OPEN HEARTH-FURNACE TEMPERATURES
FOR HEARING AIDS 
VEST POCKET RADIOS 
AIR BORNE DEVICES

UTC SUB-OUNCER SERIES

UTC Sub-Ouncer units are 9/16" x 5/8" x 7/8" and weigh only 1/3 ounce. Through unique construction, however, these miniature units have performance and dependability characteristics far superior to any other comparable items. The coil is uniform layer wound of Formex wire . . . on a molded nylon bobbin . . . insulation is of cellulose acetate . . . leads mechanically anchored (no tape) . . . core material Hipermagnetic alloy . . . entire unit triple (waterproof) sealed. The frequency response of these standard items is ± 3 DB from 200 to 5,000 cycles.

<table>
<thead>
<tr>
<th>Type</th>
<th>Application</th>
<th>Level</th>
<th>Pri. Imp. D.C. in Pri.</th>
<th>Sec. Imp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO-1</td>
<td>Input</td>
<td>+ 4 V.U.</td>
<td>200</td>
<td>250,000</td>
</tr>
<tr>
<td>SO-2</td>
<td>Interstage</td>
<td>-4 V U</td>
<td>10,000</td>
<td>90,000</td>
</tr>
<tr>
<td>SO-3</td>
<td>Plate to Line</td>
<td>+ 23 V U</td>
<td>25,000</td>
<td>500</td>
</tr>
<tr>
<td>SO-4</td>
<td>Output</td>
<td>+ 20 V U.</td>
<td>50,000</td>
<td>100</td>
</tr>
<tr>
<td>SO-5</td>
<td>Rectifier 50 Hz at 1 mil. D.C.</td>
<td>300 ohms D.C. Res.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

UTC OUNCER SERIES

The standard of the industry for seven years. The overall dimensions are 7/8" diameter by 1-3/16" height including lugs. Mounting is effected by two screws, opposite the terminal board side, spaced 11/16". Weight approximately one ounce. Units not carrying D.C. have high fidelity characteristics being uniform from 40 to 15,000 cycles. Items with D.C. in pri. are for voice frequencies from 150 to 8000 cycles.

<table>
<thead>
<tr>
<th>Type</th>
<th>Application</th>
<th>Pri. Imp.</th>
<th>Sec. Imp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>Mike pickup or line to I grid</td>
<td>50, 200, 300</td>
<td></td>
</tr>
<tr>
<td>0-4</td>
<td>Single plate to 1 grid</td>
<td>8,000 to 15,000</td>
<td></td>
</tr>
<tr>
<td>0-5</td>
<td>Single plate to 1 grid, D.C. in Pri.</td>
<td>8,000 to 15,000</td>
<td></td>
</tr>
<tr>
<td>0-6</td>
<td>Single plate to 2 grids</td>
<td>8,000 to 15,000</td>
<td></td>
</tr>
<tr>
<td>0-8</td>
<td>Single plate to line</td>
<td>50, 200, 300</td>
<td></td>
</tr>
<tr>
<td>0-9</td>
<td>Single plate to line, D.C. in Pri.</td>
<td>8,000 to 15,000</td>
<td></td>
</tr>
<tr>
<td>0-12</td>
<td>Mixing and matching</td>
<td>50, 200, 300</td>
<td></td>
</tr>
<tr>
<td>0-13</td>
<td>Reactor, 200 Hz to 5000 D.C. 50 Hz-75A</td>
<td>50, 200, 300</td>
<td></td>
</tr>
<tr>
<td>0-14</td>
<td>Reactor, 50 Hz-75A D.C. 500 ohms</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Manufacturers: Our experience in building hundreds of thousands of Ouncers and sub-ouncers is yours for the asking. Special types, and mountings are readily available. U.T.C engineers can help you save weight and space in the design of miniature equipment.
OPEN HEARTH FURNACE TEMPERATURE TEST . Cover

Radiation from 4,000-degree flame gives check on steel-melting efficiency at Trenton plant of John A. Roeblings Sons Co. (see page 102)

ELECTRONICS AT BIKINI, by D. G. Fink and Captain C. L. Engleman . 84

First published details of Crossroads electronics program

WIDEBAND MICROWAVE AMPLIFIER TUBE . 90

Electron coupling within the tube, to a nonresonant circuit, gives unusually wide band and high gain

DUPLEX OPERATION OF INDUCTION HEATERS, by W. C. Rudd . 93

Two units can be connected in parallel for double power or switched back to single operation within one minute

DESIGN OF F-M SIGNAL GENERATOR, by Donald M. Hill and Murray G. Crosby . 96

Circuit date of reactance modulator for constant deviation of a variable oscillator

FLAME RADIATION MEASURING INSTRUMENT, by Edward M. Yard . 102

Bridge-type vacuum-tube voltmeter with radiation pyrometer checks efficiency of open-hearth steel furnace

LOGARITHMIC PHOTOMETER, by Monroe H. Sweet . 105

Logarithmic response is obtained from multiplier phototube by means of electronic feedback

CONTINUOUSLY VARIABLE RADIO REMOTE CONTROL, by David Wm. Moore, Jr. . 110

A servo motor automatically resonates its own circuit to the supply frequency

NOISE AND OUTPUT LIMITERS—PART I, by Emeric Toth . 114

Survey, presenting basic limiter circuits with parts values, analysis of operation, and performance data

TEST OSCILLOSCOPE FOR TELEVISION STATIONS, by A. H. Brolly and W. R. Brock . 120

Sound-broadcasting modulation measurement techniques are permitted by the use of modified equipment

TWO-WAY RADIO FOR POWER LINE CREWS . 123

Description of 37.18-mc f-m system used for dispatching service trucks to line breaks in emergencies

COMPONENTS OF UHF FIELD METER, by Eduard Karplus . 124

Tuned circuits, attenuator, and voltmeters that are suitable for uhf are described

CONSTANT CURRENT CIRCUITS, by G. J. Wheeler and O. T. Fundingsland . 130

Corrective networks applied to exponential circuits improve current linearity

VHF ANTENNA FOR TRAINS, by E. G. Hills . 134

Design and characteristics of a five-inch high, vertically polarized antenna

MUTUAL INDUCTANCE OF CONCENTRIC COILS, by T. C. Blow . 138

Nomogram gives coil dimensions to produce a specified mutual inductance in r-f transformers

BUYERS' GUIDE ADDITIONS AND CORRECTIONS . 217

Changes and additions to be used as a supplement to the 1946-47 guide

CROSSTALK 83 ELECTRON ART . 194 NEW BOOKS . 284

TUBES AT WORK . 140 NEW PRODUCTS . 220 BACKTALK . 290

INDUSTRIAL CONTROL . 178 NEWS OF THE INDUSTRY . 248 INDEX TO ADVERTISERS . 298

KEITH HENNEY, Editor; DONALD G. FINK, Executive Editor; W. W. MacDonald, Managing Editor; John Markus, Vin Zeluff, Associate Editors; Frank Rockett, A. A. McKenzie, Assistant Editors; Frank Haylock, Los Angeles Editor; Gladys T. Montgomery, Washington Editor; Jeanne M. Heron, Make-up Editor; Jeanne E. Grolmund, Editorial Assistant; Harry Phillips, Art Director; Eleanor Luke, Art Assistant

H. W. MATER, Publisher; WALLACE B. BLOOD, Manager; J. E. Blackburn, Jr., Director of Circulation; Dexter Keeler, Director, Economics Department; John Chapman, World News Director; D. H. Miller, H. R. Dunmead, Jr., New York; Ralph H. Flynn, H. D. Randall, Jr., New England; F. P. Coyle, R. E. Miller, Philadelphia; C. D. Wardner, Chicago; E. J. Smith, Cleveland; J. W. Otterson, San Francisco; Ray H. Phelan, Los Angeles; Ralph C. Moulton, Atlanta

Contents Copyright, 1946, by McGraw-Hill Publishing Company, Inc. All Rights Reserved. McGRAW-HILL PUBLISHING COMPANY, INCORPORATED, JAMES H. McGraw, Founder and Honorary Chairman; J. L. B. Cotton, J. J. Hogan; 16:10106 - President; Hugh M. Duggan, Vice-President; Donald G. Fink, Executive Editor; Robert A. Held, Manager, Advertising Operations; John W. Rosenthal, Manager, Experiments; Thomas J. Keenan, Executive, Director of Advertising; Eugene O'Donnell, Editorial Assistant to the President; Joseph A. Vonrath, Secretary; and J. J. Hogan, Jr., Vice-Pres. for Technical and Educational Operations. EDITIONS: November, December, January, February, March, April, May; C fixing, June, July, August, September; October, November, December. All communications about subscriptions should be addressed to the Director of Circulation. For Classified Advertising, 10-1026-334; for Classified Display, 10-1026-335. Subscription rates—United States and possessions, $5.00 per year; Canada (Canadian funds accepted) $2.60 per year; other countries $8.00 per year. Single copies 50 cents. "Back Issues" at a special price of $4.25 per copy. Subscription orders for two years, $4.00 per year; for three years, $14.00 for three years. Fn: American edition for the first two years, 25.00 for two years, $15.00 for three years. All other countries $10.00 for one year, $15.00 for three years. Available by subscription only to radio workers, broadcast engineers of radio stations, radio research laboratories, schools and individuals. Limited supply available to others. Regular rates to new customers; August 25, 1938, to Paul Allen, AJA, New York, under the cover of March 1, 1939, BR-15-7. 21 at 212 New York Avenue, Chicago 11, 82 10th Street, San Francisco 4; Addyton Hale, 11111 London, V. O. S. Westmore, 20; E. R. D. Phelan, Chicago 13, D. L. J. 7 10th Street, Atlanta 2, Ga.; 611 Be. Hope Bl., Los Angeles 14, A. R. P. New Bedford, 15.
These data explain the outstanding performance of Tobe “Oil-Mites” ... demonstrate their qualifications for use under extreme humidity and temperature environment ... show the diversity of mounting provisions, sizes, housings, and electrical ratings for convenient incorporation in electronic and electrical apparatus.

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

### With Attached Channel Bracket

<table>
<thead>
<tr>
<th>VDC</th>
<th>Case A</th>
<th>Case B</th>
<th>Case C</th>
<th>Case D</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>—</td>
<td>.01 — .25</td>
<td>.01 — 1.0</td>
<td></td>
</tr>
<tr>
<td>200</td>
<td>—</td>
<td>—</td>
<td>2 x .05, 2 x .1</td>
<td></td>
</tr>
<tr>
<td>400</td>
<td>—</td>
<td>2.0</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>600</td>
<td>.01 — 1.0</td>
<td>—</td>
<td>.01 — .25</td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td>.05 — .50</td>
<td>1.0</td>
<td>—</td>
<td></td>
</tr>
</tbody>
</table>

### With Reversible Hold-Down Bracket

<table>
<thead>
<tr>
<th>VDC</th>
<th>Case E</th>
<th>Case F</th>
<th>Case G</th>
<th>Case H</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>—</td>
<td>.01 — .25</td>
<td>.01 — 1.0</td>
<td>4.0</td>
</tr>
<tr>
<td>200</td>
<td>—</td>
<td>2 x .05, 2 x .1</td>
<td>2 x .05, 2 x .1</td>
<td>—</td>
</tr>
<tr>
<td>400</td>
<td>—</td>
<td>.01 — .5</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>600</td>
<td>.01 — 1.0</td>
<td>2 x .05, 2 x .1</td>
<td>.01 — .25</td>
<td>.05 — 1.0</td>
</tr>
<tr>
<td>1000</td>
<td>—</td>
<td>.01 — .1</td>
<td>—</td>
<td></td>
</tr>
</tbody>
</table>

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

Reprints of this specification page are available and will be sent on request. For detailed data on “Oil-Mites” and other Tobe Capacitors ask for Catalog 4611-E.
Creative men... engineers and engineering draftsmen... plan and build things to last. By the same token they look for instruments and equipment that will last. The tracing paper they draw on must be permanent. Their drawings must serve as lasting records. They may even have to use these same drawings years later to make new reproductions.

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

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

640 PAGES OF RELAY ENGINEERING INFORMATION... Have you gotten your copy?

Price $3.00

STRUTHERS-DUNN, INC., 1321 ARCH STREET
PHILADELPHIA 7, PA.

STRUTHERS-DUNN
5,327 RELAY TYPES

ATLANTA • BOSTON • BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • DALLAS
DENVER • DETROIT • HARTFORD • INDIANAPOLIS • LOS ANGELES • MINNEAPOLIS • MONTREAL
NEW YORK • PITTSBURGH • ST. LOUIS • SAN FRANCISCO • SEATTLE • SYRACUSE • TORONTO
want to strike a new note in your product?  

use RESINOX

Here is another ideal example of complete harmony between material and product needs. Resinox... now being used in large area moldings... meets the following important requirements for this attractive new-style electric guitar:

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

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

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

TECHNICAL INFORMATION ON HIGH NICKEL ALLOYS FOR...

Low Expansion
Temperature Compensation
Glass Sealing
Magnetic Permeability

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

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

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

Typical Applications for Carpenter High Nickel Alloys

- Watt-hour meter permanent magnet assembly with shaft of Carpenter Temperature Compensator “30”.
- Thermal switch using Carpenter Low Expansion “42” for low expansion struts as indicated.
- Water heater thermostat employing Carpenter Free-Cut Invar “36” together with a high expansion alloy.
- High wattage lamp with ferrules of Carpenter Glass Sealing “42” used to bring out leads.

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

November, 1946 — ELECTRONICS
A LONG AND
STABLE LIFE...

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

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

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

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

THE SHAPE OF THINGS: More than 200 theoretical shapes for the VC50 electrodes were tested in the electrolytic bath. Resulting lines-of-force curves dictated the shapes finally adopted. These spread the fields of force, eliminating destructive concentrations. It was discovered, also, that elements carrying high frequency current had to offer surface areas much larger than those which had contented older practice. Wires even of comparatively large diameter were found electrically insufficient and in addition, presented mechanical hazards. Elimination of current-carrying welds was indicated. Basic developments and numerous manufacturing refinements growing out of these tests were built into the Amperex VC series. They are responsible for outstanding performance records.
EACH day brings a greater number of active amateurs to the ham bands. If you want successful QSO's you need a scientifically designed filter to give the exact degree of selectivity necessary to avoid QRM. The uniformly smooth response curve of the HQ-129-X filter also makes it ideal for Narrow Band FM.
WHISTLER Adjustable Perforating Dies Offer Added Production Economy

5-10-50 and even more different set-ups with the same dies? Impossible? Not when you use Whistler Multi-Use Adjustable Dies. For it's simple to rearrange these units...add or delete...get back into production within a few hours. Even so-called complicated arrangements are easy to set up. And, with first cost invariably less than for single purpose dies, this continued re-use of the same dies effects added economy in quickly writing off initial die investment. Over 750 prominent manufacturers have proven in their own plants that Whistler Adjustable Dies have sent costs into a nose dive.

No special tools are needed. Work in practically any size and type of press. Ordering now is particularly advantageous. Large stocks of standard diameter units from 5/32" up are available for overnight shipments. Notching, group dies and special shapes and sizes can be quickly made to order. Write today to:

S. B. WHISTLER & SONS, Inc.
752-756 Military Road
Buffalo 17, New York

WRITE FOR YOUR WHISTLER CATALOGS. Know the production advantages of Whistler Adjustable Dies.
"Hey, You're Sitting On My Production Costs!"

I wrote a delighted manufacturer of electrical household appliances.

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

Perhaps we can help you with some special capacitor problem. Write us.

Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey. Five other plants in New Bedford, Providence, Worcester and Brookline.

MICA • DYKANOL • PAPER • ELECTROLYTIC

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

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

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

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

CAPACITOR #4. Tubular paper capacitor for bypass applications in radio receivers. This unit is encased in a metal tube which is then fully insulated with a cardboard sleeve. Meets all UL requirements for non-combustible case type capacitor.
The job of a vacuum tube designer would really make you tear your hair. Drawing mainly on long experience — only the bare principles of tube design are found in books — the design engineer must co-ordinate the innumerable interlocking characteristics you specify.

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

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

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

a new bar contact tape service
by D. E. MAKEPEACE COMPANY
under license arrangement with
WESTERN ELECTRIC COMPANY, INC.

Further broadening our outstanding position in the laminated precious metal field, we are proud to announce our appointment as a licensee under Western Electric patents for manufacturing bar contact tape and attaching this tape to contact arms.

These bar contacts may be made in bi-metallic form of palladium, platinum or silver, pure or alloyed, on nickel or nickel silver...or in solid form of any precious metal or alloy. We are now prepared to—

... supply bar contact tape for your own attaching
... attach bar contact tape to arms supplied by you
... provide complete assemblies of arms with tape attached

These new bar contacts result in a great saving of precious metals with larger contact area and with marked economy in attaching. Let one of our sales engineers help you compare the cost of our attached tape contacts with conventional types.

START RIGHT with

Makepeace PRODUCTS
SHEETS • WIRE • TUBING • SOLDERS • FABRICATED PARTS AND ASSEMBLIES
OF SOLID AND LAMINATED PRECIOUS METALS

D. E. MAKEPEACE COMPANY
Main Office and Plant, Attleboro, Massachusetts
NEW YORK OFFICE, 30 CHURCH ST. CHICAGO OFFICE, 55 EAST WASHINGTON ST.
"Temper Is Unaffected ... Output Is Up 200%!"

Says Mr. Warren Hastings, Plant Manager, ROCHESTER MFG. CO.

"MAINTAINING TEMPER of materials during soldering operations used to be a real test for our tempers! But now that we've installed our new Allis-Chalmers Induction Heater, we're able to apply just the right amount of heat to form an air-tight seal between our assembled parts. Not only does the temper of the materials remain unaffected, but now the operation is so simple that production tripled, and one man handles the entire job!"

These results are typical of how electronic induction heat solves problems of soldering, brazing and hardening metals... does better, faster work at lower cost!

If you have a similar job to do, or one which you think can be improved, why not let A-C's experts help you. Send samples to our modern process laboratories for careful analysis, estimates of per-piece production, and equipment costs. No obligation. Meanwhile, write for our educational bulletin 14B6430. ALLIS-CHALMERS, MILWAUKEE 1, Wis.

ALLIS CHALMERS
INDUCTION HEATERS

One of the Big 3 in Electric Power Equipment
Biggest of All in Range of Industrial Products

ELECTRONICS — November, 1946

www.americanradiohistory.com
NEW! WESTON Mutual Conductance Tubechecker and Circuit Analyzer

Outstanding Features

- Direct-reading mutual conductance tests, and "Good-Bad" indications.
- New patented high frequency tube testing circuit.
- AC-DC volt-ohm-milliampere ranges.
- Tests 4, 5, 6, 7 prong octal, loctal, miniature, and acorn tubes...spare octal and miniature sockets.
- Hot neon leakage test between any two tube elements...neon short check.
- Adjustable plate, screen, grid bias, and signal voltages.
- Flexibility in switching simplifies testing present and future tubes.
- Durable heavy-gauge, light-weight aluminum case.

Model 798 combines broad utility, ruggedness, and dependable accuracy for maintenance of sound and electronic equipment. Detailed bulletin available. Weston Electrical Instrument Corporation, 618 Frelinghuysen Avenue, Newark 5, New Jersey.
In all these years of concentration on custom made technical ceramics, the American Lava Corporation has developed special equipment, practical skill and specialized engineering knowledge available from no other source.

Complicated shapes, obtainable only by machining, can be produced quickly on high speed semi-automatic turning and milling equipment. Surprisingly low prices are possible. Send your designs and let us review them from our production standpoint, submit recommendations, and show you what American Lava can do for you.

Chart of the physical characteristics of the more frequently used ALSIMAG compositions sent free on request.

