MOTORS

Bodine Ball Bearing Reduction Gear Type R N S H—12R L/70 H.P. 1725 RPM 115V. D.C. .28 Amp Ratio 25/1 ¼" Shaft 69 R.P.M. Torq 4 Cont. Duty Temp. R. 55 Base Mount. **Bodine** Ball Bearing Reduction Gear Type........Bronze Case **$15.00**

Type Rsh-54R 1/12 H.P. 2200 R.P.M. 115V. D.C. 1.0 Amp Ratio 2.5/1 R.P.M. 880 5/16 Shaft Torq 4.1 Cont. Duty Temp. R45 Base Mount ....**$20.00 ea.**

Genl. Elect. Ball Bearing 1/60 H.P. 1725 R.P.M. 115V. A.C. 60 Cycle .7 Amp 40 Temp R. Cont. Duty Base Mount **$10.00 ea.**

Jay Electric ¼ H.P. 3450 R.P.M. D.C. Motor 230V. Arm. 30 V. Field Single Shaft Ext. Navy No. 211887..........**$15.00 ea.**

Genl. Electric Antenna Gear Motor Type G.E. 5BC44AB1643 Gear 7G 120YY18 **$40.00 ea.**

Genl. Electric Antenna Gear Motor Type G.E. 5C44AB1643 Gear 76120YY16A. **$40.00 ea.**

Electric Motor Corp. Motor. ±500 D.C. A20 Reduction Gear Motor 24V. D.C. 1/100 H.P. 244V. Arm. 24V. Fld. 21 R.P.M. Ft. Mount. ....**$20.00 ea.**

RELAYS

Automatic R. A74 Remote control Reset Stepping Twin Coil 24 to 30V./DR 10 Circuit. ....**$5.50 ea.**

Allied Control 110 Volt D.C. Double Pole Single Throw No. BO6d42 ......**$2.00 ea.**

TIMERS

Square D. Type ATOX3 Equipped with KB Interlock Calibrated 0-100 Cycles No. 899 **$15.00 ea.**

G.E. Motor Timer No. CR-1706A4 110V. 60 Cycles with Telechron Synchronous motor Type B3 I R.P.M...............**$10.00 ea.**

BLOWERS

American Blower Size & Model No. 125 Direct Control Utility Set. Ser. No. A14142 115-230 Volts 60 Cy. Fan R.P.M. 1725 Motor ⅓ H.P. G.E. 1 Phase Rotation CW Discharge B H D.................**$50.00 ea.**

Square D Switch Open Type 110V. 60 Cy. Type No. ARO30 Sq. D. No. 8990. .**$8.00 ea.**

SELSYN MOTORS

5F 5G 6G 7G 5C.T. All Makes G. E. Control Inst. Arma Bendix and Ford Instrument **Resistors** all types.

FRANKLIN SUPPLY & APPLIANCE CO.

51 INDIA STREET

Tel. HA. 6-4931 BOSTON, MASS.

ICONOSCOPES

We have available for immediate delivery 3 new 1846 RCA Iconoscopes. These are electrically and physically interchangeable with the 1848 type. Can be used in field pickups, for instruction, etc.

$250 Each

VILLAGE RADIO EQUIPMENT CO.

201 W. 16 St. New York 11, N. Y.

WESTERN ELECTRIC TRANSMITTER

TYPE T-112-B (14-C)

- Freq range 2 to 18 MC.
- Power Output: 800 w. A1, 400 w. A2 A3.
- Telephone dial 10-channel selector.
- Input: 220/3/60.

This equipment is packed in 8 cases and includes 2 cases of spares. Export crated, F.O.B. N.Y.C. subject to prior sale.

AIRCRAFT RADIO INDUSTRIES, INC.

101 Dixwell Ave., New Haven, Conn.

A/N Connectors

We have a large selection of war surplus A/N Connectors of Standard line manufacture. Our catalog will be furnished to Industrials, Manufacturers and Laboratories upon request.

MARCO ELECTRONICS, INC.