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

www.americanradiohistory.com
YOU’VE EVERYTHING TO GAIN BY GETTING IN TOUCH WITH

Accurate

FOR THE SPRINGS YOU NEED

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

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

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

WRITE FOR THE ACCURATE HANDBOOK ON SPRINGS

Springs

Wire Forms • Stampings

November, 1946 — ELECTRONICS
Using Strength, Light Weight, and Finish

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

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

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

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

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

SYNTHANE CORPORATION • 6 RIVER ROAD • OAKS • PENNSYLVANIA
SOME THINGS YOU MAY NOT KNOW ABOUT LAMINATED PHENOLIC PLASTICS

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

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

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

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

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

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

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

*An approximately 1200-page compendium of plastics issued by the publishers of Modern Plastics.
How Big is an EL-MENCO Capacitor? The physical dimensions are small but in terms of performance, each capacitor is a giant. The same sterling qualities that helped maintain vital communications for the Armed Forces under grueling wartime conditions are in every EL-MENCO Capacitor that goes into your circuit.

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

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

*Foreign Radio and Electronic Manufacturers communicate direct with our Export Department at Willimantic, Conn. for information.*
COMMON SENSE ASSEMBLY ENGINEERING

Makes Child's Play of a Tough Assembly Job

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

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

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

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

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

Sold Only Through Accredited Distributors

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

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

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

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

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

**ELECTRICAL CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Nominal Attenuation (db/100 ft.)</th>
<th>Maximum Capacity Unbalance</th>
<th>Nominal Characteristic Impedance (ohms)</th>
<th>Nominal Capacitance per ft. (uuf)</th>
<th>Volts (rms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 mc</td>
<td>1%</td>
<td>95</td>
<td>16</td>
<td>2000</td>
</tr>
<tr>
<td>30 mc</td>
<td>0.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 mc</td>
<td>1.7</td>
<td>3.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>300 mc</td>
<td>7.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>400 mc</td>
<td>10.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Federal Telephone and Radio Corporation

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

Newark 1, New Jersey

ELECTRONICS — November, 1946
DuMont has many accessories for your Cathode-Ray Equipment...

**CALIBRATED SCALES**

Provide a convenient means for making calibrated and quantitative measurements with a cathode-ray oscillograph. Types 216 are available in 3-inch and 5-inch rectangular coordinate scales calibrated in inches and tenths of inch; also in 5-inch polar coordinate scales. 5-inch logarithmic scales are also available for direct-reading of logarithmic decrements or Q measurements.

**COLOR FILTERS**

Increase contrast and relieve eye-strain by filtering out all but the desired light. Available in the 5-inch size for use with blue, green or amber screens. Made of plexiglass which fits between the calibrated scale and the face of the cathode-ray tube.

**VIBRATION PICKUPS**

Types VP-5 and DP-1 convert vibrations into electrical potentials which can be applied to the input circuit of the oscillograph. The response of the VP-5 is proportional to velocity; that of the DP-1 is proportional to displacement. The DP-1 is especially suited to low-frequency work.

**VIEWING HOOD**

Use our Type 276 rubber viewing hood to shield the eyes and the tube screen when observing oscillographic patterns under unfavorable ambient light conditions. It fits any oscillograph equipped with a 5-inch cathode-ray tube.

**CRYSTAL MICROPHONE**

The Type 277, of unusually high impedance, is specially designed for direct connection to cathode-ray oscillograph input circuits. The directional response is practically circular in both horizontal and vertical planes at all audio frequencies.

**CONSTANT-VOLTAGE TRANSFORMER**

A "must" where irregularity of supply voltage interferes with the performance of oscillographic equipment. The Type 283 is designed for operation from 60-cycle, single-phase alternating current. It delivers a constant secondary-output potential of 115 volts, at loads up to 250 volt-amperes, for input-potential variations from 95 to 125 volts.

Write for descriptive literature

© ALLEN B. DUMONT LABORATORIES, INC.
SEND FOR OUR NEW 4-PAGE GEAR CATALOG

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

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

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

SIMPLICITY of installation and wiring results in reduced costs.

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

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

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

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

WARD LEONARD
RELAYS • RESISTORS • RHEOSTATS

WARD LEONARD ELECTRIC COMPANY
32 SOUTH STREET, MOUNT VERNON, N.Y. • OFFICES IN PRINCIPAL CITIES

November, 1946 — ELECTRONICS
"These are Good Numbers

- make a note of them!

The wells of each painted calibration, numeral and character are deeply depressed — sharp, clear, clean-cut! To achieve these results, Consolidated begins by engraving the scales into the steel hob. Then when the cavities are hobbed in mild steel, the characters are raised so as to produce a molding depth sufficient to anchor and hold the paint — permanently!

Should you be planning dial elements — identification knobs — or any plastic part incorporating calibration — we'd like you to know that our way with numbers makes them stand out — and not rub out! Inquiries invited.

Consolidated
MOLDED PRODUCTS Corporation
309 CHERRY STREET, SCRANTON 2, PA.

ELECTRONICS — November, 1946
This cross section of a MYCALEX-to-metal molded component part was made for one of the country’s leading manufacturers, and is the result of close cooperation between the customer’s and our own engineering staffs. It exemplifies a new development in the molding of MYCALEX 410 with metal to form a hermetic seal.

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

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

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

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

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

Contributing to the built-in ruggedness of this Chatham type 3B28 rectifier are vital Callite tungsten welds and filaments. Because of their inherent stamina and ready adaptability, this tube is better able to stand the "gaff" of high voltage service.

Chatham Electronics designed the 3B28 rectifier to withstand heavy vibration and shock, to operate normally through an ambient temperature range of -75°C to +90°C. This required tube components of high current carrying capability and great mechanical strength. That is why Chatham called on Callite for this vital job.

Leading electronic manufacturers have been relying for many years on Callite tube and lamp components. They have discovered that our 26 years of metallurgical pioneering produce parts which safeguard the life and performance of their products. If you have a particularly exacting or unusual problem, we can help you solve it. Consult with our engineers for practical suggestions and benefit from their successful experience. Callite Tungsten Corporation, 544-39th Street, Union City, New Jersey. Branch Offices: Chicago and Cleveland.
YES—there's plenty of power behind the usual electric connection to burn out any electrical instrument or equipment not properly protected—if something goes wrong!

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

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

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

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

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

LITTELFUSE Plus FEATURES!

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

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

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

ELECTRONICS — November, 1946
MITCHELL-RAND

- the one dependable central source of supply for everything in electrical insulation

MITCHELL-RAND INSULATION COMPANY, INC.
51 MURRAY STREET
Cortlandt 7-9264
NEW YORK 7, N.Y.

Fiberglass Varnished Tape and Cloth
Insulating Papers and Twines
Cable Filling and Felted Compounds
Friction Tape and Splice
Transformer Compounds

A PARTIAL LIST OF M-R PRODUCTS
Fiberglass Saturated Sleeving, Varnished Tubing
Asbestos Sleeving and Tape
Varnished Cambric Cloth and Tape
Mica Plate, Tape, Paper, Cloth, Tubing

Fiberglass Braided Sleeving
Carbon Tape, Webblings and Sleeving
Impregnated Varnish Tubing
Insulating Varnishes of all types
 Extruded Plastic Tubing

November, 1946 — ELECTRONICS
...for clear, crisp, intelligible Speech Reproduction

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

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

MODEL AR-10 SPEECH MASTER ALNICO 5 design. Specially constructed reflex horn increases efficiency in mid-frequency range, giving added effectiveness and "punch" to speech quality; prevents direct access of rain and snow to speaker diaphragm. Voice coil impedance, 4 ohms and 45 ohms; power rating, 6 watts. Space provided inside for 1/2" x 1/2" transformer. Overall diameter 10"; depth 8". Complete with mounting bracket.

MODEL AP-10 SPEECH MASTER (Desk or Wall type). Similar to AP-10 but without base. Mounts in 4-27/64" cut-out; clearance eyelets for mounting screws. Depth 4-1/4" from front panel. Screws and drilling template included. Voice coil impedance 4 ohms or 45 ohms; power rating, 5 watts.

MODEL AP-11 SPEECH MASTER (Panel mounting). Similar to AP-10 but without base. Mounts in 4-27/64" cut-out; clearance eyelets for mounting screws. Depth 4-1/4" from front panel. Screws and drilling template included. Voice coil impedance 4 ohms or 45 ohms; power rating, 5 watts.

MODEL AP-10 SPEECH MASTER (Desk or Wall type). PM design. Desk or wall mounting. Complete with base and tilt adjustment. Double dustproofed, rubber covered 36" cord. Internal mounting bracket for 1/2" x 1/2" transformer. Voice coil impedance 4 ohms or 45 ohms; power rating, 5 watts. Height 6-3/4"; depth 4-1/8"; diameter 5". Finish hammered gray with satin chrome trim.

MODEL NF-300 SPEECH MASTER (Navy Type). Developed for use as a loud speaker and microphone. Special case design over-rides wind and background noises for talk-back. Enclosed case and protective screen renders this model proof against weather, dust and moisture ALNICO 5; PM design. Power rating, 10 watts; voice coil impedance 12 ohms. Mounts in 5-3/4" cut-out; six screw holes in rim. Overall diameter 6-7/16"; depth (from front of panel) 2-5/64". Finished in Munsell N4-5 gray enamel.

MODEL AP-20 SPEECH MASTER Heavy-duty unit for high-level paging and call systems in noisy industrial installations. PM design. Furnished with eyebolt for overhead suspension but available with stand for wall or table mounting. Voice coil impedance 8 ohms; power rating, 25 watts. Overall diameter 12-1/2"; depth 9".

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

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

Monographs Available:
- Loud Speaker Frequency Response Measurements
- Impedance Matching
- Power Distribution
- Frequency Range in Master Reproduction
- The Effective Reproduction of Speech
- Horn Type Loud Speakers

25¢ each

ELECTRONICS — November, 1946

www.americanradiohistory.com
BEAT FREQUENCY GENERATOR
TYPE 140-A

This instrument has found universal acceptance because of its wide frequency coverage from 20 cycles to 5 megacycles. A five step decade attenuator provides a means by which extremely small output voltages can be accurately set and a six position switch enables any one of a variety of output impedances to be quickly selected.

SPECIFICATIONS:
FREQUENCY RANGE: 20 cycles to 5 megacycles in two ranges.
Low range: 20 to 30,000 cycles.
High range: 30 kc to 5 megacycles.
FREQUENCY CALIBRATION: Accuracy ±2 cycles up to 100 cycles,
_2% above 100 cycles.

STABILITY: About 5 cycles drift below 1000 cycles. On low range, drift becomes negligible percentage with increasing frequency. On high range, drift is 3% or less.

ADJUSTMENT: High and low ranges have individual zero beat adjustments. Low range may be checked against power line frequency with front panel 1 inch cathode ray tube.

OUTPUT POWER AND IMPEDANCES: Rated power output: One watt, available over the low frequency range from output impedances of 2C, 50, 200, 500, 1000 ohms, and over both high and low frequency ranges from an output impedance of 1000 ohms.

DISTORTION: 5% or less at 1 watt output, 2% or less for 1/2 volt output.

VOLTMETER ACCURACY: ±3% of full scale reading.

For further details write for Catalog D

QX-CHECKER TYPE 110-A

This production-test instrument is specifically designed to compare relative losses or Q simultaneously with inductance or capacitance in one operation and with a single setting. Built to laboratory precision standards, the QX-Checker is a sturdy, foolproof instrument for use in production work by any usual factory personnel.

SPECIFICATIONS:
FREQUENCY RANGE: 100 kc to 25 mc in 6 ranges using plug-in coils.
ACCURACY OF COIL CHECKS: May be checked against standard to within about 0.2% with coil values of 10 microhenries to 10 millihenries and Q of 100 or greater.
CAPACITANCE RANGE: Capacitance values ranging between approximately 2-1000 mmf may be checked against a standard to an accuracy of a few tenths of one mmf if the Q of the capacitor is high.

November, 1946 — ELECTRONICS
BOROTHERED with "BUGS" like these?

The picture shows the cure: "dag" colloidal graphite. But it doesn't show all the "bugs" that versatile "dag" dispersions can put to sleep for good.

That's why Acheson Colloids-experts have prepared the comprehensive line of free booklets shown below:

to describe the 18 "dag" colloidal graphite dispersions (in water, oils, alcohols and special liquids), and to give to users a complete list of profitable applications in their own industries.

Are you up-to-date on "dag" dispersions?

ACHESON COLLOIDS CORPORATION, Port Huron, Michigan

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

- [ ] A data and reference booklet regarding "dag" colloidal graphite dispersions and their applications. 16 pages profusely illustrated.
- [ ] Facts about "dag" colloidal graphite for ASSEMBLING AND RUNNING-IN ENGINES AND MACHINERY.
- [ ] Facts about "dag" colloidal graphite as a PARTING COMPOUND.
- [ ] Facts about "dag" colloidal graphite as a HIGHTEMPERATURE LUBRICANT.
- [ ] Facts about "dag" colloidal graphite for IMPREGNATION AND SURFACE COATINGS.
- [ ] Facts about "dag" colloidal graphite in the FIELD OF ELECTRONICS.

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

NAME
POSITION
FIRM
ADDRESS
CITY
ZONE
STATE
OUR PRESENT OIL SUPPLIER IS
(Lubricants containing "dag" colloidal graphite are available from major oil companies.)
SPECIAL WARTIME DEVELOPMENT NOW AVAILABLE FOR PUBLIC USE . . . TYPE P6 DUMONT PAPER CAPACITORS

AC - DC CONTINUOUS AT HIGH TEMPERATURES

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

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

DUMONT ELECTRIC CORP
34 HUBERT STREET
NEW YORK, N. Y.
Just as a superior instrument responds to the sensitive fingers of a master pianist—so do the true degrees of Typhonite Eldorado leads respond to the skilled fingers of a draftsman. Eldorado is the easy drawing pencil that puts harmony in all work. Let it work for you!

DIXON'S TYPHONITE
ELDORADO

PENCIL SALES DEPARTMENT, OSKER D. O. CRUCIBI CO., JERSEY CITY, N. J.
Why there are so many REVERE METALS

There are so many Revere Metals because no one metal can possibly fill all requirements. For high electrical and heat conductivity, for example, the coppers are supreme, but where heat conductivity plus extra strength is required, as in condensers and heat exchangers, alloys such as cupro-nickel or Admiralty metal may be required. Special corrosive conditions likewise may affect the choice of metal. When weight is a factor, as in anything that must be moved by mechanical or manpower, there are Revere aluminum and magnesium alloys. If fabrication costs are an important element, copper in one of its several types will be selected for some products, free-cutting brass rod for screw machine work, brass sheet and strip for severe forming operations, Herculoy for the corrosion resistance of copper with strength of mild steel plus ready weldability. Seldom, however, is there only one factor to be considered in selecting a Revere Metal; usually there are several, and striking the correct balance may not be easy. In such cases, Revere is glad to offer the cooperation of its Technical Advisory Service.

Revere Metals are offered in the form of raw products, as follows: Copper and Copper Alloys: Sheet and Plates, Rod and Strip, Rod and Bar, Tube and Pipe, Extruded Shapes, Forgings. Admiralty Alloys: Tube, Extruded Shapes, Forgings. Magnesium Alloys: Sheet and Plate, Rod and Bar, Tube, Extruded Shapes, Forgings. Steel: Electric-Welded Steel Tube.

REVERE
COPPER AND BRASS INCORPORATED

115 East 16th Street, New York 3, New York

Many Bathrooms, Many Kitchens

COPPER AND BRASS INCORPORATED

666 West 42nd Street, New York 36, New York

COPPER AND BRASS INCORPORATED

218 West Diversey Avenue, Elmhurst, Illinois

COPPER AND BRASS INCORPORATED

701 West Hanley Road, Detroit 7, Michigan

COPPER AND BRASS INCORPORATED

616 Industrial Way, Philadelphia 21, Pennsylvania

COPPER AND BRASS INCORPORATED

1107 South Railroad Avenue, South Gate, California

COPPER AND BRASS INCORPORATED

6201 North Mobile Avenue, Los Angeles 23, California

COPPER AND BRASS INCORPORATED

1801 South Naughton, Chicago 35, Illinois

COPPER AND BRASS INCORPORATED

2401 East Walton Avenue, Chicago 13, Illinois

COPPER AND BRASS INCORPORATED

14701 West Hueneme Road, Chatsworth, California

COPPER AND BRASS INCORPORATED

10 Hammond Avenue, Lorain, Ohio

COPPER AND BRASS INCORPORATED

2666 Wawasee Drive, Lafayette, Indiana

COPPER AND BRASS INCORPORATED

4945 North 11th Street, Kansas City 12, Missouri

COPPER AND BRASS INCORPORATED

4101 West 8th Avenue, Denver 13, Colorado
There is a DRIVER-HARRIS ALLOY for Every Electrical Resistance Requirement

NICHROME* & NICHROME V for winding large value resistors where space factors call for compactness in design without sacrificing dependability. Available in all shapes and sizes drawn down to the extremely fine gauge of .001" diameter—67 miles to the pound.

Also the time-tested standard alloys for all vitreous enamel resistor requirements due to the complete absence of occluded gases. NICHROME V is particularly recommended when a more constant resistance at variable temperatures is specified.

MANGANIN for precision bobbin-, Wheatstone Bridges, Decade Resistance Boxes, Potentiometers and National Bureau of Standards type resistance standards which require fixed stability and constant resistance under normally variable operating conditions and negligible thermal e.m.f. against copper.

ADVANCE* for winding precision resistors used in electric meters and laboratory testing devices. In finer sizes its negligible temperature coefficient of resistance (±.00002) combined with high resistivity makes it the most desired alloy for this use.

In addition to these we manufacture over 80 different electrical heat and corrosion-resistant alloys. If your resistance requirements are different tell us about them and depend on it...Driver-Harris will develop the alloy best suited to your specifications.

NICHROME is made only by

Driver-Harris COMPANY

COMPACT • POWERFUL • DURABLE
with graphite, the real low temperature anode

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

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

**GENERAL CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filament, 6.3 volts at 3.0 amps.</td>
<td></td>
</tr>
<tr>
<td>Amplification factor</td>
<td>60</td>
</tr>
<tr>
<td>Transconductance</td>
<td>2500 micromhos</td>
</tr>
<tr>
<td>Direct interelectrode capacitance</td>
<td></td>
</tr>
<tr>
<td>Input to plate</td>
<td>2 mmfd</td>
</tr>
<tr>
<td>Input</td>
<td>6.5 mmfd</td>
</tr>
<tr>
<td>Output</td>
<td>1.8 mmfd</td>
</tr>
</tbody>
</table>

**MAXIMUM RATINGS**

<table>
<thead>
<tr>
<th>Class C</th>
<th>Class C</th>
</tr>
</thead>
<tbody>
<tr>
<td>D.C. Plate Voltage</td>
<td>1250 volts</td>
</tr>
<tr>
<td>D.C. Grid Voltage (Grid #1)</td>
<td>230 volts</td>
</tr>
<tr>
<td>D.C. Grid Voltage (Grid #2)</td>
<td>350 volts</td>
</tr>
<tr>
<td>D.C. Plate Current</td>
<td>100 ma</td>
</tr>
<tr>
<td>D.C. Grid Current</td>
<td>20 ma</td>
</tr>
<tr>
<td>Plate Input</td>
<td>125 watts</td>
</tr>
<tr>
<td>Screen Input</td>
<td>8 watts</td>
</tr>
<tr>
<td>Plate Dissipation</td>
<td>35           watts</td>
</tr>
</tbody>
</table>

**NEW UNITED ISOLATED GETTER TRAP**

Keeps tube free from gas
Preserves filament emission

**$10.00 ea.**
Many evidences of superiority in JOHNSON condensers reflect the twenty-three years of experience that has gone into them. Each type is carefully designed by electronic engineers for maximum circuit efficiency. A primary design objective at JOHNSON'S has been the accommodation of a greater number of specific requirements with a standard condenser or minor modification of a standard. JOHNSON'S search for better design and methods is continuous and employs first class engineering talent and equipment. Many developments, such as the new plate design mentioned below, not only bring increased efficiency but a saving in cost.