513A W. Franklin Street

Balto. 1—Md. Lex. 0198

WANTED

WANTED

W. E. Carrier Telephone and Carrier Telegraph Equipment and components. Filters, repeating Coils, Transformers, Equalizers. Type CF1, CF2, H, C, and other carrier equipment, telephone and telegraph repeaters.

W-6660, Electronics
330 West 42nd St., New York 18, N. Y.

WANTED

TS-13 18
TS-14 18
TS-33 18
TS-34 18
TS-35 18
And other test sets

W-7335, Electronics
330 West 42nd Street, New York 18, N. Y.

WANTED NEW OR USED

Crystal Mfg. Equipment • Finch Duplicators
Felker Model 80 Saws • Crystal Holders
Lapp Grinders • Crystal Blanks
Gen. Radio Freq. Standard • Electrodes
Vokel Grinders • Plating Equipment

And any other associated equipment used in the manufacture of crystals.

W 7117 Electronics
330 West 42nd St., New York 18, N. Y.

WANTED

300-1000 Mc. sig. gens., test equipment transmitters, recvrs., etc.

J. H. POOLE
1009 SECURITY BLDG.
LONG BEACH, CALIF.

WANTED
WESTERN ELECTRIC VACUUM TUBES

Types 101F, 102F, 272A, 274A or B, 310A or B, 311A, 313C, 323A, 328A, 329A, 348A, 349A, 352A, 373A, 374A, 393A, 394A, 121A Ballast Lamps.

W-6641, Electronics
330 West 42nd St., New York 18, N. Y.

WANTED, AIRCRAFT RADIOS

AN/ART-13, BC-348, RTA-1B, AN/APN-9, R5A/ARN-7, AN/ARC-1, AN/ARC-3, SCR-718, BC-788-C, I-152, MN-26-C, Test Sets with TS- or I- prefix. State quantity, condition and best price first letter.

HI-MU ELECTRONICS
BOX 105, NEW HAVEN, CONN.

WANTED

Teletypewriters complete, components or parts. Any quantity and condition.

W-6654, Electronics
330 West 42nd St., New York 18, N. Y.

WANTED

AN/TRC-1 Radio Sets, PE-214 Power Units, RA-83 Rectifiers, CF-1, 2, 3, 4, 5 and 6 Telephone Carrier Equipment.

W-7313, Electronics
330 West 42nd Street, New York 18, N. Y.

INDEX TO ADVERTISERS

Aeronautical Communications Equipment, Inc. 12
Aircraft Radio Corp 188
Allen Co., Inc., L. B 219
Allen-Bradley Co. 16
Allied Control Company, Inc 60
Alpha Metals, Inc 156
American Lava Corp 51
American Phenolic Corporation 184
American Screw Company 34
American Television & Radio Co 192
American Time Products, Inc 46
Amperite Company 178
Anaconda Wire and Cable Co 147
Arnold Engineering Company 40
Art Wire and Stamping Company 213
Astatic Corporation 175
Audak Company 254
Audio Development Company 173
Audio Devices, Inc 137

Ballantine Laboratories, Inc 146
Barber Laboratories, Alfred W 198
Barker & Williamson, Inc 57
Barry Corporation 204
Beaver Gear Works, Inc 152
Bell Telephone Laboratories 157
Bendix Aviation Corp., Pacific Div 27
Bendix Aviation Corp., Red Bank Div. 145
Bentley, Harris Mfg. Co 42
Beta Electronics Company 205
Bird Electronic Corp 194
Birtcher Corp 209
Biwax Corporation 20[illegible]
Bliley Electric Co 148
Boland & Boyce, Inc., Publishers 214
Boonton Radio Corporation 131
Borg Corp., Geo. W 36
Bradley Laboratories, Inc 208
Brand & Co., Wm 141
Browning Laboratories, Inc 180
Burlington Instrument Co 170
Burnell and Company 6

Cannon Electric Development Co 171
Capitol Radio Engineering Institute 205
Carter Motor Co 196
Central Screw Co 129
Centralab, Div. Globe-Union, Inc. 7, 11, 15
Chicago Condenser Corp 193
Chicago Transformer, Div. of Essex Wire Corp. 50
Cinch Manufacturing Corp 123
Clare and Co., C. P 49
Clarostat Mfg. Company, Inc 20[illegible]
Cleveland Container Company 215
Cohn Corporation, Sigmund 214
Collins Radio Company 52
Condenser Products Company 161
Consolidated Molded Products Corp 58
Continental Electric Co 174
Cornell-Dubilier Electric Corp 31
Craft Manufacturing Company 160
Cramer Co., Inc., R. W 154
Cross Co., H 219

Dano Electric Company 201
Daven Co. Inside Back Cover
Dial Light Company of America 202
Driver-Harris Company 47
Dumont Electric Corporation 149
Du Mont Laboratories, Inc., Allen B. 4, 38
du Pont de Nemours & Co. (Inc.), E. I. 11

Eastern Air Devices, Inc 193
Edison, Inc., Thomas A 220
Eisler Engineering Company, Inc 219
Eitel-McCullough, Inc. 43
Electric Indicator Co 195
Electrical Reactance Corp 21
Electro Engineering Works 219
Electro Motive Mfg. Co., Inc 2
Electro Products Laboratories 209
Electro-Voice, Inc. 185
Electrons, Inc. 70
El-Tronics, Incorporated 219
Engineering Associates 213
Erie Resistor Corporation 18
Essex Wire Corporation 206

Fairchild Camera and Instrument Corp. 166
Fairchild Recording Equipment Corp. 211
Federal Telephone & Radio Corp. 56, 127
Freed Transformer Co., Inc 61
Furst Electronics 199

Gamewell Company 182
General Aniline & Film Corp 17
General Cement Mfg. Co 219
General Ceramics & Steatite Corp 210
General Electric Company
Apparatus Dept. 24, 25
Chemical Dept. 55
Electronics Dept. 15, 59, 174
General Industries Co 41
General Radio Company 159
Graphite Metallizing Corp 186
Gray Research and Development Co., Inc. 210

Harvey Radio Company, Inc 198
Hathaway Instrument Company 179
Haydon Mfg. Company, Inc 164, 165
Helipot Corporation 151
Heller Sales Co., George P 201
Hewlett-Packard Company 35
Hickok Electrical Instrument Co 183

Indiana Steel Products Co 26
Instrument Resistors Company 218
Insulation Manufacturers Corp 155
International Machine Works 213
International Nickel Co., Inc 48
International Resistance Co 69
I-T-E Circuit Breaker Co 32

Jensen Manufacturing Co 19
Johnson Company, E. F 203
Jones Div., Howard B., Cinch Mfg. Corp. 220

Kahle Engineering Co 219
Karp Metal Products Co., Inc 28
Kenyon Transformer Co., Inc 182
Kester Solder Company 53
Knights Co., James 194
Kurman Electric Co 205

Lampkin Laboratories, Inc 219
Lavoie Laboratories 139
Leland, Inc., G. H 181
Lenkurt Electric Company 206
Lewis Engineering Company 191
Linde Air Products Co 205
Lord Mfg. Co 39

Mallory and Company, Inc., P. R. 72, 125
Manning, Maxwell and Moore, Inc 144
MB Manufacturing Co., Inc 20
McGraw-Hill Book Company 191
Measurements Corporation 212
Milford Rivet and Machine Co 170
Millen Mfg. Co., Inc., James 190
Miniature Precision Bearings 219
Mitchell-Rand Insulation Co., Inc 67
Mosinee Paper Mills Company 176
Mycalex Corp. of America 62, 63

National Moldite Co 166
National Varnished Products Corp 23
Newark Electric Company 213
Ney Co., J. M 218
North American Philips Co., Inc 54
Northern Radio Co., Inc 201
Nothelfer Winding Laboratories 207