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

Johnson products include

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

Plates for types A and B condensers are of the new heavy rounded edge design recently developed by JOHNSON engineers. Their higher breakdown voltage permits closer spacing, a shorter condenser, lower minimum, and less inductance at UHF. These features combined with new end frame design reduce weight to minimum, yet cost no more, in most cases less because of the saving in material.
Soldering irons require an insulation of high dielectric strength that can stand temperatures up to 1200°F.—will not react to heat conducted through wire. Read the results obtained by a manufacturer who put this problem up to Bentley, Harris:

"We tested BH Fiberglas Sleeving in our soldering irons for over 1,000 hours of continuous duty, heating and cooling over 2,000 times. The results were entirely satisfactory without any defect in heat resistance or in required dielectric strengths."

Test BH Fiberglas Sleeving in your own plant, in your own product—under actual service conditions. Compare it with ordinary saturated sleeving. See how it remains flexible as string and non-fraying. Learn why America’s leading makers of home appliances, radios and industrial equipment have standardized on BH Fiberglas Sleevings in their plans for post-war production.


*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.**


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 and prices on other BH Products as follows:

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

November, 1946 — ELECTRONICS
SHERRON MULTIWAVE SHAPE GENERATOR

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

SHERRON R.F. NULL DETECTOR

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

SHERRON D.C. VACUUM TUBE VOLTMETER-MICROAMMETER

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

SPECIFICATIONS:

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

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

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

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

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

SHERRON ELECTRONICS COMPANY

Division of Sherron Metallic Corporation

1201 FLUSHING AVENUE, BROOKLYN 6, NEW YORK

West Coast Sales Office: MECHANICS INSTITUTE BLDG., 57 Post St., San Francisco, Calif.
Anyone concerned with insulation for electrical, radio, electronic or video applications can use the Fiberglas Electrical Insulation Materials Catalog to advantage.

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

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

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

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

In Canada, Fiberglas Canada Ltd., Toronto, Ontario.
The Dalmo-Victor designed air pump is a slow-speed, single-action piston pump, which requires no extra power source. Air is delivered to rear joint of the antenna wave guide, and will maintain a pressure of 10 pounds per square inch gauge at all altitudes up to 30,000' above sea level against an air leakage of 4 cubic inches of free air per minute.

This feed is a pressurized X-Band rearward directing feed horn for circular paraboloids. The electrical features include high gain, low VSWR, and external tuning adjustment. The mechanical features include 100 per cent pressure tight sealing, light weight, few parts, and ease of fabrication and assembly.

The AN/APS-6 Antenna is a high-speed spiral type of scanner driven at 1200 r.p.m. through enclosed helical gearing, and simultaneous nod motion is introduced by means of a crank reciprocated rack and pinion mechanism to impart a nod motion of ±50° at a rate of 15 complete nod cycles per minute.

Dalmo-Victor developed this 2 phase, 20 cycle generator for use on the AN-APS/6 Antenna, using a permanent magnet type rotor and to develop 67 volts r.m.s. at 1200 r.p.m. Total harmonic content does not exceed 5%. Simplicity of construction makes possible ease of assembly and phasing.

At the close of hostilities Dalmo-Victor was producing and delivering nearly 90% of the night fighter Radar Antenna-Scanners used by the U. S. Navy. We had developed the top quality product in this field.

Our "know-how" is ready for commercial and research development purposes, our engineering and electronic research staff is intact, our manufacturing and testing facilities are ample. We solicit inquiries from electronic engineers, aircraft companies — from all who may be properly interested.
CQ(\text{bsmc}) + e + \frac{73c}{7s(8a)} + 4(\text{ii}) = (Tfp + eoi)(iyUHFe)^* 

*CENTRALAB Quality button silver mica capacitors + early delivery + 73 combinations made up of 7 styles with 8 available terminals + 4 individual inspections (capacitance, power factor, voltage breakdown and leakage resistance) = Trouble free performance and ease of installation in your Ultra High Frequency equipment.

Send for Bulletin 586

Centralab
Division of GLOBE-UNION INC., Milwaukee

PRODUCERS OF
Silver Mica Capacitors
Bulletin 620
Ceramics
Bulletin 720
Ceramic High Voltage Capacitors
Bulletin 630
Ceramic Plate Capacitors
Bulletin 630
Tubular Ceramic Capacitors
Bulletin 630
Radiohms
Bulletin 697
Selector Switches
Bulletin 722

**Note:** The mathematical expression appears to be a creative or stylized representation of the text, possibly related to a specific context not directly translatable.
FOR AN HONORED PLACE IN THE HALL OF FAME

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

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

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

UNUSUAL VERSATILITY

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

LONG DEPENDABLE LIFE

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

PERFORMANCE PLUS

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

HIGH POWER-GAIN

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

POST-WAR IMPROVEMENTS

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

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

EITEL-McCULLOUGH, INC.
1305E San Mateo Ave., San Bruno, Calif.
Export Agents:
Frazar and Hansen, 301 Clay St., San Francisco 1, Calif.

Follow the Leaders to Eimac TUBES

THE COUNTERSIGN OF DEPENDABILITY IN ANY ELECTRONIC EQUIPMENT
WRONG WIRING CAN WRECK IT

No matter how carefully you plan, it's hard to determine just how well your new product is going to perform in actual service. But you are in a position to know whether it generates heat that may bake out and crack the insulation of the wiring or cause it to flow. And you can also anticipate whether it will be subject to attack by corrosive fumes, oil or grease.

In all such cases **permanently** insulated wiring is a **must**. And the name to remember for complete assurance of permanence is Rockbestos. Each of the 125 wires, cables and cords in this time-tested line was developed to outlast the products in which they are installed. Write for catalog or recommendations.

ROCKBESTOS PRODUCTS CORPORATION, 441 NICOLL ST., NEW HAVEN 4, CONN.

ROCKBESTOS
The Wire with Permanent Insulation

Permanent Insulated Wiring Insures Your Product’s Performance

The large cable illustrated to the left is Rockbestos A.V.C. Motor Lead and Apparatus Cable. Insulated with asbestos and varnished cotton, and covered with a heavy asbestos braid, it is made in sizes 18 AWG to 5000,000 CM.

Rockbestos Firewall Hookup Wire

This heat, flame and moisture resistant wire, insulated with high dielectric tapes and impregnated felted asbestos and covered with color-coded lacquered glass braid, has a maximum operating temperature of 150° F. Ideal for radios, television, amplifiers, calculators or small motor, coil, dynamotor and transformer leads. No. 22 to 14 AWG in 1000 volt rating — No. 12, 14 and 16 AWG in 3000 volt, also in twisted pair, tripled, shielded and multi-conductor constructions.

ROCKBESTOS A. V. C. 600 VOLT SWITCHBOARD WIRE

(National Electrical Code Type A17B)

This wire was designed to make complicated wiring jobs permanent. The impregnated felted asbestos will withstand the flameproofed cotton braid to heat, flame and moisture resistant and assures fine appearance of boards and gives no bends to prevent heat cracking. Sizes 14 to 1/0 AWG with a white or stranded conductor in black, grey, or colors. Rockbestos A. V. C. Hinge and Bus Cable have the same characteristics.

These are but a few of the 125 different permanently insulated wires, cables and cords designed by Rockbestos to meet severe or unusual operating conditions.
One year of -hp- achievement

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

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

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

2018 AF OSCILLATOR
Meets every requirement for speed, ease of operation, accuracy and purity of wave form in FM and other fields where high fidelity is important.
Frequency range from 20 Cps to 20 Kc. Up to 3 watts power into 600 ohm resistive load with distortion of less than 1%. (Distortion not more than 1/2% at 1 watt output.) Frequency control is accurately obtained by direct or a 6-1 vernier tuning over a large illuminated, no parallax dial. Price $190.00 FOB Palo Alto.

330B DISTORTION ANALYZER
Unusually valuable for measurement through the audio spectrum in broadcast, laboratory or production problems. Measures "total" distortion at any frequency from 20 Cps to 20,000 Cps, and will accurately make noise measurement of voltages as small as 100 microvolts. Linear r-f detector makes possible measurement direct from modulated r-f carrier. May be used as voltmeter for measuring voltage level, power output, amplifier gain; or serves as high-gain, wide-band stabilized amplifier with maximum gain of 75 db. Price $375.00 FOB Palo Alto.

410A VACUUM TUBE VOLTOMETER
Measures voltage over wide frequency range (from audio to microwave regions) at high impedance. High input impedance and low shunt capacity makes possible testing video and VHF amplifier circuits without disturbing circuit under test. Measurements: Six ranges, full-scale readings from 1 to 300 volts. Input impedance 6 megohms in parallel with 1,300 ohms. Frequency response 20 Cps to 70 Mc. ±1 db. de measurements: Seven ranges, full-scale readings from 1 to 1000 volts. Input impedance 100 megohms, all ranges. Resistance measurements: Seven ranges, mid-scale readings 10 ohms to 10 megohms. Price $210.00 FOB Palo Alto.

430A AMPLIFIER
A stable, wide-band, general purpose laboratory instrument. 40 db or 20 db gain of unusual stability, low phase shift. Frequency response flat within 1/2 db between 10 and 1,000,000 cycles. Input impedance 1 megohm shunted by 15 ufd. Internal impedance less than 150 ohms over entire range. Fully operated from 115 volts, 60 cycles AC power supply. Can be used with 400A Vacuum Tube Voltmeter to measure voltages as low as 5 microvolts. Price $125.00 FOB Palo Alto.

430B DISTORTION ANALYZER
Unusually valuable for measurement through the audio spectrum in broadcast, laboratory or production problems. Measures "total" distortion at any frequency from 20 Cps to 20,000 Cps, and will accurately make noise measurement of voltages as small as 100 microvolts. Linear r-f detector makes possible measurement direct from modulated r-f carrier. May be used as voltmeter for measuring voltage level, power output, amplifier gain; or serves as high-gain, wide-band stabilized amplifier with maximum gain of 75 db. Price $375.00 FOB Palo Alto.

710A POWER SUPPLY
Ideal power supply for general, laboratory, or production use. Delivers any required voltage between 180 and 250 volts, with approximately 1% variation for output currents of from 0 to 75 ma. Maximum current: 100 ma. Line voltage variation of +10% causes less than 1% change in output voltage. Total noise and hum output is less than .005 volts. Supplies up to 5 amperes at 60 volts AC for heating filaments. Either positive or negative terminal may be grounded. Price $75.00 FOB Palo Alto.

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

ELECTRONICS — November, 1946
Don't buy an electronic heater blindly

INSIST ON PROOF BY TRIAL

Do you do soldering, brazing, surface-hardening, annealing or other heat-treating operations? Or do you use heat to treat non-metallic substances such as plastics, plywood, rubber, etc.?

It is quite possible that you can use electronic heating apparatus for these operations, profitably replacing older and slower heating methods. The savings and increased efficiency are decidedly worthwhile. The speed-up in production is as great as 700% in some instances. Work that formerly took minutes or hours now requires only SECONDS.

Investigate the possibilities of high frequency heating for your production. But be sure and get plenty of sound experienced advice before you buy. Don't just buy a "machine." Let our engineers prove to you by actual demonstration under your own conditions, how Scientific Electric equipment fits your exact needs. Remember, there is no such thing as an all-purpose electronic heater. Each individual operation and each factory production set-up requires a specific type of installation, with the proper combination of frequency and power output. Consult us without obligation. We will engineer the right installation to your particular requirement. Buy nothing till we've PROVED IT BY TRIAL for you.

Scientific Electric

DIVISION OF "S" CORRUGATED QUENCHED GAP CO., 107 MONROE ST., GARFIELD, N.J.

Scientific Electric Electronic Heaters are made in the following range of power; 3—5—7½—9—10—12½—15—18—25—40—60—80—100—220 KW — and range of frequency up to 300 Megacycles depending on power required.

November, 1946 — ELECTRONICS
AN accurate meter is a sensitive mechanism, and a sensitive mechanism is also a delicate mechanism. It can't stand the buffettings of vibration, and continue its normal functioning. Yet some of the most important services that meters render must be rendered in the midst of chaotic disturbances.

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

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

Every genuine Lord Mounting carries the name "LORD" embossed in the rubber or in raised letters on the forgings.
Mineral oil filled to assure longer life and more stable performance over a wider range of operating temperatures.

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

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

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

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

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

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

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

WRITE FOR OUR NEW CATALOG.

KARP METAL PRODUCTS CO., INC.
Custom Craftsmen in Sheet Metal

124 - 30th STREET, BROOKLYN 32, N. Y.
The resistor element is molded as a single unit, with insulation, terminals, face plate, and threaded bushing. There are no rivets, welded or soldered connections.

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

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

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

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


Allen-Bradley
Fixed & Adjustable Radio Resistors

November, 1946 — ELECTRONICS
More Than Relays...
It's CLARE Reputation
They Hold In Their Hands!

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

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

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

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

See your nearest Clare sales engineer. They are located in principal cities to work with you in the development of "custom-built" relays to meet your most unusual relay requirements. Let them show what Clare "custom-building" can mean to you. Do you have the new Clare Engineering Data Book? If not, send for your copy today.

Address: C. P. Clare & Company, 4719 West Sunnyside Ave., Chicago 30, Ill. Cable Address: CLARELAY.

In Canada: Canadian Line Material Ltd., Toronto 13

CLARE RELAYS
"Custom-Built" Multiple Contact Relays for Electrical and Industrial Use
RCA-Victor uses a post-formed Lamicoid laminated plastic part, on which is stamped the RCA trade name, as an insulating part, and a case for the internal antenna on their 66BX Globetrotter—the portable radio.

Whatever your uses and requirements may be for a laminated plastic insulating material for electric and electronic equipment, we can supply you with Lamicoid because it is available in so many grades and types. Coil forms, panel boards, charts, signs, gears, machine parts and many other insulating or structural pieces can be made of Lamicoid to exact specifications. Lamicoid has high dielectric strength,
Lamicoid used on this terminal block can be machined, sawed, drilled and easily printed for circuit identification. Lamicoid sheets are obtainable with rubber for terminal connections that must be sealed against moisture and various liquids.

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

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

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

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

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

MICA Insulator COMPANY
Dept. 22, Schenectady 1, New York

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

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

ELECTRONICS — November, 1946
### Important FM news for Broadcast Managers... Engineers... Listeners

**Unexcelled Performance of Western Electric FM Transmitters**

<table>
<thead>
<tr>
<th>Audio Frequency Response</th>
<th>Intermodulation</th>
<th>FM noise level</th>
<th>AM noise level</th>
<th>Carrier Frequency stability</th>
</tr>
</thead>
<tbody>
<tr>
<td>±0.25 dB from 30 to 45,000 cycles</td>
<td>±3 dB</td>
<td>65 dB below 75 Kc-coupled</td>
<td>50 dB below 100% amplitude modulation</td>
<td>Less than 2000 cycle deviation (no crystal heater)</td>
</tr>
<tr>
<td>Harmonic distortion — for</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>±55 Kc-coupled</td>
<td>±100 Kc-coupled</td>
<td>Less than 0.75% for 20% to 15,000 cycles</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Intermodulation — for</td>
<td>±35 dB-coupled</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>—</td>
<td>±75 Kc-coupled</td>
<td>Less than 0.5% for 60% of cycles and 20% of cycles; less than 1.0% for 80% of cycles and 20% of cycles</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

**FROM AN ARTICLE BY EDWIN H. ARMSTRONG**

**BROADCASTING, JULY 1, 1946**

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

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

For other important features of Western Electric's complete new line of FM transmitters, contact your nearest Graybar Broadcast Equipment, Representative, or write to Graybar Electric Company, 420 Lexington Avenue, New York 17, N.Y.
A STREAMLINED METHOD OF FASTENING MOTOR COILS with SCOTCH BRAND Electrical TAPE

"SCOTCH" Electrical TAPE simplifies and speeds up fastening motor coils after the winding operation. The procedure is shown on the left.

1—A single piece of "SCOTCH" Electrical TAPE is passed inside the coils and brought around the outside with the adhesive side bearing against the coils.

2—The adhesive faces of the tape, pressed together between the coils, provide a tight, secure band for each coil.

3—When cut apart each banded coil is held neatly in place.

This operation is just one of the countless ways in which "SCOTCH" Electrical TAPES speed up and simplify the production of electrical equipment. There are more than twenty distinct types of "SCOTCH" Electrical TAPES, each designed to perform some specific electrical holding or insulating task. Write Department R for samples and complete information.
Accurately detects sources of wear, strain and noise.

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

The Vibrometer is an invaluable design aid. It prevents breakdowns, locates trouble, speeds production, reduces rejects. It is particularly useful in measuring the vibration in motors, gears, bearings, rotors, fans, propellers, presses, aircraft structures, stokers, etc. Ninety-five percent of all vibration measurements needed by industry are covered.

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

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

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

---

**Specifications**

| Operation | 105-125 volt, 50-60 cps. power. |
| Frequency Response | 5-2500 cps., uniform within 2%. Correction graph for 2 cps. can be supplied. |
| Weight | 31 pounds. |
| Size | 17” high, 12” deep, 11” wide, 10° slope. |
| Displacement Range | 5 ranges, 0-.01”, 0-.03”, 0-.1”, 0-.3”, 0-1” in RMS displacement. |
| Velocity Range | 5 ranges (in inches per second), 0-1, 0-3, 0-10, 0-100, 0-1000. |
| Acceleration Range | 5 ranges (in inches per second per second), 0-10, 0-30, 0-100, 0-1000, 0-10,000. |
| Output Jack | Available at rear of Vibrometer for use with phones, oscillograph, wave analyzer, or recording devices. |
| Construction | All aluminum mechanical components housed in a solid oak, copper lined cabinet. The black, wrinkle finish panel is engraved. |
| Guaranty | The Vibrometer is guaranteed for two years. |
HERE'S A New Line OF D-C CAPACITORS

BETTER IN "Civvies" FOR HAVING WON THEIR SERVICE STRIPES

It's an open secret among the trade that G-E Pyranol capacitors, which enjoyed such an enviable reputation before the war, are now better than ever!

The reason for this is obvious. Some pretty tough demands had to be satisfied during the war. The strict quality control methods, new manufacturing techniques, and improved materials, instituted at that time have produced outstanding results which General Electric has now incorporated in a new line of Pyranol capacitors designed to meet commercial requirements.

This new listing makes available a wider range of sizes, ratings, and mounting arrangements with characteristics for operation over wider temperature ranges (−55°C to +85°C), at altitudes up to 7500 ft.

These G-E *Pyranol-treated fixed paper dielectric capacitors range in size and shape from bathtub and small rectangular case styles to large, welded steel case designs. Capacity ratings from .01 muf to 100 muf, and voltage ratings from 100 to 100,000 volts are listed. The high dielectric strength and stable characteristics of the special Pyranol-impregnated Kraft paper are hermetically sealed into these non-inflammable units, thus assuring long life.

*Pyranol is General Electric's non-inflammable liquid dielectric for capacitors.

GENERAL ELECTRIC COMPANY
Apparatus Department, Section K 407-108
Schenectady 5, N. Y.
Gentlemen: Kindly send me further information on “Fixed Paper Dielectric Capacitors for DC Applications.”

Name _____________________________
Organization _____________________________
Address _____________________________
City _____________________________ State _____________________________

GENERAL ELECTRIC
ELECTRONICS — November, 1946
Once again, Fairchild takes the lead in improved sound equipment design — for even finer performance. This time it’s the new cast panel and motor mount for the Unit 539 Portable Recorder, shown above.

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

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

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

Where double turntable or continuous recording and direct playback are required, a second identical Unit 539 Recorder can be connected to a Unit 540 or 295 Amplifier-Equalizer.
SYLVANIA COMMERCIAL ENGINEERING DIVISION AIDS IN PRODUCING EFFICIENT SET CIRCUITS

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

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

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

For nearly twenty years Sylvania's Commercial Engineering Department has contributed to the advancement of circuit design as well as to the development of a great variety of electronic and lighting products.
Meissner Coils, long the accepted standard for engineers who insist on high quality performance, are designed to meet your most exacting requirements. Precision-made, these superior components are backed by a 24 year reputation for quality and uniformity in manufacture.