Palnut Co. 212
Panoramic Radio Corporation 192
Paramount Paper Tube Corp 191
Park Metalware Co., Inc 209
Penn Rivet and Machine Co 170
Philco Corporation 16A, 16B, 16C, 16D
Polarad Electronics Company 170
Potter Instrument Co., Inc 207
Precision Apparatus Co., Inc 253
Precision Paper Tube Co 178
Premier Metal Etching Co 174
Presto Recording Corporation 10
Progessive Mfg. Company 186
Pyramid Electric Co 68

Quaker City Gear Works, Inc 172

Radio Corp. of America 150, Back Cover
Radio Receptor Company, Inc 153
Railway Express Company, Air Express Div. 168
Raytheon Manufacturing Co 135
Reeves Hoffman Corporation 158
Reeves Soundcraft Corp 163
Revere Copper and Brass, Inc 3
Richardson Company 44
Roanwell Corp., Aviometer Div 197

Sanborn Co. 166
Scientific Electric, Div. of "S" Corrugated Quenched Gap Co 178
Scott Incorporated, Hermon Hosmer 186
Secon Metals Corp 197
Shallcross Manufacturing Co 187
Sigma Instruments, Inc 71
Signal Engineering and Mfg. Co 196
Smith Paper, Inc 216
Sola Electric Company 61
Solar Electric Corporation 219
Soldering Specialties 200
Sorensen and Company, Inc 29
Sound Apparatus Co 202
Specialty Battery Company 201
Sprague Electric Company 8, 9
Stackpole Carbon Company 30
Standard Electric Time Co 215
Standard Piezo Company 190
Star Expansion Products Co., Inc 201
Steward Manufacturing Co., D. M 209
Stewart Mfg. Corp., F. W 220
Struthers-Dunn, Inc 169
Superior Tube Company 208
Sylvania Electric Products, Inc 37

Taylor Fibre Co 177
Technicraft Laboratories, Inc 199
Technitrol Engineering Co., Inc 152
Tektronix, Incorporated 211

TEL Instrument Company, Inc 148
Terminal Radio Corp 220
Thompson Corp., George S 219
Titeflex Inc. 200
Triplett Electrical Instrument Co 33
Turner Company 167

Union Carbide and Carbon Corp 205
United-Carr Fastener Corp 216
United Transformer Company
Inside Front Cover

Varflex Corporation 133
Vickers Electric Div., Sperry Corporation 13
Victoreen Instrument Company 162
Vitamite Company 213

Ward Products Corporation 182
Webster Spring Corporation 219
Welwyn Electronic Components, Inc. 193
Whistler and Sons, Inc., S. B. 5
White Dental Mfg. Co., S. S 189, 197
Whitehead Stamping Company 209
Workshop Associates, Inc 203

PROFESSIONAL SERVICES 217

SEARCHLIGHT SECTION
(Classified Advertising)

EMPLOYMENT
Positions Vacant 221, 222, 223
Selling Opportunities Offered...... 222
Positions Wanted 221, 222
Selling Opportunities Wanted...... 222
Employment Services 222

SPECIAL SERVICES
Contract Work 222
Rebuilding 222
Repairing 222

BUSINESS OPPORTUNITIES
Offered 222

EQUIPMENT
(Used or Surplus New)
For Sale 224-252

WANTED
Equipment 252

ADVERTISERS INDEX

A & M Radio Sales Co...... 250
Acousticraft Corp. 246
Airborne Instruments Laboratory...... 221
Aircraft Radio Industries Inc...... 252
American Electrical Sales Co., Inc...... 248
Bell Aircraft Corp...... 221
Bennet, Douglas T...... 222
Bendix Aviation Corp...... 223
Blan 249
Brooks Inc., R. D...... 251
Buffalo Radio Supply...... 242
Communications Devices 244
Communications Equipment Co......228, 229
Compass Communications Co...... 246
Eastern Radio Sales...... 250
EPCO 246
Electro Impulse Laboratory......247, 250
Electro Sales Co...... 241
Electronicraft, Inc. 236
Electronics Research Publ. Co...... 222
Excess Inventory Corp......230, 231
Franklin Supply & Appliance Co...... 252
Goodyear Aircraft Corp...... 222
Heath Company 243
Hi-Mu Electronics 252
Instrument Associates 239
Interstate Appliance Co...... 250
Lea Electric Equipment Co...... 251
Lectronic Research Laboratories...... 248
Leru Laboratories Inc...... 250
Life Electronics Sales...... 248
Long Island Radio Co...... 251
Marco Electronics Inc...... 252
Maritime Switchboard 233
Maxson Corp., W. L...... 222
Melpar, Inc. 223
Milo Radio & Electronics Corp...... 247
Mogull Company Inc., Alexander...... 251
National Geophysical Co., Inc...... 223
National Instrument Co...... 249
National Union Radio Corp...... 221
Niagara Radio Supply Corp......226, 227
Opad-Green Co. 244
Peak Electronics Co...... 234
Photocon Sales 249
Poole, J. H...... 252
Powertron Electrical Equip. Co...... 232
Precision Electrical Instrument Co...... 250
Radio Ham Shack, Inc...... 235
Reliance Merchandising Co...... 237
Servo-Tek Products Co., Inc...... 238
Sperry Gyroscope Co...... 221
Standard Radio-Electrical Products...... 251
Sylvania Electric Products Inc......222, 223
Tab 224, 225
Telemarine Communications Co...... 240
Universal General Corp...... 248
Veterans Salvage Co. Inc...... 248
Village Radio Equip. Co...... 252
Wells Sales Inc...... 245
Winters Radio Lab...... 222

Let MARION help you . . .

. . . seal components *hermetically*

. . . speed up sub-assemblies

Marion portable, bench-type induction soldering unit . . . .

- SMALL
- COMPACT
- ADAPTABLE
- EFFICIENT
- ECONOMICAL
- EASY-TO-USE

A PRODUCTION TOOL This unit was designed to simplify and improve both the quality and quantity of production of many different assemblies in the electronic and electrical fields. It has been used successfully for many years in the manufacture of Marion hermetically sealed instruments. Assembly applications include magnet assemblies, relay armatures, connectors, capacitors and transformer cans and germanium diode assemblies; also jewelry, watches, toys, automotive parts, household fixtures, etc.

HERMETICALLY SEALED COMPONENTS Because of the present intense interest in hermetically sealed components, Marion offers the benefit of its experience in true glass-to-metal hermetic sealing with the Marion Induction Soldering Unit and Marion metalized (platinum film) glass. Marion platinum film base glass has been developed to permit higher sealing temperatures, greater thermal shock range and resoldering if necessary.

PROFIT FROM EXPERIENCE Investigate now. Submit your requirements. We will be glad to supply samples and quotations. Ask for bulletin.