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

Available Soon!

The new Hazeltine Combination AM-IF and FM-IF Single Unit Coils. The answer to space and production problems in the design of AM-FM receivers.
Recently released from Army-Navy classification, this equipment, formerly known as the TS-223/AP, is now being produced by Aircraft Radio Corporation as the A.R.C. Test Set, Type H-10.

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

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

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

AIRCRAFT RADIO CORPORATION
BLOONTON, NEW JERSEY
This high impact shock machine is

THE PROVING GROUND

—for Chatham rugged industrial tube designs!

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

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

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

CHATHAM ELECTRONICS
475 WASHINGTON STREET, NEWARK 3, NEW JERSEY

November, 1946 — ELECTRONICS
Light weight, and non-tiring balance are built-in features of the Eject-O-Matic. This modern soldering tool weighs only 20 ounces fully loaded with a 4-ounce reel of solder. The center of gravity is located near the trigger. The molded, pistol-grip handle fits the hand snugly, and the fatigue factor is reduced to minimum. Eject-O-Matic can be used for hours without tiring the operator! And actual industrial tests prove that it speeds up production — nearly doubles the output per operator.

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

Model 19-5 (illustrated) with base — retails at $18.95

Individual packed. Shipping wt. per carton of 12 units, approx. 42 lbs.

Send for literature

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

ELECTRONICS — November, 1946
In the market for a small variable transformer of about 1/2 KVA capacity? To be more specific...

**INPUT** — 115 volts, 50/60 cycles, 1 phase. **OUTPUT** — 0-135 volts or 0-115 volts, 3.0 amperes.

Take a look at **POWERSTAT type 20**.

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

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

Mounting holes are located on a 1 3/4 inch radius.

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

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

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

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

---

Send for Bulletin 150 LE

---

THE

SUPERIOR ELECTRIC COMPANY

711 LAUREL STREET

BRISTOL, CONNECTICUT, U.S.A.

November, 1946 — ELECTRONICS
What's the mystery...here what comes? Chances are, it's a problem in plastics. We get them every day. It may involve an insulating part for an electrical application, or a non-corrosive part for chemistry. It might turn out to be a quieter streetcar bearing, collector rings on a power shovel, or thread advancing reels for textile applications. Whatever it is...Richardson versatility will soon have it solved.

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

Professional Recordists Recommend...

Sapphire Recording Audiopoints

Designed for the professional—Guaranteed to do a professional job

With These Three Outstanding Features

- Individually disc-tested on a recording machine.
- Expertly designed to insure proper thread throw.
- A product of the manufacturer of Audiodiscs—America's leading professional recording blanks.

Professional recording engineers know, from years of experience, that Sapphire Recording Audiopoints offer the ultimate in recording styli. Made by skilled craftsmen to most exacting specifications and individually tested in our laboratories, these Audiopoints are of consistent fine quality.

A good recording stylus requires a perfectly matched playback point. The Sapphire Audiopoint for playback fills this need completely. In materials, workmanship and design, it is the finest playback point obtainable. (Should not be used on shellac pressings.)

These Audiopoints are protectively packaged in handy cellophane covered cards—cards that are ideally suited for returning points to be resharpened.

Other popular Audiopoints, that complete a full line of recording and playback styli, are: Stellite Recording Audiopoint, a favorite with many professional and non-professional recordists; Diamond-Lapped Steel Audiopoint, a recording stylus particularly adapted for non-professional recordists; Playback Steel Audiopoints (Straight Shank and Bent Shank), the most practical playback points for general use. One hundred per cent shadowgraphed.

For further information, see your Audiodiscs and Audiopoints distributor, or write

AUDIO DEVICES, INC.
444 Madison Ave.,
New York 22, N.Y.

The jewelled point, with 87° included angle, correct radius and fine polish, cuts a silent shiny groove for many hours. When dulled or chipped, these points may be resharpened several times. Each resharpened Audiopoint is disc-tested to insure perfect performance. For this service return points through your dealer.
NEW!

Self-Clinching Fastener

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

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

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

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

4. Ring clinches fastener and prevents turning.

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

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

Penn Engineering & Manufacturing Corp.
South Main Street, Doylestown, Pa.

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

NAME...........................................................................................................

COMPANY................................................................................................

ADDRESS................................................................................................

Penn Engineering & Manufacturing Corp.
South Main Street, Doylestown, Pa.

Enlarged to show detail. Available in thread sizes #2-56, #4-40, #6-32, #8-32, #10-32, and #10-24.
THE 1-10A

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

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

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

The ONE-TEN-A is a fine receiver.
Light-weight — Resilient
NATIONAL VULCANIZED FIBRE
protects against shock and strain
... in products or plant equipment

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

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

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

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

NATIONAL VULCANIZED FIBRE COMPANY

Wilmington 99, Delaware  Offices in Principal Cities

ELECTRONICS — November, 1946
"Unbrako" Self-Locking Set Screws DO come in #0 size—with all the quality, accuracy and strength of the big #1" size.

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

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

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

OVER 43 YEARS IN BUSINESS

STANDARD PRESSED STEEL CO.
JENKINTOWN, PENN., BOX 596

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

November, 1946 — ELECTRONICS
AMERICAN PHILLIPS SCREWS
are "FIRST MATES" Cost-wise

...BOTH TO BOAT-BUILDERS AND OWNERS

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

And American Phillips savings reach straight through to the buyer of the boat.
For these screws resist corrosion, withstand vibration, remove screw-driving from
his maintenance work, help to keep his craft always trim, tight, and shipshape.
You can steer by this: American Phillips Screws are profitable not only production-wise.
They're potent sales promotion, as a mark of quality construction . . . and they're
sound sales-protection, too. You can get these same production and sales advantages
in American Phillips Screws in any type or metal (see below) for any fastening require-ment. Write.

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

AMERICAN PHILLIPS Screws

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

November, 1946 — ELECTRONICS
Alliance Powr-Pakt Motors will open and close valves, switches, operate toys and motion displays, actuate parts in business and vending machines, and can be used as component power sources in electronic control systems.

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

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

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

THE K-TRAN is very small.

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

THE K-TRAN is standard. At 455 KC or 265 KC, four types meet practically every need, eliminating the need for many different numbers.
one source
one contract
one "packaged" communication system

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

BUILDING A COMPLETE communication system to
meet your particular needs is a
job for experts. Unless all units
in the system are properly inte-
grated, the end result may prove
unsatisfactory and costly.
In spite of the fact no two commu-
nication problems are identical,
Press Wireless—with their world-
wide operating and manufactur-
ing experience—can engineer a
combination of standardized units
to do your job. Obviously, such a
procedure results in greater effi-
ciency, lower cost.
After thorough analysis, and this
means much more than "desk work", PW will present recom-
mendations for your "packaged"
communication system—all units
of which are designed and built to
work together. Such a system will
be complete from soil analysis to
antenna tower, even to equipment
housing where necessary. Thus,
you will be able to obtain all the
factors of a successful communi-
cation system from one source,
under one contract. Press Wireless
Mfg. Corp., Executive Offices, 1475
Broadway, New York 18, N.Y. USA

UNITS IN THE PW "PACKAGE"
RADIO-TELEGRAPH
AND TELEPHONE TRANSMITTING
FREQUENCY SHIFTER
RADIO-PHOTO
COMMUNICATION RECEIVERS
PLUS
ASSOCIATED TERMINAL
EQUIPMENT
Your installation is engineered from any com-
bination of the above standardized PW units.

PRESS WIRELESS
First in "Packaged" Communications Equipment

ELECTRONICS — November, 1946
At 225 miles...13,000 feet **VHF reception** good

**VHF TEST FLIGHT**

**Engineering Report**


Aircraft: NC 90421  Date: 8/20/46

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

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

*Transmitter:* Radio Receptor TV-50A  *Output Power:* 50 watts

*Receiver:* Radio Receptor RV-1A

*Antenna:* Ground Plane - located atop Marine Terminal, LaGuardia Field

*Frequency:* 123.3 Meg.

---

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

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

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

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

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

---

Please send me the bulletins checked:

- "Packaged Radio Station RSV-1.1" (VHF)
- "Packaged Radio Station RSL-1.1" (low frequency)
- LF Transmitter (Bulletin No. 5009)
- HF Receiver (Bulletin No. 5008)
- VHF Receiver (Bulletin No. 5007A)
- VHF Transmitter (Bulletin No. 3006)
- "Highways of the Air" (the story of airway radio)

Name:

Position:

Company:

Address:

City: State:

Communications Division

RADIO RECEPTOR CO., INC.

Since 1922 in Radio and Electronics

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

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

SCHWEITZER PAPER CO.
182 Cornelison Ave., Jersey City, N. J.
Plants: Jersey City, Mt. Holly Springs, Pa.
Research Laboratories: Chrysler Bldg.
New York, N. Y.
INTERESTED IN LARGE PLASTIC PIECES?

Dispelling the time-worn theory that large molded plastic pieces are impractical and uneconomical, these Admiral phonograph and radio-phonograph cabinets effectively demonstrate that large products as well as small can be molded of Durez phenolic plastics. The bigger cabinet (right) when assembled contains a five-tube radio and automatic record player. The molded Durez body weighs 9 1/2 pounds and the cover 3 1/2 pounds. This makes a total cabinet weight of only 13 pounds.

Radio Frequency Preheat

Compression-molded in a 400-ton press, the special Durez compound used in this larger unit is preheated by radio frequency. This modern method of production facilitates the molding operation considerably and results in the strong, attractive cabinet shown. The smaller unit, Admiral's automatic record player, is also molded of Durez but in a 300-ton press.

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

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

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

Write for Free Booklet

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

FOR CLOSE-UP READING . . .

LOOK AT THIS MB PRECISION MINIATURE

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

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

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

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

MINIATURE ELECTRICAL INSTRUMENTS FOR ANY PURPOSE

ELECTRONICS — November, 1946

www.americanradiohistory.com
FERRANTI DIVISIONS OFFER
LOW COST PRODUCTS

FERRANTI HIGH QUALITY
TRANSFORMERS
AUDIO AND POWER TRANSFORMERS
CHOKES · FILTERS · COILS · ETC. ETC.
STOCK UNITS
HERMETICALLY SEALED — CUSTOM BUILT
LARGE OR SMALL QUANTITIES

FERRANTI HIGH QUALITY
WIRING & ASSEMBLIES
ELECTRONIC AND MECHANICAL ASSEMBLIES
SUB-ASSEMBLIES · COMPONENT PARTS
FERRANTI NOW OFFERS
THE BENEFITS OF WAR-GAINED EXPERIENCE
ON ALL TYPES OF
ASSEMBLY JOBS — LARGE OR SMALL

FERRANTI HIGH QUALITY
SHEET METAL & BAKELITE
FABRICATION
FROM SHEETS, RODS AND TUBES — PANELS
CASES, TERMINAL BOARDS, RACKS, CHASSIS, ETC.
CUT — PUNCHED — DRILLED — ENGRAVED
FINISHED TO SUIT YOUR NEEDS

QUALITY — AT LOW COST · PROMPT DELIVERY
FERRANTI ELECTRIC, INC. · RCA BUILDING
NEW YORK 20, NEW YORK
SEND US YOUR SPECIFICATIONS FOR IMMEDIATE ATTENTION

November, 1946 — ELECTRONICS
Playback Time = 15 Minutes ± Zero

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

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

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

Solar Manufacturing Corporation
GENERAL OFFICES: 285 MADISON AVENUE, NEW YORK 17, N. Y.
PLANTS AT CHICAGO, ILL.; NORTH BERGEN AND BAYONNE, N. J.
PAPER, MICA AND ELECTROLYTIC CAPACITORS FOR THE ELECTRICAL AND ELECTRONIC INDUSTRIES
DEPRESSION IN ’47?

...controls can bring one

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

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

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

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

Well, What Of It?

At least four things of major importance:

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

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

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

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

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

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

Wage Complications

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

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

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

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

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

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

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

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

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

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


www.americanradiohistory.com
TELEX tells an impressive PLASKON story

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

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

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

Plaskon materials have distinctive features that give them wide-spread application in the electrical, cosmetic, drug, garment and many other industrial fields. We shall be glad to help you adapt the many advantages of these versatile materials to your manufacturing and merchandising needs. Write for free illustrated book on Plaskon plastics.
"Built to Last" tells only part of the story of this Mallory switch which combines compact design with remarkable circuit flexibility.

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

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

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

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

MALLORY SWITCHES
(INDUSTRIAL AND ELECTRONIC)

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA
D. G. F... As part of a plan conceived before the war and delayed in coming to proper fruition because of the war, Donald G. Fink becomes Editor of ELECTRONICS on November 15.

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

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

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

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

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

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

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

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

TABLE I

<table>
<thead>
<tr>
<th>Electronic Equipment</th>
<th>Able Test</th>
<th>Baker Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire-control radars</td>
<td>48</td>
<td>46</td>
</tr>
<tr>
<td>Air-search and airborne radars</td>
<td>35</td>
<td>68</td>
</tr>
<tr>
<td>Radar repeaters</td>
<td>100</td>
<td>97</td>
</tr>
<tr>
<td>Radar countermeasures equipment</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td>Radar and radio beacons</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>IFF equipment</td>
<td>277</td>
<td>237</td>
</tr>
<tr>
<td>Radio transmitters</td>
<td>251</td>
<td>222</td>
</tr>
<tr>
<td>Radio receivers</td>
<td>813 720</td>
<td>66 64</td>
</tr>
<tr>
<td>Radar repeaters</td>
<td>498 523</td>
<td></td>
</tr>
<tr>
<td>Sonar echo-ranging equipment</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Sonar echo-sounding equipment</td>
<td>78</td>
<td>61</td>
</tr>
<tr>
<td>Loran navigation equipment</td>
<td>37</td>
<td>36</td>
</tr>
<tr>
<td>Communications auxiliary equipment</td>
<td>1069 1013</td>
<td></td>
</tr>
<tr>
<td>Teletype equipment</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Test equipment</td>
<td>288 274</td>
<td></td>
</tr>
<tr>
<td>Telephone, intercommunication</td>
<td>123</td>
<td>70</td>
</tr>
<tr>
<td>Radio direction-finding equipment</td>
<td>4 3</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>3835 3529</td>
<td></td>
</tr>
</tbody>
</table>

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

To implement this program, the Electronics Coordinating Officer was appointed to organize and direct the work. A staff of 85 officers, 75 civilians and 300 enlisted men was assembled, all electronic specialists. The civilians were recruited from the Naval Research Laboratory, the Signal Corps Engineering Laboratory, and from 18 industrial and academic laboratories. This group was charged with all the electronic activity of the task force, except the airborne drone control equipment and the Manhattan District bomb-detonating and timing-signal systems.

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

Telemetering receivers (center) for recording pressure-time pulse of underwater burst. High-speed camera (right) records at the rate of 600 inches of 35-mm film per second
All set for the Baker Blast. Technical personnel aboard radar platform of USS Avery Island, a few minutes before the second atomic explosion. Note radar monitoring dishes, and intercept antennas on mast (top center)

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

Exposure and Inspection of Equipment

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

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

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

Details of the damage caused to electronic equipment have been classified "secret" by the Joint Chiefs of Staff and hence cannot be revealed. The distance relative to the bomb within which equipment suffers severe damage, not repairable at sea, the additional distance within which minor damage is sus-
tained, and the distance beyond which the damage is negligible, are known. Thus, the damage-inspection function of Operation Crossroads was successfully accomplished. General conclusions have been drawn, the weak points of particular equipments revealed, and this information is being forwarded to equipment designers in the Naval Bureaus and the Signal Corps.

Electronic Instrumentation

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

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

The Television System

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

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

To protect the camera which viewed the air burst directly, a magnetically operated solenoid carrying a neutral-density filter of density 2.4 was positioned in front of the lens and controlled by a timing circuit having a delay of 13 seconds. The filter was positioned by a radio timing signal, scheduled for 5 seconds before the blast, and removed 8 seconds after the blast.

For reasons of safety and security, several of the observing ships were stationed at about 20 miles from the air blast. This exceeded the range of the 10-watt carrier, since the transmitter and receiver antennas were no more than 75 feet above ground. Accordingly, it was decided to operate an airborne television relay on the stratovision principle. Transmitting equipment identical to that on Bikini Island was installed on two PBM Mariner flying boats. Standard Block III receivers, which had been installed in the aircraft to permit motion-picture photography of the television scenes, were connected to the transmitters. The frequency separation between received signal and relayed signal was 24 mc, sufficient to avoid feedback difficulties. Excellent reception at the 20-mile range was achieved by this method, and recognizable pictures could be seen at 45 miles. During the Baker test, the ships were located at 10 to 12 miles, and the relay proved unnecessary when three-element directive arrays were installed on the Bikini transmitters.

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

Radio and Radar Monitoring

The monitoring of radio and radar equipment had two purposes:

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

Don Fink, Executive Editor of Electronics, makes wire recording just prior to Able Day blast. Goggles reduced glare of blast by more than 10,000 times.
One was to observe the effects of the blast on the frequency, power output, pulse rate and pulse width of various radio and radar transmitters which were operating at the time of the blast on the target ships. The second was to observe what effects the blast cloud and its associated phenomena would have on radio wave propagation at various frequencies, particularly attenuation, generation of noise and atmospheric disturbances, and radar reflections from the target array.

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

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

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

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

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

Monitoring equipment and recorders. The photograph shows just a small portion of the gear used to cover all frequencies from 5 mc to 26,000 mc, during the Able blast. Oscillographic cameras (left and right) and recording milliammeters (center) made permanent records.
after the Baker test by helicopter. Since the radioactivity was too intense to permit approaching the island by boat. Film records of the radar images were fogged by radioactivity and might have been completely ruined if allowed to remain until the radioactivity had subsided.

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

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

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

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

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

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

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

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

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

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

**Coupling Circuit**

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

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

---

**FIG. 1**—The traveling-wave tube projects through the input and output couplings of a waveguide circuit. Electron gun is at the left.
Characteristics and operating principles of the traveling-wave tube are explained in nonmathematical terms. The tube, designed for multichannel microwave relay systems, provides a high gain, wideband amplifier for use in television or f-m network circuits.

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

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

Amplification

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

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

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

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

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

**Electron-Wave Interaction**

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

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

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

During the war, R. Kompfner and others in the Clarendon Laboratory at Oxford showed that amplification was possible with a device consisting of an electron stream and a helix. J. R. Pierce and L. M. Field at the Bell Telephone Laboratories have successfully produced such an amplifier with the astonishingly high gain and broad band just described. Practical significance of the tube can be appreciated by the fact that it provides more gain over a wider band than any other tube. It could handle 10,000 telephone conversations or several dozen television programs simultaneously.—F. R.
Duplex Operation of INDUCTION HEATERS

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

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

Fundamental Unit

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

The tank circuit within the cabinet consists of the tank capacitor and an inductor. The inductor, in conjunction with a grid coil, provides adjustable feedback. The balance of the tank inductance is in the primary of the radio-frequency output transformer. The work coil is connected to the secondary of this transformer and can be of single- or multiple-turn construction.

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

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

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

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

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

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

**Synchronizing Tank Circuits**

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

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

**Use of Multiphase Power Lines**

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

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

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

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

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

**Balancing the Oscillator Loads**

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

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

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

By DONALD M. HILL and MURRAY G. CROSBY
Development Engineer
Boonton Radio Corporation
Boonton, New Jersey
Consulting Engineer
Paul Godley Company
Upper Montclair, New Jersey

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

Heterodyne System

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

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

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

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

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

November, 1946 — ELECTRONICS
not very inviting since the rate of change of the output frequency is considerably different from the rate of change of the variable-oscillator frequency.

Constant-Deviation Variable-Oscillator System

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

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

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

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

\[ L_t = L/L + L^2/(1 + L/L) \quad (1) \]

where \( L \) is the fixed inductance of the tuned circuit and \( L \) is the effective inductance of the reactance tube.