MANUFACTURERS OF HERMETICALLY SEALED METERS SINCE 1944

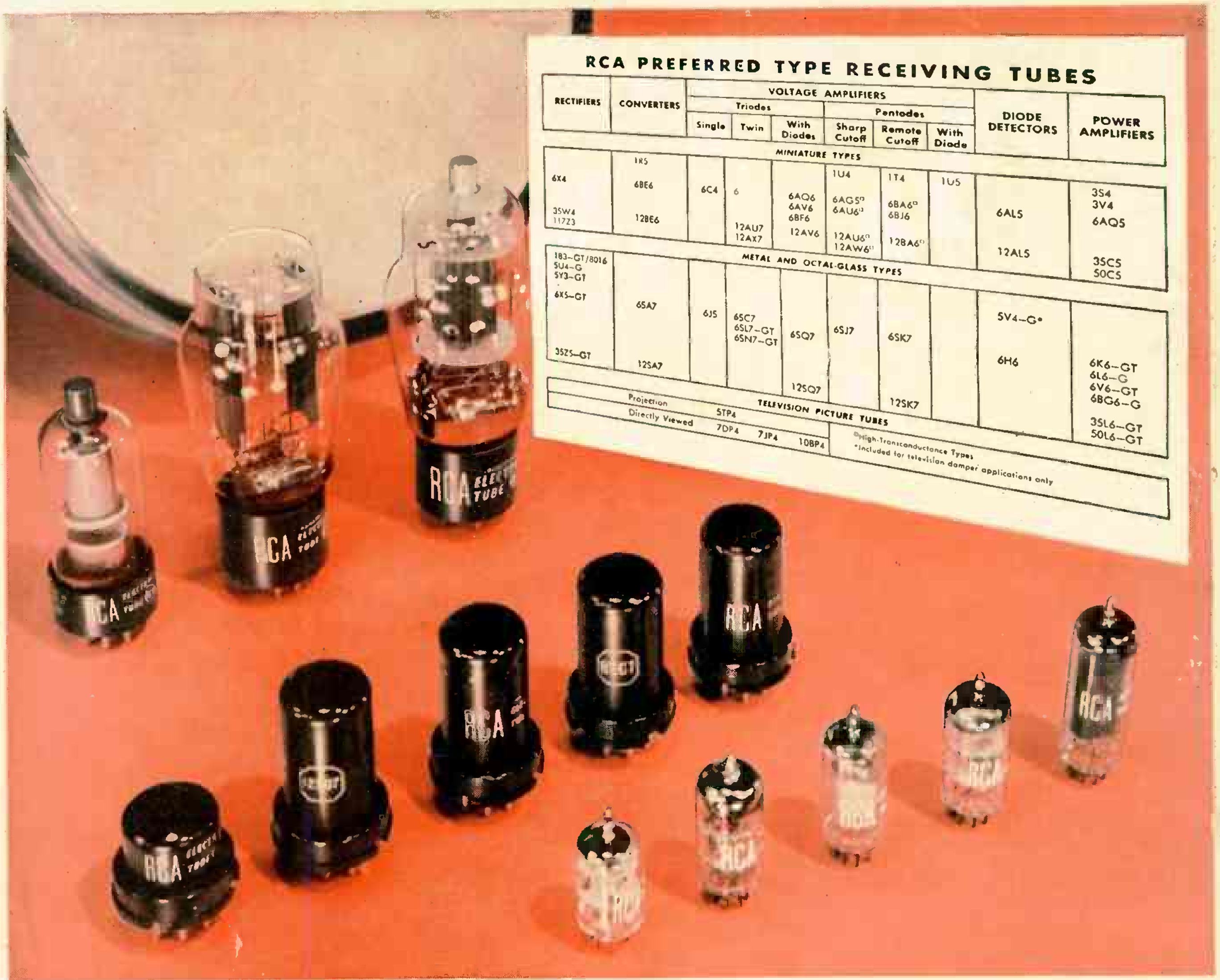
M·E·I

MARION ELECTRICAL INSTRUMENT COMPANY

MANCHESTER, NEW HAMPSHIRE

Export Division, 458 Broadway, New York 13, U. S. A., Cables MORHANEX

IN CANADA: THE ASTRAL ELECTRIC COMPANY, SCARBORO BLUFFS, ONTARIO



The RCA List of Preferred Type Receiving Tubes fulfills the major engineering requirements for future receiver designs.

Most likely to succeed . . .

RCA preferred type tubes for AM, FM, and TV receiver designs

WHETHER IT'S GLASS, metal, or miniature—RCA *preferred type* receiving tubes will serve your major requirements for a long time to come . . . and RCA preferred types are the tubes you can bank on for your future designs.

These RCA receiving types are especially recommended because their wide-spread application permits production to be concentrated on fewer types. Longer manufacturing runs reduce costs—lead to improved quality and greater uniformity. These benefits are shared by you and your customers.

RCA Application Engineers are ready to suggest the best preferred types for your receiver design requirements. Just contact our nearest regional office—or write RCA, Commercial Engineering, Section 42AR, Harrison, New Jersey.

The Fountainhead of Modern Tube Development is RCA

TUBE DEPARTMENT
RADIO CORPORATION of AMERICA
HARRISON, N. J.