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

\[ f = L/(2 \pi \sqrt{LC/(1 + L/L))} \]

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

\[ f = L/(1 + L/L) \quad (2) \]

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

For the capacitive type of reactance tube, the resulting total tuned-circuit capacitance is that of the tuned circuit and the reactance
actance tube is of the inductive type, the frequency deviation may be taken from Eq. 3 which is \( f/L/2L \). In this type of circuit, \( f \) is fixed and \( L \) is independent of frequency. The result is a fixed percentage variation of inductance which produces a fixed percentage frequency variation. The frequency deviation in cycles is therefore proportional to the resonant frequency.

For the tuned circuit of the variable-capacitance fixed-inductance type, and a capacitive reactance tube is used, the percentage capacitance variation varies with frequency as the tuning capacitor is varied. That is, the ratio \( C/C \) varies with frequency since \( C \) is varied.

The value of \( C \) is varied in accordance with the formula \( f = 1/(2\pi \sqrt{LC}) \), which may be rewritten

\[
C = 1/(L/[2\pi f]^2)
\]

Substituting Eq. 6 in Eq. 5 gives

\[
f = f_0 - 2\pi C/L f^2
\]

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

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

\[
L = 1/[C/[2\pi f]^2]
\]

Substituting Eq. 8 in Eq. 3 gives

\[
f = f_0 + 1/[2\pi C/L f^2]
\]

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

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

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

**Correction Methods**

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

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

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

**Equivalent Circuits**

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

\[
Z_p = E e^{j\omega t}/i_p
\]

(10)

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

\[
i_p = e_{gs}g_m
\]

(11)

in which \( g_m \) is the transconductance of tube \( T \). The grid voltage \( e_g \) is

\[
e_g = BE e^{j(\omega t + \phi)}
\]

(12)

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

\[
Z_p = E e^{j(\omega t + \phi)}g_mBE e^{j(\omega t + \phi)} = e^{j(\phi/2)}g_m
\]

(13)

\[
Z_p = (e^{j\phi} - j\sin\phi)/g_m
\]

(14)

in which

\[
R_1 = \cos\phi/g_m
\]

(15)

and

\[
X_s = -\sin\phi/g_m
\]

(16)

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

\[
|X_s| = 1/g_m
\]

(17)

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

\[
L_s = X_s/e = 1/e g_m
\]

(18)

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

\[
f = f_0 + f_0LBg_m/2 = f_0 + fLBg_m/2
\]

(19)

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

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

\[
C_s = 1/e X_s = Bg_m/e
\]

(20)

Inserting \( C \) from Eq. 20 in Eq. 5 gives

\[
f = f_0 - f_0LBg_m/2\pi C = f_0 - Bg_m/2\pi C
\]

(21)

The deviation term \(-Bg_m/2\pi C \) in Eq. 21 shows that the deviation is independent of frequency if the phase-shifter attenuation \( B \) and the tuned circuit capacitance \( C \) are also independent of frequency. Hence, constant-deviation operation may be obtained by the use of a fixed-capacitance, variable-inductance tuned circuit and a capacitive-type reactance tube employing a phase-shifter having an attenuation independent of frequency.

Figures 5 and 6 show capacitance-tuned circuits and inductive-reactance tube arrangements which produce constant frequency deviation over a range of frequencies. The resulting phase-shifter attenuations have the general shape shown in Fig. 7. The attenuation is such that the phase-shifter output amplitude is inversely proportional to the square of the frequency over the tuning range \((Bz1/f)\), assuming constant phase-shifter input. The normal attenuation produced by conventional two-element phase-shifter tube is an output amplitude inversely proportional to the first power of the frequency, \( Bz1/f \). In Fig. 5, this inverse square-law characteristic is obtained by tuning \( LC \), to frequency \( F \), in Fig. 7. Tuned circuit \( LC \), operates on the capacitive side of resonance and therefore appears as a capacitance to produce an inductive-reactance tube.

In Fig. 6, the bridged-T network \( RR \), and \( C,C,C \), is tuned to locate its rejection frequency at the frequency \( F \). This network is capable of constant-deviation operation over a frequency range of about two-to-

---

**Fig. 5.** Constant-deviation reactance-tube circuit. Phase shifter \( R \), \( C \), and \( L \) produces an attenuation inversely proportional to the square of the frequency over the tuning range.

**Fig. 6.** In this constant-deviation network, the required inverse-square attenuation is obtained by the bridged-T phase-shifting network \( R \), \( R \), \( C \), \( C \), and \( C \).

**Fig. 7.** Attenuation \( Bz1/f \), produced by conventional two-element inductive reactance-tube phase shifter and attenuation \( Bz1/f\) required by an inductive reactance tube for constant deviation of a capacitance-tuned circuit.
one, while the network of Fig. 5 covers a range of about 1.5 to one. The exact magnitude depends upon the constancy of deviation required.

Over-All Design

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

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

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

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

The reactance tube uses a bridged-T type network similar to that of Fig. 6, in which a and C, are replaced by the input capacitance and the grid-to-plate capacitance of the reactance tube. Capacitor C, is made variable and ganged with the tuning capacitor to provide the precision of deviation calibration required in a signal generator. The slotted stator of C, is visible in the foreground of Fig. 9. By bending the sections of the stator, the deviation can be made as constant as desired over the entire frequency range. Resistor R, is bypassed for r-f only so that it causes degeneration at modulation frequencies and is used as a modulation sensitivity control. Resistor R, controls the cathode bias by bleeding current through the cathode resistor and is used to adjust the modulator tube to its most linear operating point. Total rms distortion of less than one percent at 75-kc deviation can be obtained with a modulating signal containing less than one-half percent distortion.

Doubler Tracks

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

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

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

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

![Fig. 8. Simplified diagram of the f-m signal generator](image-url)
introduced on frequency-modulated signals by the selectivity of the circuit. In the final design, the damping was adjusted to reduce spurious signals to more than 35 decibels below the desired signal. The resulting amplitude modulation at 75-kc deviation is about two percent.

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

Figure 10 shows the design of the output system. The voltage induced in the attenuator coupling loop \( L_0 \) in Fig. 10A is

\[
\epsilon' = I_0 M = \frac{E}{\omega L_0} \omega k \sqrt{L_0 L_2} - E K \left| L_2 \right|
\]

where \( \omega = 2\pi \) frequency, and \( k \) is the coefficient of coupling between \( L_0 \) and \( L_2 \).

This equation shows that \( \epsilon' \) is a function of the tank voltage \( E \) and the coefficient of coupling \( k \) only. The attenuation law of the piston attenuator controls \( k \). Voltage \( E \) is monitored by a voltmeter of the set-to-line type, the level being adjusted by a control in the screen circuit of the output tube. The output tank coil is physically flattened on the side facing the attenuator to present a more uniform field to the attenuator and permit larger values of \( k \) than are obtainable with a coil of circular cross-section. Although tank voltage \( E \) is smaller when doubling, the transformer ratio \( (\sqrt{L_0}/L_0) \) of Eq. 22 is larger and the allowable \( Q \) is greater. By placing the attenuator in proper relation to the tank coil, equal output is obtained on the two frequency ranges with very little change in the gain control setting.

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

**Output**

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

\[
\epsilon = \frac{53 \epsilon'}{\sqrt{(106)^2 + (\omega L_2)^2}}
\]

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

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

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

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

By adjusting the over-all conversion-amplification of the converter for unity gain, the output voltage can be read directly from the attenuator dial of the signal generator without requiring an additional monitoring system or attenuator. Provision is also made for an uncalibrated voltage with about ten times the amplitude of the input signal. The fixed oscillator is provided with a calibrated incremental trimmer capacitor for selectivity measurements.

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

**References**

Flame Radiation

By EDWARD M. YARD
Staff Engineer
John A. Roebling's Sons Co.
Trenton, N. J.

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

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

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

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

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

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

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

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

Choice of Circuit

Because of the small permissible current drain in a radiation pyrometer it is not practical to use a microammeter directly as the indicating instrument. This suggested the use of a bridge-type vacuum-tube voltmeter. The basic circuit chosen (Fig. 1) achieves the required stability by using vacuum tube T1 as a fixed resistance in one leg of the bridge and by employing resistor R6 to provide degeneration.

The design problem involved securing a sensitivity of the order of a galvanometer current of 50 microamperes for a grid input of 100 millivolts. This would give a deflection of at least half scale using a radiation pyrometer as a detector, when directed at flames of normal intensity in open hearth furnaces.

To keep weight down, it was decided to limit supply voltages to 67½ volts and limit current drain to about 10 milliamperes.

A type 1S4 button-base tube having a 1.4-volt filament was found to be most suitable. When operated as a triode, its plate resistance was sufficiently low to provide favorable comparison with the smaller power triodes for bridge use.

Design Procedure

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

\[ e = E \left( \frac{R_2}{R_1 + R_3} - \frac{R_4}{R_1 + R_4} \right) \]  

(1)

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

\[ R = R_1 + R_2 + R_3 + R_4 \]  

(2)

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

\[ I_o = e/R \]  

(3)

For assumed increments of \( R_2 \) and
operation

of

input

signal

in

activity

be

to

resistance

of

wires

of

were

resistance

of

of

of

the

of

the

of

the

the

of

of

the

of

the

the

of

the

of

the

of

the

of

the

of

the

of

the

of

the

of

the

of

the

of

the

of

the

of

the

of

the

of

the

of

the

of

the

of

the

of

the

of

the

of

the

of

the

of

the

of

the

of

the

of

the

of

the

of

the

of

the

of

the

of

the

of

the

of

the

of

the
**Logarithmic Photometer**

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

**By Monroe H. Sweet**

Physics Laboratory
Anesco
Binghamton, N.Y.

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

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

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

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

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

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

**Principle of Operation**

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

**USEFUL CIRCUITS**

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

**FIG. 1—Basic feedback circuit for producing logarithmic relation between light intensity and dynode voltage of multiplier phototube**
the dynode voltage is adjusted so as to maintain constant anode current in the presence of variations in incident light intensity, the relationship between the logarithm of light intensity and voltage will be

\[ \log F = -(n/2) \log V + k' \tag{2} \]

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

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

**Voltmeter Response**

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

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

and

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

For practical multiplier tubes such as the S31-A or 1P21 the relationship for \( d (\log S)/dV \) versus \( V \) indicated in Fig. 2 is representative and it will be observed that a range of 25 to 70 volts per stage corresponds to a sensitivity ratio of 1,000 to 1. It will be noted that the actual slope \( d (\log F)/dV \) is reasonably uniform over this voltage range, more so than Eq. 3 indicates, and the slight nonlinearity of this function can be compensated by the corrective output circuit whose basic features are shown in Fig. 3.

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

**High-Voltage Supply**

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

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

**Control Tube**

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

1. Optimum signal-to-noise

![Figure 2](image-url)

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

![Figure 3](image-url)

**Figure 3**—(below) Automatic electrical introduction of meter shunts compensates for nonlinearity of phototube circuit response.
ratio for multiplier phototubes of present day construction occurs when they are operated at about 70 to 95 volts per stage. Higher voltages give rise to spurious gas discharge pulses and overall instability.

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

By using an 807 power pentode as shown, it is possible to operate the multiplier tube under conditions which give excellent stability and sensitivity. Because the total dynode voltage varies from approximately 300 to 900 volts, the 807 plate to cathode voltage will range from about 850 to 250 volts. The 807 control tube meets the requirement for extremely low grid current, even in the presence of very high plate voltages. Tests conducted with several 807's at 1,000 volts plate to cathode voltage show that if the screen voltage is maintained at 40 volts the grid current is less than 0.01 µa over a plate current range of 0-8 µa. Under these conditions and with a 135,000-ohm load the voltage gain of the tube is quite high, about 150, so that the control-grid to cathode voltage varies by only 4 volts over a light intensity range of 1,000 to 1.

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

- **Figure 5**: Voltage versus current relationship of anode of multiplier phototube for constant dynode voltage and constant incident illumination.

- **Figure 4**: Complete logarithmic multiplier phototube photometer circuit.
some extent with voltage, particularly at low voltages, as is evident from the curve shown in Figure 5.

Regulated Low-Voltage Supply

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

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

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

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

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

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

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

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

Calibration and Accuracy

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

The output meter had been pre-calibrated to indicate density uniformly with respect to input current. As mentioned earlier, the uncompensated log \( P \) (or density) versus dynode voltage characteristic is not strictly uniform. However, it is sufficiently close so that, with the meter shunt properly adjusted, density readings from 0 to 0.8 are in satisfactory agreement with the reference densities without resort to compensation. By

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

FIG. 6—Improved gaseous tube stabilizer circuit makes voltage across load resistance independent of input over a wide voltage range
adjusting the \( S_1 \) rectifier voltage tap of Fig. 3 so that the rectifier passes current only at densities of 0.8 and higher, correction is effected at densities above 0.8. In this way the instrument response is satisfactorily corrected for densities up to approximately 1.5. Similarly, by adjustment of the voltage tap for rectifier \( S_2 \) additional correction can be obtained for densities above 1.5. By proper choice of both the two rectifier voltage taps and the supplementary shunt resistors \( r_1 \) and \( r_2 \) satisfactory accuracy was obtained over the whole range (0 to 3). The corrective action is smooth and instantaneous and thereby facilitates use of the circuit in conjunction with automatic recording instruments.

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

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

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

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

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

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

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

**REFERENCES**

(3) Hoetnner and Brewington, The Applications of Multiplier Phototubes to Quanti
(4) Iwae and Crosswhite, Direct Measurements of Spectrum Lines with Photo
(5) Neumann, Nolle, and Peterson, A Photometric Instrument for Direct Spectro
(6) Patents on novel features of this circuit have been applied for.
(7) For a discussion of various types of optical density, see American Standard for Diffuse Transmission Density Z88.2—Annex.
Phase-shifting properties of a resonant circuit provide automatic self-adjustment of a radio control system. Guided missiles, aircraft, satellite transmitters, and telemetering systems can be radio controlled by the stepless positioning provided.

By DAVID W. MOORE, JR.
Engineer in Charge
Fairchild Camera and Instrument Corp.
Jamaica, New York

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

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

Resonant Circuit

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

FIG. 1—Near resonance, the phase angle changes rapidly. Advantage of this characteristic is taken in design of the control system
resonant frequency of the circuit to the applied voltage frequency. If the resonant frequency of the circuit is the same as the line frequency, the current flowing will be in phase with the line voltage and the series resonant circuit is said to be tuned to resonance with the line.

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

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

**Use of Servo Motor**

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

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

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

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

**Motor Controls Inductance**

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

In appearance, the variable inductance resembles a motor. Figure 4 shows the construction of a double variable inductance unit. There are no windings on the rotor, and conse-
quently no brushes or slip rings to wear and deteriorate. The inductance variation is linear for a little more than sixty degrees rotation of the shaft.

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

Values of Circuit

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

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

The control whose calibration is shown in Fig. 7 was adjusted for a different frequency band, seventy degrees of motion being controlled by a frequency variation from 135 to 198 cycles. The value of inductance is 28.2 henrys and the tuning capacitor 0.035 \( \mu \)F.

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

Torque-error Data

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

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

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

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

Complete System

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

The radio position transmitter is designed to operate in conjunction with a standard type of audio-frequency oscillator and adjusts the tuning control of the oscillator until its output frequency is equal to the resonant frequency of the circuit \( L_2C_2 \). The resonant frequency of this circuit is adjusted to the desired value.
by setting $L_n$ manually or otherwise. The oscillator frequency is then transmitted by radio to the radio position receiver.

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

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

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

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

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

Small, two-phase, servo motors operating in the type of circuits shown will develop adequate power to set the controls of an automatic pilot in any aircraft to be remotely guided. More power, to adjust the aircraft control surfaces directly, could be easily obtained by having the two-phase, servo motor operate a hydraulic pilot valve or through the use of thyratron tubes. Other interesting variations can be worked out.
LIMITERS, as the name implies, are restrictive devices. The limiter circuits discussed in this report are curative means designed to mitigate the effects of undesired electrical disturbances of an impulse nature, such as static, ignition noise, and radar signals, on the output of radio receivers designed particularly for amplitude-modulated communications use.

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

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

Instantaneous Noise-Peak Limiters

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

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

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

Series Noise-Peak Limiters

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

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

Simple Series Limiter

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

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

---

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

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

By EMERICK TOTH

Associate Head, Receiver Section
Electronics Shipboard Radio Division
U. S. Naval Research Laboratory
Washington, D. C.

November, 1945 — ELECTRONICS
OUTPUT LIMITERS

Part I

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

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

Under the above conditions, capacitor $C_t$ is charged through

to assume a new potential. Therefore, if a noise potential of perhaps 100 volts suddenly appears across $R_t + R_2$ and brings the plate of the limiter diode to $-50$ volts from ground potential, the diode plate becomes about 43 volts more negative than its cathode and the diode stops conducting. This in effect disconnects output capacitor $C_t$ from point $B_t$ and the a-f amplifier has no appreciable input for the duration of the noise modulation. By the time that the cathode of the limiter diode has assumed an effectively more negative potential, the noise pulse will usually have decayed and the limiter diode will have become conductive again, restoring the a-f input to the audio amplifier.

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

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

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

1-megohm resistor $R_2$, to a potential of about $-7$ volts. Any appreciable change in this potential would require about 0.01 second, due to the time-constant of $R_2C_w$. The time-constant of $(R_t + R_2)C_t$ is, however, only about 50 microseconds, so that the potential at the limiter diode plate can change in about $1/200$th of the time required for its cathode.

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

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

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

**Series-Type Noise Limiter With Threshold Adjustment**

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

The modified circuit, shown in Fig. 4, may also include an additional diode. This is shunted across resistor \( R_c \) to buck the internal (thermonic) potential of the limiter diode, as this residual voltage reduces the effectiveness of the limiter at low carrier levels by raising the limiting threshold in terms of modulation percentage. The voltage built up across \( R_c \) due to rectified direct current from the detector will, together with the time-constant of \( C_i \) and the grid resistor in the first a-f stage, tend to maintain this additional diode biased to cutoff, except on weak signals. The price paid for this improvement in weak-signal limiting, however, is generally a considerable increase in audio distortion at all useful levels. Making the time-constant of \( C_i \) and the audio amplifier grid leak equal to that of \( R_c \), will assist in keeping this increase in distortion to a minimum.

**Low-Loss Series-Type Noise Limiter**

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

The cathode of limiter diode \( D_2 \) is biased negative relative to its plate by connection to the junction of detector-load resistors \( R_2 \) and \( R_4 \). Through resistors \( R_4 \) and \( R_6 \), \( R_6 \) and \( C_3 \) provides a long-time-constant circuit similar to \( R_5 C_1 \) in Fig. 1 while \( R_5 \) serves as the cathode load resistor across which the limiter output voltage is developed in a manner similar to \( R_5 \) in Fig. 1. Capacitor \( C_2 \) provides a-f coupling to the plate of \( D_3 \) for the detector a-f output voltage appearing between the junction of \( R_2 \) and \( R_4 \) and ground. Resistor \( R_1 \) serves only as an r-f filter element. The action of this circuit in limiting peaks of noise or other modulation is identical to the circuit shown in Fig. 1, the plate of \( D_4 \) being free to follow variations in detector a-f output voltage, while the cathode circuit is held by the longer time constant of \( R_6 C_1 \).

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

**Hum Reduction in Simple Series Limiter**

When using the simple series limiter circuit of Fig. 1 with a 6H6 duodiode, the hum voltage appearing across \( R_4 \) may be approximately halved by grounding that end of the heater which is closer to the cathode element used for the limiter diode, since in the 6H6 the individual diode heater windings are in series. With even fairly high-gain a-f amplifiers, however, the hum will usually be troublesome even though this precaution is taken.

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

The equivalent circuit is that of a bridge, with \( e_c \) as the limiter diode heater voltage (normally grounded on one side in most receivers) and \( C_{he} \), as the heater-cathode capacitance. \( R_4 \) and \( C_4 \) form another arm of the bridge and are shunted by the equivalent resistance \( R_4' \) which is a composite of \( R_4 \), \( R_4' \) the effective resistance of \( D_2 \), etc. \( R_3 \) is the cathode bias resistor for a-f amplifier tube \( V_4 \). The
bridge configuration is completed by capacitor \( C_1 \), which is connected between the ungrounded side of the heater supply and the cathode of \( V_n \). Fortunately, the value of \( C_1 \) with the usual limiter circuit values is quite low; in the circuit shown it is only 150 \( \mu \)F. It should be noted that this hum-bridge scheme allows normal location and operation of the a-f gain control \( R_n \) even to the extent that despite unby-passed cathode resistor \( R_e \), the gain control can reduce the input to \( V_s \) substantially to zero, since its low end returns to the cathode of \( V_n \). It should also be noted that, if a LIMITER ON-OFF switch is used, two different values of \( C_1 \) will be required, due to slight changes in bridge configuration when switching from the cathode to the plate of the limiter diode.

**Balanced-Detector Noise Limiter**

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

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

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

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

**Automatic Balanced-Detector Noise Limiter**

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

**Balancing-Type Noise Limiter**

The balancing (or bucking) effect of a diode shunted across the second detector with reversed polarity is used in the circuit of Fig. 9. When the limiting threshold is passed, as on noise peaks, the variations in limiter diode current oppose the normal demodulation current in the second detector. Assume that an unmodulated car-
rier produces a rectified potential of 10 volts across second detector diode load $R_s$, making point A 10 volts negative with respect to ground. Then, on positive peaks of carrier input, point D will be close to ground potential, because point A remains relatively constant over an r-f cycle and the 10-volt positive r-f peak across the i-f transformer secondary acts to cancel the negative 10 volts at A. On negative peaks, point D will therefore be about -20 volts with respect to ground.

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

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

**Triode Shunt-Type Noise Limiter**

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

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

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

**Simple Diode Shunt-Type Noise Limiter**

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

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

**Modified Shunt-Type Noise Limiter**

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

Assume a constant carrier making point $E$ on the detector diode load 10 volts negative with respect to A (ground). Points $B$ and $C$ are then both -5 volts to ground because the limiter diode is nonconducting, its plate being effectively at the -10 volt potential of $E$. The plate circuit time-constant is much longer than that of the cathode circuit of the limiter, so that any noise surge in excess of 20 volts across the entire detector load drives the cathode of the limiter diode more than 10 volts negative with respect to ground and the diode conducts, shunting the input to the follow-

ing a-f stage. This shunting action is made more effective by series cathode resistor $R_c$, which with the limiter diode closed acts as part of a voltage divider to attenuate detector-load voltage peaks. Limiting action ceases when $C$ becomes positive with respect to $D$ due either to decay of the noise pulse or to charging up of $C$. The limiter will begin to cause audio distortion at about 100-percent modulation for the values shown. If $R_2$ equals 0.4 $R_n$, distortion will begin at about 40 percent modulation and a greater percentage of the a-f output developed across the detector load will be available to the following a-f amplifier. This limiter has been found to be much more effective than the simple shunt limiter, although not as good as the simple series-type limiter at the lower carrier frequencies.

**Degenerative Noise Limiter**

Degenerative feed to the i-f amplifier prior to final detection is used in the circuit of Fig. 13. A portion of the output from the first i-f amplifier is amplified in the first and second noise limiter amplifiers, and the resulting i-f output is coupled into a full-wave rectifier having $R$, as a load. The d-c voltage developed across $R$, provides the bias for the injector grid of a 6L7 pentode serving as the final i-f amplifier tube. Front-panel control $R_2$ provides a positive delay voltage for the diode cathodes, to prevent rectification until signal or noise peaks exceed this bias. Since the time-constant of the diode load is only 5 microseconds, the d-c potential across $R$, can fluctuate at a rate of up to about 200 kc.

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

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

![Fig. 13—Degenerative noise limiter, acting between first and second i-f stages](www.americanradiohistory.com)
TEST OSCILLOSCOPE for Television

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

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

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

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

Choice of Standard Oscilloscope

Use of the type 5JP1 cathode-ray tube is advantageous since the deflection plate leads terminate on the
bulb. This feature minimizes capacitance coupling between horizontal and vertical plates, and simplifies the r-f circuit. It is desirable to shield the tube electrostatically by wrapping it in a sheet of copper foil as shown in Fig. 2, and to provide an aluminum or brass case for the whole instrument. In addition to shielding it is wise to isolate the leads from the horizontal sweep amplifier by some resistance to prevent any possibility of resonance in these lines. For this purpose 1,000 ohms was found satisfactory.

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

The most critical consideration when using very high frequencies for vertical deflection is the tendency of these voltages to stray over to the horizontal deflection plates, causing a curvature of the parts of the pattern that should be vertical. The resulting image distortion can be prevented by symmetrical voltage distribution in the r-f circuit and effective r-f bypassing of the horizontal deflection plate leads. Capacitors must be selected that will have a low reactance at carrier frequency but a high reactance through the tenth harmonic of the horizontal sweep frequency. A 250 microfarad capacitor has a reactance of 10.7 ohms at 60 megacycles and 8,100 ohms at 7,875 x 10 cycles and gives good results. The frequency 7,875 is one half the 15,750 cycles required for horizontal scan in 525-line television. This sweep frequency permits patterns of two scan lines to be shown on the screen.

The vertical deflection plates are driven by a tuned circuit that provides enough voltage at resonance to produce adequate deflection with small power input. In the lower group of television channels, 44 to 88 megacycles, a split-stator capacitor of 20 to 30 micromicrofarads per section is used for tuning. It is not necessary to load the circuits to pass the wide sideband since the highest frequency components in the extremes of the sideband are not necessary for ordinary measurements.

The center of the coil feeding the vertical deflection plates must be grounded to provide the required d-c potential on these plates. The rotor of the tuning capacitor may also be grounded. This common ground must be connected to the shield on the cathode-ray tube by a strap, ribbon, or wire of large area and as short as is feasible. Such an arrangement assures symmetry of voltage on the vertical deflection plates and reduces coupling to the horizontal plates.

A coil suitable for the lower group of television frequencies can be wound with no. 12 wire on a ½-inch form. An 8-turn coil of this diameter has been found suitable for the 60- to 66-megacycle channel. One or two turns more or less will be required for other channels of the group.

R-F Pickup

To secure a balanced feed, a dual coaxial line is desirable. The line should be flexible so that it can be run through conduits or wire ducts with ease and its losses are low enough so that almost any reasonable length can be used.

Coupling coils at the input and output of the feed line are connected to the inner conductors and not to the outer sheath. The feed line input coil is a ½-inch, one-turn loop inserted part way into an opening in the outer conductor of the transmitting antenna coaxial line just outside the transmitter cabinet. Where the coaxial line enters the oscilloscope cabinet the outer sheath must be grounded to the metal cabinet. The cable terminates in a two-turn coil of ½-inch diameter and is loosely coupled to the tuned circuit of the oscilloscope.

Since such a loop cannot be expected to provide an entirely nonreflecting termination there will be some standing waves in the line, and some degree of unbalance in spite of precautions. Coupling between loop and tuning coil is ad-
justed by trial, inserting the loop a small distance between the turns of the coil; the most effective point may be found one or two turns above or below center as shown in Fig. 2. Because of standing waves in the line it is possible for the loop initially to be at a low-current point in the standing-wave pattern, in which case the line can be shortened somewhat.

Synchronizing voltage for the horizontal sweep may be taken from a video line if available or, if more convenient, it may be taken from the r-f signal (Fig. 1). The detector circuit shown is suitable for either method.

A small pickup coil of two turns is loosely coupled to the lower end of the tuned circuit and applies about a volt to the cathode of the 6H6 tube. This tube is located directly below the pickup coil so that the leads are kept short. Peaks of the r-f signal corresponding to the synchronizing pulses are rectified, biasing the cathode of the diode positively so that only synchronizing pulses appear in the plate circuit.

The diode performs the two functions of rectifying r-f and clipping off picture components. Negative impulses appear across the plate load resistor. If video signals are used for synchronizing, they may be applied to the diode that will serve in the same way to separate synchronizing pulses from the picture. If the pulses are negative with respect to ground, the signal is applied to the cathode of the 6H6 tube in the same manner as the r-f signal. If the pulses are positive, they are applied to the plate of the diode through a network consisting of 0.05 microfarad capacitor and a one megohm resistor. The output is then taken from the cathode across a 25,000-ohm load resistor. In this case the output pulse is positive. This difference of polarity does not adversely affect synchronization of the sweep for reasons that will be pointed out later.

**Signal Amplifier**

The output pulses from the detector are amplified by the two-stage amplifier utilizing a type 6N7 tube that operates without external bias since the plate current is sufficiently limited by the 10,000-ohm plate resistors. As long as there is a substantial signal applied to this amplifier, grid rectification provides bias for the tube. The time constants of the grid resistor and coupling-capacitor networks are large enough to permit amplification of the 60-cycle field scanning impulses.

Impulses passing through the amplifier will usually be of both line and field frequencies. It is the function of the two networks in the plate circuit of the left section of the 6N7 tube to separate the two frequencies so that either can be applied to the horizontal sweep oscillator of the scope. The network consisting of two 8.250 ohm resistors and 0.005 microfarad capacitors, separates by integration the vertical pulse from the composite of both pulses. After separation the pulse is partially differentiated by the 3,500 micromicrofarad coupling capacitor and the 884 tube grid resistor producing both a positive and negative pip as shown in Fig. 3. Therefore, the polarity of the pulse from the 6N7 amplifier is unimportant since the 884 tube will always receive a positive impulse on which it synchronizes best.

The horizontal pulses are separated from the vertical by differentiation in L. Again a positive and negative swing is produced, as shown in Fig. 4, to synchronize the 884 tube.

Switching circuits are provided to select synchronizing voltage from either the vertical or horizontal separator output or from the 60-cycle line.

Appropriate RC networks can be switched into the plate circuit of the 884 tube to generate suitable sawtooth waves at 30 and 7,875 cycles for sweep speeds to show either frame or line patterns. Provision is made for external deflection for special cases. A potentiometer in the plate circuit of the 884 tube permits continuous adjustment of sweep frequency over a range from 3 or 4 lines or frames to one line or frame. The sawtooth output of the sweep oscillator is amplified by a 6F8G and two 6V6 tubes in a conventional circuit before being applied to the horizontal deflecting plates. A back-trace blanking impulse is fed to the cathode ray tube from the cathode circuit of the 6F8 tube.

**Use of the Instrument**

A typical pattern of two frame periods of a television signal as it appears on the oscilloscope screen is shown in Fig. 5. The synchronizing pulse envelope may be seen at the vertical extremities of the pattern. Between these the horizontal line indicates the peaks of the line impulses.

At the base of the synchronizing impulses, the bright line indicates the blanking pulse shoulders or black level. The whole central portion of the pattern is taken up with picture components.
A TWO-WAY radio system employing frequency modulation on 37.18 megacycles has proved the answer to West Penn Power Company's problem of providing quick and reliable communication between central stations and service trucks when line trouble develops. Fourteen trucks have been equipped, each having a 35-watt transmitter, and the 250-watt fixed station with call letters WNAA is now in regular operation at the company's principal substation. Reliable reception is obtained in trucks within a 30-mile radius of Charleroi in all kinds of weather, and the station has been heard up to 150 miles away. Mobile radio is now being planned for the rest of the system.

**ABOVE—Transmitter of main station is located in small house at base of tower, and remotely controlled from four points in Charleroi, Pa.**

**LEFT—Transmitting antenna atop 175-foot steel tower**

**LOWER RIGHT—Radio hand-set and control panel are conveniently located in cab of each truck. Controls are, left to right: squelch switch, transmitter pilot lamp, receiver pilot lamp, and volume control. Receiver is in operation at all times for emergency calls, and push-to-talk switch on hand-set is the only transmitter control**
Components of

By EDUARD KARPLUS

Engineer
National Defense Research Committee
Cambridge, Mass.

Frequency limits of electronic equipment were rapidly pushed into the hundreds of megacycles during war development. To learn about propagation and equipment capabilities a field strength meter was developed for the range from 300 to 1,000 mc. This meter was intended for measurements in the laboratory or field. It had to be quickly tunable to any frequency within its range. A sensitive receiver, which could be calibrated by a standard signal generator, was required to measure the voltage induced by an unknown field in an antenna of known characteristics. The completed equipment for making these measurements is shown in Fig. 1.

Field Strength Measurements

In using the field strength measuring equipment the antenna and receiver are tuned to the incoming signal; the antenna is disconnected from the receiver and replaced by a dummy antenna and a standard signal generator which is adjusted to give the same receiver response. The field strength in microvolts per meter is related to the standard signal generator voltage \( E \) in microvolts by

\[ e = E \frac{1}{h_a} \]

where \( h_a \) is the height of the antenna in meters. If the antenna is adjusted to half-wave resonance

\[ h_a = 0.636l = 0.636 \frac{\lambda}{2} = 0.5 \]

to a first approximation, where \( f \) is the operating frequency in megacycles. Therefore the unknown field strength is

\[ e = 0.0105f E \]

The receiver and the standard signal generator have since found wide application in other fields, and, although the original models are obsolete today, many of their components will be found useful in similar applications.

Tuned Circuits

The butterfly circuit, as well as its application in negative-grid triode oscillators, has been described in detail, but the wide interest shown in this development justifies a few further remarks.

The butterfly circuit used in the signal generator has 2\( \frac{1}{2} \)-inch outside diameter and 5 and 6 plates on the rotor and stator respectively, has a tuning range of 220 to 1,100 mc and is equipped with terminals for grid and plate of the oscillator tube. The butterfly circuit can be considered a parallel combination of inductances and capacitances. This combination is seen in the schematic diagram of Fig. 2 where the capacitive branch is represented by two series capacitors and the inductive branch by two parallel inductors between terminals one and two. Variation of both capacitance and inductance is brought about by rotation of the inner, butterfly shaped, member. The capacitive branch is the familiar series-gap tuning capacitor. Variation of the two identical inductive branches is achieved as the rotor progressively blocks out the area through which a magnetic field can pass.

At 220 mc, with the plates fully

FIG. 1—Field-strength meter and standard-signal generator developed for National Defense Research Committee by General Radio Co. to be used for measurements between 300 and 1,000 mc

November, 1946 — ELECTRONICS
UHF Field Meters

Tuning limitations of resonant circuits, tunable doublet antenna, uhf voltmeters, cavity attenuators, power-supply stabilizer of early model of field-strength meter, and standard-signal generator are described.

meshed, the effective inductance of the circuit is 0.011 μh, the effective capacitance is 48 μf, and the effective Q is 650. The corresponding values at 1,100 mc are 0.004 μh, 5 μf, and a Q of 300.

Common to all butterfly circuits is a series-gap capacitor for capacitance variation across two fixed terminals, which eliminates the necessity of sliding contacts, and the direct incorporation of a parallel inductive path into the structure of this capacitor. This integral design is important in reducing metallic losses at points where capacitive and the inductive paths of the tuned circuit join and makes it possible to use lumped parameter elements at these high frequencies. The eddy-current shielding effect of the rotor plates, which reduces the effective inductance in the high frequency position, helps to obtain very wide tuning ranges, but increases the losses to some extent.

If low losses are important, and wide tuning ranges are not required, butterfly circuits should not be used. Better results can be obtained with a cylinder circuit. This circuit can be represented by a diagram similar to Fig. 2 with a single and fixed inductive branch. The tuning ranges of cylinder circuits are considerably smaller than the ranges obtained with butterfly circuits, but their losses are lower and their Q's are practically constant. A cylinder circuit with cylinders one inch in diameter and two inches in length has a tuning range of approximately 500 to 1,000 mc with a Q of 1,200.

In a broadcast receiver a three-to-one frequency variation is ordinarily produced by a 180 degree rotation of the capacitor shaft, but a typical butterfly circuit varies from 220 to 1,100 mc between two rotor positions which are only 90 degrees apart. To compensate for this difference, and for an uneven frequency distribution, the angular precision of the drive has to be about seven times better in the butterfly circuit than in a comparable variable capacitor circuit. The precision required to prevent axial movement of the plates is the same in both cases provided the air gap and the care used in centering the plates are equal. This relation is based on percentage accuracy and has to be multiplied by the ratio of frequencies if frequency increments are considered. In our example this ratio would be 1,000.

Frequency Limits

The 220 to 1,100 mc butterfly circuit has an air gap of 0.04 centimeter, which is not adequate for high-power applications. If this air gap were changed to 0.2 centimeter, the maximum capacitance across the terminals would be reduced to one fifth its previous value and the frequency range would be 500 to 1,000 mc, to a first approximation. This large reduction in tuning range cannot be offset by an over-all increase in the size of the unit. A 50 percent increase in diameter would increase both capacitance and inductance by a factor of about 2.3 and would approximately restore the bottom frequency of 220 mc, but the top frequency would have dropped to under 700 mc. An increase in the number of plates would seem to be a possible solution, but unfortunately butterfly circuits with more than a certain number of plates have spurious modes which interfere with their proper operation. It appears, therefore, that the maximum size and the maximum number of plates that can be used in a butterfly circuit are limited by the top frequency, and that the bottom frequency is then determined by the air gap.

In practice it is very hard to compute the top frequency of a butterfly circuit without a good deal of experi-
mental data taken from similar designs because the mechanical shapes determining both capacitance and inductance are too complicated for simple approximations. The bottom frequency can be obtained with reasonable accuracy if the capacitance of the series gap capacitor is computed as in any low-frequency application and the inductance as

\[ L = 4.0 \, \log_{10} \left( \frac{r}{t + w} \right) \cdot 10^{-4} \text{ Henry's} \]

where \( r \) is the inside radius of the butterfly stator plates and \( t \) and \( w \) are thickness and width of the stator stack, all in centimeters. To arrive at an estimate of the top frequency of a butterfly circuit, a range factor is used which varies between two and 12 for the circuits that have been built so far. The range factor increases as frequency and air gap are reduced.

**Tunable Resonator**

Another component of general usefulness is a tunable resonator which is incorporated in the signal generator and in the receiver of the field strength measuring equipment. In both cases resonators with a five-to-one frequency range were required and adjustment by turning a dial seemed desirable. Figure 3 shows schematically these two applications.

In Fig. 3A a 70-ohm feeder line is connected to a doublet antenna, the length of which has to be \( \frac{\lambda}{4} \) at the operating frequency. In Fig. 3B a mutual inductance type attenuator is coupled to a 220 to 1,100 mc butterfly oscillator. A quarter-wave resonator with the current loop in the attenuator produces a strong field of the desired mode and reduces in proportion undesirable modes which might otherwise cause errors in attenuation.

This same system was used in a 1,000 to 3,000 mc signal generator to select, in addition, the second and the third harmonics of a 500 to 1,000 mc oscillator. In this particular case the oscillator used a quarter-wave open line and could be driven much harder for harmonic generation than would be possible with a butterfly oscillator.

In both cases conventional telescoping tubes could have been used, conveniently located dial. By proper choice of the location and size of the insulated pulleys inside the oscillator housing, coupling between the resonator and the oscillator can be adjusted over the frequency range.

Conditions in the tunable antenna are somewhat different because no ground plane is available for separating the used and the unused parts of the resonator. In that case, the flexible resonator is fed through a hollow feeder line as shown schematically in Fig. 4B. The feeder line is composed of two tubes spaced to provide the desired characteristic impedance of 70 ohms and bent at the upper end to give the flexible resonator a right angle deflection. The unused parts of the resonators are within the feeder lines and do not disturb the field of the antenna.

To avoid complications, a driving mechanism has been omitted in the 220 to 1,100 mc doublet antenna shown in Fig. 5. The feeder lines are aluminum channels spaced for 70-ohm characteristic impedance by a polystyrene bar. The flexible conductors are self-supporting flat strips of slightly curved spring material, similar to the strips used in the familiar steel rules. Adjustment of antenna length is easily made by hand using pins which are fastened to the conductors and project through the aluminum channels.

**Crystal Detectors**

After a careful study of uhf voltimeters, it was decided to use a crystal detector as the rectifying element because, in spite of all their shortcomings, voltmeters of this type can be built with lower corrections for frequency than any of the others. A suitable crystal detector had to be developed for this application in 1941, but today completely sealed detector cartridges with standardized dimensions and reliable performance are available.

Up to a few thousand megacycles the action of the detector junction is independent of frequency if precautions are taken in its manufacture and the frequency characteristic of a crystal detector type voltmeter is determined by its resonant frequency. Series resonance of the shunt capacitance of the detector junction and the lead inductance between voltmeter terminals increases
the voltage \( E \) appearing across the detector junction with respect to the terminal voltage \( e \) and causes a corresponding frequency error \( F \) such that

\[
F = \frac{E}{e} = \frac{1}{1 - (f/f_s)^2}
\]

where \( f \) and \( f_s \) are operating frequency and resonant frequency of the voltmeter respectively. In any particular voltmeter design the resonant frequency \( f \), varies only slightly with individual detector cartridges. In a typical application, using the type 1N21-B detector, which is the most suitable for this purpose, the resonant frequency varies from 3,500 to 3,900 mc, corresponding to a frequency error of 9 to 7 percent at 1,000 mc.

Erratic variation or drift of crystal detectors have been largely reduced by modern design and it has been found that in most cases the drift is independent of frequency. Because this assumption is certainly correct for small drift, detectors can be checked periodically and corrected at any convenient frequency, for instance at 60 cps.

Another peculiarity of crystal detectors which sets them apart from vacuum-tube voltmeters and thermocouples, ordinarily used at lower frequencies, has to be mentioned as it bears on their application. Vacuum-tube voltmeters can be built for a wide range of voltages, and their circuits can be so designed that no permanent damage is done by overloads. Thermocouples can be built for a wide range of currents. They are readily burned out, but this damage is immediately obvious. Most crystal detectors will not stand more than a few volts, and great care has to be taken to prevent overloads which might change the characteristic of their junction before it is made ineffective or burned out.

**Attenuator**

A voltmeter placed at the input to the attenuator of a signal generator will read independently of attenuator setting, but a voltmeter placed at the output terminal will read only over a limited range of low attenuation. It would seem, therefore, that the first location, which is always used at low frequencies is more desirable, but at ultrahigh frequencies the second method will give more accurate results.

In both cases the accuracy at low output voltages depends on the attenuator calibration, which can be computed precisely for the mutual inductance type attenuator commonly used at ultrahigh frequencies. The quarter-wave resonator described in connection with Fig. 3B is not required, and better results are obtained if the end of the attenuator tube is fitted with a shield to exclude undesirable modes and is pointed toward a part of the oscillator circuit which carries current in the plane of the pickup loop. The field of this current passes the shield and enters the attenuator tube where it is attenuated logarithmically, decreasing by 32 db for each diameter traveled.

If a voltmeter is placed at the output side of a line connected to the pickup loop, a reference point of attenuator output voltage can be established for any position of the pickup loop that provides sufficient voltage to make the meter read, and accurate lower output voltages can be obtained by moving the pickup loop by accurately determined amounts. A complete output system of this type includes resistors, \( R \), and \( R_L \) and capacitor \( C \), as shown schematically in Fig. 6. Resistor \( R \) is required to terminate approximately the short line between pickup loop and voltmeter in order to prevent excessive voltage rise which might overload the crystal detector, if the proper load is not connected. Resistor \( R_L \) is a matching resistor to provide desirable values of output impedance. It will ordinarily be determined by the characteristic impedances of the cable connecting the load and was 70 ohms in the field strength measuring equipment to simulate the radiation resistance of the doublet antenna. Capacitor \( C \) is sufficiently large to be

---

**FIG. 6**—Output meter of standard-signal generator can be located at output of attenuator

**FIG. 7**—Output meter of standard-signal generator can be located at input to attenuator

---

WEB: www.americanradiohistory.com
ineffective at radio frequencies and has been inserted only to facilitate low frequency calibration of the crystal detector.

In this output system, the accuracy of output voltage at the reference point is determined by the voltmeter alone and does not depend on any other circuit elements. The accuracy of the output impedance is determined by \( R_z \) alone because this resistor is immediately preceded by the output voltmeter, which can be considered a zero-impedance source. Obviously no signal generator could have sufficient power to meet this requirement, but as long as its output voltmeter is reset to the same value whenever the load is changed, the terminals of the voltmeter have all the characteristics of a zero-impedance source. In operation, therefore, the reference level of the logarithmically calibrated attenuator has to be established with the load connected, and as we have seen, this has to be done at a high output level to provide a reliable reading of the output meter. If, for some reason, the load changes with the signal amplitude, the attenuator calibration will be in error.

**Alternative Output Circuit**

To follow the more conventional output system the voltmeter is placed at the attenuator input as shown in Fig. 7 where it samples the field in the attenuator tube. This field decreases within the attenuator according to the same logarithmic law as before. Output voltage depends on the size and position of the pickup loop, the output impedance on the characteristic impedance, and length of the short line connecting the pickup loop with the output terminals. To eliminate a frequency dependent effect, this line has to be terminated at the pickup loop. Resistor \( R \) is inserted for this purpose, but because the reactance of the pickup loop itself is included in the determination, an accurate solution of this problem is difficult at uhf.

If an adequate solution is possible at lower frequencies, however, or over a limited range at some high frequency, two advantages are obtained, compared to the output system shown in Fig. 6. That the output meter reads at all attenuator settings is convenient as mentioned before. In addition the generator voltage is now independent of the load because it is determined by field strength in the attenuator tube.

Both these disadvantages of the simpler and more accurate system, which uses the meter at the output terminal, can be overcome. The crystal-detector type output meter has to work at a low level to prevent damage to the crystal junction and will not be able to indicate modulation peaks. By coupling a high-level peak-reading diode voltmeter to the oscillator, modulation can be determined accurately. In addition, a permanent indication of oscillator amplitude is obtained which is useful for monitoring purposes even if it cannot be made proportional to the output voltage. To eliminate errors caused by a load that changes its impedance at high levels, an attenuation pad can be inserted between the terminal of the signal generator and the load, or resistance \( R_z \) and \( R_g \) of Fig. 6 can be rearranged to give a fixed initial attenuation.

No matter which attenuator output system has been used, terminals for connecting the load have to be provided. At uhf this connection is always a matched concentric cable, and no particular advantage is obtained by locating the signal generator output terminal at the end of another cable as is customary at lower radio frequencies. The output terminal, in form of a concentric cable fitting, can be located on the front panel of the instrument.

**Regulated Power Supply**

Another problem encountered in the design of the field strength measuring equipment concerns the power supply. The equipment was built for 60-cps operation, but for at least part of the time the power required had to be produced by a motor-generator set driven from a storage battery. Under these conditions both voltage and frequency vary widely. Some means had to be provided to regulate filament and plate supplies.

The regulated power supply adopted for the field strength measuring equipment presents a solution of this problem by magnetic and electronic means. The fundamental schematic diagram is shown in Fig. 8.

The two outer a-c windings of the regulator are connected in series with the power transformer. A d-c winding is energized from a twin triode tube \( T \), which acts as a grid-controlled rectifier. The reactance of the regulator is determined by the d-c
current in the middle winding and automatically varies to maintain the primary voltage of the transformer constant.

Control voltage for the rectifier tube \( T_1 \) is derived from the main B-supply. At normal line voltage the grids of tube \( T_1 \) are slightly negative with respect to its cathode and allow some current to flow through the d-c winding of the regulator. At higher line voltages the grids become more negative because the voltage across the glow tube \( T_2 \) does not change. The rectified current through \( T_1 \) then decreases and the impedance of the regulator increases to bring the primary voltage of the transformer back to its previous value.

**Regulator Design**

Figure 9 shows voltage and current relations of the system for minimum and maximum line voltage \( E_{1a} \) and \( E_{1b} \). Line current \( I \) and transformer voltage \( E_1 \) are independent of line voltage. \( E_a \) and \( E_m \) are the voltages across the regulator which are out of phase with the line current except for a small component which covers the a-c losses in the regulator and increases slightly with line voltage. Input power, therefore, is essentially constant including a regulator loss of about ten percent. The phase angle of the input power varies between \( \phi \) and \( \phi_a \) and can be corrected for average line voltage by a fixed capacitor across the line terminals.

To compute the regulator characteristics, the power required by the instrument and the expected line voltage variations have to be known. By assuming a minimum voltage drop \( E_{m} \) in the regulator, the operating voltage of the transformer \( E_1 \), the line current \( I \), and the maximum volt-amperes \( I E_m \) that the regulator has to handle can be established. For good regulation, the flux density in the regulator should be kept low. At high flux densities, considerable distortion of current waveform results, which causes poor regulation in the filament and heater supplies. It should be remembered that the regulation control voltage is derived from the main B-supply, which is proportional to the rms value of heater current only as long as the waveform of the power source remains constant. Depending on filament circuit and load, output voltage of the B-supply will be determined by average or peak values of the power source rather than by its rms value. The flux density of the regulator is determined by its ampere-turns \( I N_1 \), and the length of its magnetic path \( l \), where \( N_1 \) is the total turns of the two outer a-c windings and \( l \) is the outer circular path of the core. The maximum regulator voltage \( E_m \) is determined by the cross-section of the core, the flux density, and the total turns of the a-c windings.

To reduce the regulator voltage to its minimum \( E_{m} \), the core material is saturated by d-c current in the middle winding. The ampere-turns required are now determined by the shorter path \( l \) through the center leg and the two outer legs in parallel. Because the magnetizing current is furnished by a vacuum tube, the d-c resistance of the middle winding can be high and its number of turns \( N_2 \) can be many times larger than \( N_1 \). The two halves of the outer winding have to be well balanced so that no a-c voltage should appear across the middle winding.

Magnetizing current is produced in the grid-controlled full-wave rectifier \( T_1 \). The plate voltage of this tube is derived from the main power transformer and should be high enough to allow the maximum current required for regulator saturation to flow without grid current. Control voltage for this tube is obtained from the glow tube and potentiometer combination across the B-supply of the instrument. Ordinarily the gain in the grid-controlled rectifier \( T_1 \) will be sufficient to change the magnetizing current of the regulator over its full range with a very slight variation of the B-supply output voltage, but there is no reason why additional gain could not be inserted between \( T_1 \) and \( T_2 \).

The characteristic curves of the power supply used in the signal generator are given in Fig. 10. The power requirement of the main instrument transformer is 70 watts, and it operates at 75 volts. It will be seen that the operating range of the regulator is extremely wide at 60 cps and is still adequate at 40 cps. Regulation of the heater supply is not as good as that of the B-supply, particularly at 40 cps. This inadequacy is due to distorted waveform of line current and has been partly corrected by capacitor \( C \) of 6 \( \mu F \) across the regulator.

**References**


---

**FIG. 10—Measured characteristics of power supply show the wide range over which the stabilizer operates.**
Exponential circuits can be made to carry more nearly constant current for longer times if corrective networks are used. Design equations and actions of these circuits are derived, and their advantages in magnetron pulse circuits are illustrated by a numerical example.

Reduced size of the reactive element made possible by these networks results in reduction of cost, bulk, and weight of the constant-current circuit. In applications where frequency stability of a self-excited magnetron oscillator is dependent upon tube current, the improved uniformity of current from these networks gives more stable operation.

**The Problem**

When a capacitor is charged or discharged through a resistor, the resultant current is an exponential function of time. However, in sawtooth sweep circuits, discriminating counter circuits, and other circuits involving pulses of constant amplitude, it is sometimes necessary or desirable to maintain constant current through a resistor, or resistive load for an arbitrarily short period of time. This requirement is especially necessary in one type of radar transmitter in which part of the energy stored in a capacitor is periodically discharged into a magnetron oscillator in the form of rectangular pulses. Approximately constant current can be obtained by inserting a parallel resistor-inductor network in series with the resistor-capacitor circuit.

To determine optimum values of these circuit parameters, consider the case of a capacitor $C$ charged to potential $E$ and then discharged through resistor $R_o$ when the switch of Fig. 1A is closed. It is desired to have the current through $R_o$ remain constant for a short interval $\Delta t$. An inductor and resistor are inserted as in Fig. 1B. The relationship of the various parameters is determined by the following analysis. By Kirchhoff's Laws

\[
L \frac{di_1}{dt} = R_i v_o \quad (1)
\]

\[
i_o = i_i + i_1 \quad (2)
\]

\[
\frac{q}{C} + L \frac{di_1}{dt} + i_0v_o = 0 \quad (3)
\]

Because it is assumed that $i_o$ is constant, that being the desired condition, let $i_o$ equal $i_o$, a constant. Then from Eq. 1 and 2

\[
L \frac{di_1}{dt} = R(L_i - i_1) \quad (4)
\]

or

\[
\frac{di_1}{dt} + \frac{R}{L}i_1 = \frac{(L/L_i)i_o}{(4)}
\]

**EXPERIMENTAL** charging and discharging currents in resistance-capacitance or resistance-inductance circuits can be made approximately constant for short durations by inserting low-loss networks. Such networks permit reducing the capacitance by a factor of four or more for a given pulse duration, or increasing the pulse duration four times for a given capacitance and percent drop in current during the pulse. Similar results can be achieved in inductive circuits.

**FIG. 1**—(A) Exponential circuit, and (B) compensated circuit from which constant current can be obtained.

**FIG. 2**—A biased diode can be a part of the load through which constant current is passed.
The complementary solution of Eq. 4 is \( i_t = A e^{-\frac{t}{R C}} \) where \( A \) is an arbitrary constant. The particular solution is \( i_t = I_o \) The complete solution is therefore

\[ i_t = A e^{-\frac{t}{R C}} + I_o \]  

(5)

Conventionally, this equation indicates that \( I_o \) is a steady-state condition, which is obviously impossible. However, because the time interval under consideration is very short, no steady-state condition is reached, and thus Eq. 5 is legitimate.

When \( t = 0 \), \( i = 0 \). Therefore, in Eq. 5, \( A = -I_o \) and

\[ i_t = I_o (1 - e^{-\frac{t}{R C}}) \]  

(6)

Differentiating Eq. 6 with respect to time and multiplying by \( L \), we obtain

\[ L \frac{di_t}{dt} = L dR t e^{-\frac{t}{R C}} \]  

(7)

Substituting this equivalent into Eq. 3 gives

\[ \frac{Q}{C} + I_o t e^{-\frac{t}{R C}} + I_o R_0 = 0 \]  

(8)

Differentiating Eq. 8 and substituting \( I_o \) for \( \frac{dQ}{dt} \) gives

\[ \frac{I_s}{C} = \frac{I_o R_0}{L} - e^{-\frac{t}{R C}} = 0 \]  

(9)

If \( L/R \) is much greater than \( \Delta T \), then \( e^{-\frac{t}{R C}} \) is approximately unity during the pulse interval. Thus Eq. 9 reduces to the familiar relationship:

\[ R = \sqrt{L/C} \]  

or \( L = R C \).

**Circuit Modification**

It is evident in the foregoing analysis that the value of \( R_0 \) does not affect the result. Consequently, if \( R_0 \) is replaced by a biased diode as in Fig. 2, it would be expected that for constant current the same relationships of the parameters must hold. In this case capacitor \( C \) is given, charged to a potential \( E \), which is to be discharged through a load with constant current for a time interval \( \Delta T \) after the switch is closed. The load in this case is a diode in series with a battery. Resistance \( R_0 \) represents the sum of the diode resistance, the switch resistance, and any other resistance in the circuit. The \( R-L \) network is inserted as before and the analysis is similar.

A new term, \( E_{in} \), will appear in Eq. 3 and 8. However, this term disappears when Eq. 8 is differentiated, resulting in the same Eq. 9 and consequently the same two relationships: \( R = \sqrt{L/C} \), and \( \Delta T \propto L/R \).

If it is desired to close the switch and maintain a constant current through \( R_0 \) for a short period of time \( \Delta T \) in the series circuit of Fig. 3A, a choke and resistor are again inserted as in Fig. 3B. Equations are again identical with those for a discharging circuit, except that the right-hand side of Eq. 3 and 8 is \( E \) instead of zero. This term disappears when Eq. 8 is differentiated. Thus the analysis is the same as before, and the same relationships hold.

Although it is not a resistor-capacitor circuit, the following analysis is included here because it is also a case of maintaining a constant current in an exponential circuit.

In a circuit including resistor, inductor, and battery as shown in Fig. 4A it is again desired to close the switch and maintain a constant current through \( R_0 \) for a short time \( \Delta T \). This result is accomplished by inserting a resistor and capacitor as shown in Fig. 4B. Just as before, and for similar reasons, \( \Delta T \) must be short compared to the time constant of the inserted network. That is, \( \Delta T \propto L/R \).

Although the characteristics of this circuit are comparable to those of the resistor-capacitor circuit previously analysed, the mathematical
analysis for this resistor-inductor circuit is included here. As before, by Kirchhoff’s Laws

$$L \frac{di}{dt} + iR_0 = E$$

(10)

$$R \frac{dq}{dt} + \frac{q}{C} + iR_0 = E$$

(11)

$$i_t + i_0 = I_0$$

(12)

From Eq. 10

$$\frac{di_0}{dt} = \frac{E - iR_0}{L}$$

From which by integration

$$i_t = \frac{E - iR_0}{L} t + A$$

When t = 0, i_t = 0, thus A = 0, and

$$i_t = \frac{E - iR_0}{L} t$$

Likewise, from Eq. 11

$$q = Bt + (E - iR_0)C$$

As in the original circuit analyzed, this simplification is permissible because \(\Delta T < RC\). When t = 0, q = 0, thus B = -(E - iR_0)C, and

$$q = C(E - iR_0) (1 - e^{-t/(RC)})$$

But \(i_t = dq/dt\), and therefore

$$i_t = \frac{E - iR_0}{R} e^{-t/(RC)}$$

(14)

Substituting the values of \(i_t\) and \(i_0\) given by Eq. 13 and 14 into Eq. 12 gives

$$\frac{E - iR_0}{L} t + \frac{E - iR_0}{R} e^{-t/(RC)} = I_0$$

(15)

Differentiating Eq. 15 gives

$$\frac{E - iR_0}{L} - \frac{E - iR_0}{L} \frac{1}{C} e^{-t/(RC)} = 0$$

(16)

During the short interval \(\Delta T\), E - iR does not equal zero. Also, if \(\Delta T\) is very small compared to RC, \(e^{-t/(RC)}\) is approximately unity. Therefore Eq. 16 reduces to the same relationship as previously obtained:

$$R = \sqrt{L/C}$$

It should be noted that in this case, as before, the result is independent of the value \(R_0\).

**Magnetron Application**

The circuit in Fig. 2 is similar to a discharge circuit used in some radar transmitters, and the load represented is essentially the equivalent circuit of a magnetron. The magnetron impedance is nonlinear, having a volt-ampere characteristic similar to that shown in Fig. 5. In general, the dynamic impedance is not constant over a wide range of voltage and current. However, over a small operating range the magnetron can be represented to a good approximation by the circuit shown in Fig. 6, consisting of a linear resistance equal to \(\Delta E_v/\Delta I\), a perfect rectifier, and a battery \(E_0\), where \(E_v\) is the voltage intercept of a line drawn tangent to the curve at the operating point.

In one application the capacitor is charged between pulses through a resistance from a d-c source. The switch is a vacuum tube which is normally nonconducting but is turned on at regular intervals to discharge part of the stored energy into the magnetron in the form of rectangular pulses. With a constant magnetic field applied to the magnetron, the output frequency of the magnetron is a function of its peak current. Consequently, to prevent frequency shift during the pulse, it is important that the discharge current be maintained very nearly constant.

Of course, the current can be held nearly constant by making the capacitor C very large. However, high-voltage capacitors are physically large and heavy, and therefore present serious difficulty in aircraft sets where space and weight are at a premium. Addition of the resistance-inductance network permits the use of smaller capacitors for a given pulse duration, or with a given size capacitance the pulse generator can produce longer pulses. These advantages are best illustrated by numerical example.

First consider the case without the addition of the resistance-inductance network. The current is found by simple circuit analysis

$$i = \frac{E - E_0}{R_0} e^{-t/(RC)}$$

(17)

Typical values are

- \(E = 14,000\) volts
- \(E_0 = 11,500\) volts
- \(R_0 = 200\) ohms
- \(C = 0.1\) microfarad

Thus

$$i = \frac{14,000 - 11,500}{200} e^{-t/(0.1)}$$

At the moment of closing the switch the current is 12.5 amp. After one microsecond the current is 11.9 amp. This change represents a current drop of about five percent, which is barely tolerable with some magnetrons.

Now an R-L network is inserted, giving the circuit of Fig. 2 with \(L = RC\). The resistance might be 50 ohms. The inductance must be 250 \(\mu\)h, and \((L/R) = 5 \times 10^4\). By conventional circuit analysis the current as a function of time is found to be

$$i = \frac{E - E_0}{R + R_0} (1/t) \times$$

$$[(\beta - \alpha)e^{-(\alpha + \beta)t} + (\alpha + \beta)e^{-(\alpha - \beta)t}]$$

(18)

where \(\alpha = 1/2RC\)

$$\beta = \alpha \left[ \frac{R_0 - 3R}{R_0 + R} \right]^{1/2}$$

At the moment of closing the switch the current is now ten amperes. After one microsecond it has fallen to 9.96 amp. In this case the current drop is less than 0.5 percent.

If it were desirable to maintain the same magnetron operating point as before with an average pulse current of approximately 12.2 amp, it is only necessary to raise the voltage on \(C\) to 14,550 instead of 14,000 volts. 

---

**FIG. 5—Load characteristics of d-c anode circuit of magnetron can be simulated by battery and resistor**

**FIG. 6—An equivalent magnetron pulsing circuit containing a storage capacitor**

---

**November, 1946 — ELECTRONICS**
The initial current is then 12.20 amp, and at the end of one microsecond \( i = 12.15 \text{ amp} \), still less than a 0.5-percent droop.

With the voltage raised to 14,625 volts, the initial current is again 12.5 amp, but it takes four microseconds for it to drop to 11.9 amp, the value reached in one microsecond without the addition of the resistance-inductance network. Thus the R-L network permits increasing the pulse length by a factor of four, provided the same percentage droop in current can be tolerated as for the shorter pulse.

If \( C = 0.025 \mu\text{F} \) and \( R \) remains 50 ohms, \( L \) must be 62.5\( \mu \text{H} \). Then with \( E = 14,625 \text{ volts} \), the initial current is 12.5 amp, and at the end of one microsecond, \( i = 11.9 \text{ amp} \). Thus, for one microsecond pulse duration the capacitance can be decreased by a factor of four without causing a greater droop than was obtained without the R-L network.

It may be noticed that the values of \( L/R \) in all these examples do not perfectly satisfy the requirement that \( L/R > \Delta T \), and that the assumption that \( e^{(1/2)k} \) equals unity for the duration of the pulse is not quite true. As a result, the current pulses are not constant but droop slightly. To fulfill this condition rigorously and also have \( L = RC \), it would be necessary to choose higher values for \( R \) and \( L \). Then this droop would be practically eliminated, but as \( R \) is increased, the power supply potential \( E \) must be increased, and the power loss in \( R \) becomes greater. In practice, the selection of values of \( R \) and \( L \) is a compromise between minimum current droop and minimum power loss.

The requirement that \( L = RC \) is also not critical. When the condition \( L/R > \Delta T \) is rigorously fulfilled, a value of \( L \) less than \( RC \) would cause the current to rise linearly during the pulse, whereas if \( L \) were greater than \( RC \), the R-L network would not be entirely effective in minimizing the current droop. In some cases it may be better to choose \( L \) less than \( RC \), and \( L/R \) of the same order as, or even less than, \( \Delta T \) so that the current, although remaining within an allowable percentage deviation from a specified mean value, first rises and then falls as shown in Fig. 7.

**Practical Design**

By more comprehensive circuit analysis or by experimentation, values of \( R \) and \( L \) can be determined for any given set of conditions which will permit increase in pulse duration \( \Delta T \) or decrease in the required value of storage capacitance up to a factor of eight or ten, with very small loss of power. To obtain best results, the choice of \( R \) and \( L \) can also be influenced to some extent by other practical considerations not mentioned here. For example, it is conceivable that under certain conditions stray capacitance across the pulse generator switch and across the magnetron may form a resonant circuit with \( L \) and give rise to undesirable postpulse oscillations. A compromise in the choice of \( R \) and \( L \) may be necessary to produce the necessary damping.

Work was done by B. Chance, R. M. Walker, and others at Radiation Laboratory and elsewhere on improvement in linearity of voltage rise across capacitors used in timing circuits, beginning in 1942. One method employed inductance in series with resistance and capacitance, with appropriate tube switching to select only a small, linearly rising portion of the exponential voltage. However, in these low-level circuits power loss is usually an unimportant consideration and magnitudes of resistance, inductance, and capacitance differ appreciably from those recommended by the preceding analysis.

For a treatment of linear timing circuits the reader is referred to the Radiation Laboratory Technical Series volume entitled "Waveforms" now being edited for publication. For a recent application of the parallel resistor-inductor network to improve linearity of high-speed sweep see Radiation Laboratory Report 1001 by D. F. Winter, and the as yet unpublished Radiation Laboratory Technical Series volume entitled "Cathode Ray Tube Displays".

**Dissipationless Circuit**

Another method for minimizing magnetron pulse current drop has been suggested both at Radiation Laboratory and elsewhere. A. A. Varela, Naval Research Laboratory, Washington, D. C., described the use of an L-C network composed only of passive elements \( L_1 \), \( L_2 \), and \( C_1 \), as shown in Fig. 8. The network is used in place of the parallel R-L unit. Such a network will accomplish the desired result but has the disadvantage of requiring one more circuit element including a second capacitor of medium voltage rating. Although this type of pulse-forming network is composed of lossless elements, the voltage drop during the pulse due to the network surge impedance causes an effective loss in pulse power which is comparable to losses in equivalent R-L networks. The energy remaining in \( L_1 \), \( C_1 \), and \( L_2 \) at the end of the pulse may be dissipated in post pulse oscillations. Therefore, in view of these considerations, it seems advisable for most applications to use the simpler R-L network.

---

This paper is based on work done for the Office of Scientific Research and Development under contract OMSR-292 with the Radiation Laboratory, Massachusetts Institute of Technology.
AN ANTENNA for use in the 158-162 mc band on trains must satisfy several requirements. It should be essentially omnidirectional in the horizontal plane because the train may be oriented in any direction with respect to the various fixed stations with which communication is desired. The angle of radiation of the antenna should be kept as low as possible in order to get a maximum concentration of energy in the horizontal plane because the omnidirectional requirement prohibits concentrating the energy in one horizontal direction at a sacrifice in some other horizontal direction. The antenna should be sufficiently rugged mechanically that men walking along the top of the train can take hold of it for support without causing damage to it.

At the present writing, indications are that train antennas should be vertically polarized as audio modulation caused by the train moving past telephone poles and other structures along the right of way seems to be less troublesome for vertical than for horizontal polarization.

Choice of Antenna Design

In order to get the maximum energy concentration in a horizontal plane, the most desirable type of antenna would be vertical colinear array placed as high on top of the train as possible. Because of the restricted clearances of most railroads this type of array is obviously impossible at these frequencies. The next best type of antenna is one that uses all of the available clearance and is tailored in dimensions and current distribution for the particular installation.

Two possibilities that exist are that of placing a relatively long vertical antenna on some low part of the train such as on the tender, or of placing a short vertical antenna on a high portion of the train such as on the engine cab. The chances are that, with the first possibility, reflections from adjacent parts of the train that are as high as part of the antenna would cause the radiation pattern to be far from omnidirectional and could quite easily cause the radiation to be concentrated in the least desired directions. Following the second possibility, an antenna was designed with such small height that it can be placed on top of a train that has approximately five inches of clearance.

Figure 1 shows the method of feeding the completed antenna. Because of corrosive fumes present behind a steam locomotive, the antenna is constructed of stainless steel. A rather wide base insulator is used to provide a long leakage path across the 50-ohm feed point in order to minimize the effects of soot deposited on the insulator.

The antenna is 5-in. or 24.3° tall and is top loaded by means of an oblong plate so that the current is nearly constant throughout the height of the antenna, being a maximum at the top. As shown, Member 2 is a steel pipe welded to the loading plate and to the ground plane, thus forming the second leg of a folded monopole. The folded type of construction was chosen for its mechanical strength and because it furnished a simple means for increasing the radiation resistance of the rather short antenna in order to facilitate the matching to a 50-ohm transmission line.

Impedance Relations

Figure 2 shows the phase and amplitude of the measured current distribution in the two members of the monopole. By changing the shape of the loading plate on top of the antenna it is possible to control this current distribution within limits. It was found necessary to extend the loading plate slightly farther on the side of the top fed member than on the side of the base fed member in

November, 1946 — ELECTRONICS
Top loaded, folded, vertically polarized, monopole antenna concentrates radiation close to the ground in an omnidirectional pattern. Antenna is only five inches high, mechanically rugged, and has an input impedance of fifty ohms. Design techniques are described

antenna is $13.3^3 R_w$. The radiation resistance referred to the current at the feed point is the antenna power divided by the square of the current at the feed point and is

$$(13.3/8.2)^3 R_w = 2.62 R_w.$$ (1)

**Antenna Feeding**

Figure 3 shows the current distribution in a vertical plane of the antenna. It will be noted that the antenna is not fed at a current loop but is fed below the current loop. There are two reasons for this practice. One is that, by raising the position of the current maximum in an antenna of this type to a point near the top, it is possible to increase the radiation along the horizontal. The other is that, due to the need for a large, rugged base insulator which shunts the feed point with a capacitance, it is desirable for purposes of matching to the transmission line to make the antenna slightly inductive. Feeding the antenna at a point below the current loop not only has the effect of making the antenna inductive, but also causes the radiation resistance to increase by a factor $1/\sin G$ where $G$ is the angular height above the base to the point at which the antenna current would reach a minimum if it were not suppressed by the top loading plate.

The radiation resistance of the current filament referred to a current loop can be computed from the formula

$$R_w = 30 \left[ \frac{\sin B}{\sin A} \left( \frac{\sin 2A/2A}{2A} \right) - 1 \right] - 0.5 \cos (2B) S_i(4A) \left( 1 + \cos (2B) \right) \times S_i(2A) + \sin (2B) \left( 0.85 \sin (4A) - S_i(2A) \right),$$

where $G = A + B$, and $A$ is the angular height of the antenna top above the ground plane and $B$ is the angular height of suppressed radiation, and $S_i = \ln x + 0.5772 - Ci(x)$.

This radiation resistance is 6.77 ohms. Referring this resistance to the base of the antenna gives $6.77/\sin^3 14.3^\circ = 8.15$ ohms. Substituting this value in Eq. 1 gives 21.4 ohms. Because the value of $G$ is greater than 90°, the antenna has an inductive component of 25 ohms at the base. The negative susceptance due to this inductive component is cancelled by the positive susceptance due to the capacitance of approximately 43 ohms across the bakelite insulator at the base of the monopole as seen in Fig. 1. The equivalent circuit of the feed point is shown in Fig. 4. It is the circuit of a parallel resonant circuit of extremely low $Q$. The input impedance of the antenna is therefore the parallel resonant impedance of this circuit and is a pure resistance of 50 ohms.

In the actual development of the antenna, preliminary calculations were made assuming an increase of radiation resistance due to the folding of the monopole of three over $R_w$ rather than the 2.62 finally obtained. The amount of top loading required to give the desired vertical current distribution was determined experimentally by sliding three metal plates over each other until a value of total current with respect

FIG. 2—Current distribution at base of antenna radiators

order to make the current approximately uniform around the two members.

Assuming that the radiation due to the current distribution is the same as that due to a thin filament of current located midway between the two members of the antenna and equal to the vector sum of an infinite number of filaments of which the actual current distribution can be considered as being composed, the radiation resistance measured at the bottom of the base fed element can be computed quite simply. This assumption is not rigorously correct because of phase differences between radiations of the various filaments in the actual distribution and also because of variations in the top loading of the different filaments, but is close enough to give a useful answer. A graphical determination of the vector sum of the current filaments in the actual distribution gives a current of 13.3 at plus 12.4° for both monopoles together and a current of 8.2 at 11.8° for the base fed member alone. The unit in which these currents are measured is not important as it cancels out in the resistance computations.

Where $R_w$ is the radiation resistance of the imaginary filament at the center of the antenna which is considered as carrying all of the current, the power radiated by the whole

$\int x \cos x \, dx$

FIG. 3—Vertical distribution of antenna current
get the current maximum as high above the train as possible. The possibility exists of placing several such top loaded antennas atop a train in the form of an array to give greater directivity when communication is to be carried on with a station or stations in a constant direction with respect to the axis of the train. An array of extremely high directivity could be obtained by placing many such antennas along the top of the train in the form of an end-fire array and switching the transmitting and receiving equipment to this array when the train is going to be on a stretch of straight track for many miles.

It is difficult if not impossible to predict what the pattern of a single antenna will be when placed atop trains in which space for a ground plane is limited. The most obvious recourse is to investigate, by field measurements on the train itself, the direction in which energy is radiated. The patterns of Fig. 6A and 6B indicate that greater signals are obtained along the horizontal with the smaller ground plane. This result is probably because the 30- by 30-in. ground plane was so small that it did not prevent antenna currents from flowing in the column on which the antenna was mounted, during test.

The curve of Fig. 6C is calculated on the assumption that there is no radiation from the top loading plate. This assumption is not valid because the loading plate is an appreciable portion of a wave length long, and even if the current distribution in the plate were symmetrical about the two axes of the plate, radiation from the plate would be zero only in directions normal to the plate. The currents in the vertical members of the antenna as shown in Fig. 2 indicate that the distribution in the loading plate can not be symmetrical so that radiation should be expected even in directions normal to the loading plate.

There are of course many manners in which the impedance of an antenna of this type could be matched to the transmission line. One of the most obvious would be to use top loading such that the value of \( G \) would be 90° and then use a top fed member of such diameter that the radiation resistance of the combination would equal the characteristic impedance of the transmission line.

References

Motion pictures, telephone, airborne radio, broadcasting equipment, electric organs and other electrical equipment need instant replacement when failures in electronic circuits occur at the capacitor connections. Cinch Know How solved this problem. Write for details and samples of our copacitor plug-in sockets.
Mutual Inductance of Concentric Coils

For air-core transformers with greater length than diameter, such as are generally used in r-f service, this nomograph provides pertinent design data in three settings of a straightedge and clearly shows the effects of changes in parameters.

By THOMAS C. BLOW
Massachusetts Institute of Technology
Cambridge, Mass.

Mutual Inductance between two concentric single-layer air-core solenoids is a circuit value that defies simple analysis. Mutual inductance is dependent on coil dimensions in such an involved manner that design of a radio-frequency transformer is difficult. This nomogram facilitates the design of these transformers.

Examination of the relationship for coaxial solenoids (Circular C74, National Bureau of Standards, Jan. 1937, p 281-282) reveals that for values of $D/l$ less than unity the formula reduces approximately to

$$M = 0.0251 \frac{d^2 N_n}{(D^2 + d^2)^{1/2}}$$

The accuracy of this approximation is within three percent for most conditions. From this formula a simple nomograph, which allows an investigation of the effects of the parameters, can be plotted. For given coil dimensions, $M$ is directly proportional to the product of primary and secondary turns. For a given value of $d$, the outer diameter $D$ does not greatly influence the mutual inductance, and the length of the shorter coil has no effect on the mutual inductance.

To show the use of the chart, consider a design where the outer coil is to be the shorter. Choosing $l$ as 8 in., $d$ as 3 in., and $D$ as 4 in., draw a line (1) through $l = 8$ and $D/l = 0.5$ extending to the $M$ scale. Connect this intersection on $M$ to $d = 3$ with a straight line (2). Use the resulting intersection with the $l$ scale as a turning point for selecting compatible values of $N_n$ and $M$, draw a straight line (3). If, as shown, the mutual inductance is to be 2 mh, the turns product should be 80. With 16 turns on the longer coil, 5 turns would be required on the shorter one. It should be noted that the 5 turns can be wound with any spacing without materially changing the value of $M$. The chart can be used to determine any one of the variables $l, d, D, N_n, or M$ when the others are known as long, as the sequence of operations is preserved, namely 1, 2, 3 or 3, 2, 1.
Built Like a Steel Bridge . . .

for Rugged Service!

There are no liquids, bulbs or moving parts in Mallory magnesium copper sulphide rectifiers. There’s nothing to give trouble or wear out quickly.

On the contrary, Mallory rectifiers are solid and compact—built of metal throughout. They are practically immune to injury or abuse.

Even should one of the radiating plates accidentally suffer damage, the efficiency of the rectifier would not be affected. That’s because all the vital rectifying material is inside the rectifier—the outside fins are for radiation only.

Right from the start you can depend on Mallory magnesium copper sulphide rectifiers for extra strength and operating life . . . just two more reasons why they outsell all other types of dry disc rectifiers. See your Mallory distributor or write direct for literature or engineering help.

Pulse Time Modulation Circuits

CIRCUIT DATA on pulse time modulation (ELECTRONICS Jan. 1945 p 100) has been released by Federal Telecommunication Laboratories at a recent demonstration. The method of multiplexing involves the transmission of a series of pulses, each about 0.5 microsecond, which are modulated by varying the time interval between pulses. At the receiver, proper selection of the pulses is made by simple timing circuits so that several channels can be transmitted on a single carrier.

The transmitting equipment demonstrated takes eight modulating signals from several studios at line level over an audio-frequency range of 50 to 9000 cycles per second. Eight sequences of pulses, derived from a common pulse generator, are individually time-modulated by the corresponding programs, interleaved with a sequence of marker pulses, and fed to the r-f modulator for further amplification and keying of the 930-megacycle oscillator. The output of the transmitter is approximately 800 to 1000 watts peak and 40 to 50 watts average. This is fed to a vertically stacked loop antenna having a gain of 9 decibels over a dipole throughout 360 degrees in a horizontal plane.

A block diagram of the system is shown in Fig. 1. The multiplex modulator consists of a sawtooth pulse generator, a delay line synchronizer, an audio amplifier for each channel, a time modulator for each channel, a marker pulse shaper, and a mixer shaper.

The 9,000-cycle audio fidelity is assured by the use of a 24-kc sawtooth pulse generator, and the basic timing of the pulse channels is obtained by a series of stable time delay elements, tapped at nine successive points. By this method, nine pulse sequences are produced, each having the basic 24-ke repetition rate, but displaced from the previous sequence by an equal time interval.

One pulse sequence is fed to the marker pulse shaper which generates a double pulse for use as a time reference base in separating the various programs at the receiver. The remaining eight sawtooth pulse sequences are fed to the corresponding time modulators of each program channel where they are converted to rectangular pulses varying in time displacement, relative to the marker pulse, in accordance with the applied audio signal.

After time modulation and marker shaping, the nine pulse sequences are interleaved and fed to the mixer shaper for further amplification and improvement of pulse shape. From here the pulses are transmitted at a peak level of five volts over 70-ohm solid dielectric coaxial transmission line to the r-f transmitter. The repetition rate of the combined pulse sequence is 9 × 24 kc or 216 kc.

Receiver Circuits

The r-f transmitter consists of a modulator and an oscillator. The modulator is a wide-band pulse amplifier raising the time-modulated pulses from five volts to approximately 300 volts for grid keying the 930-mc oscillator. The latter contains an air-cooled uhf triode type 2214-B which is tuned by an auxiliary resonant coaxial-line element. Single-control tuning is provided within the operating range of 929 to 940 mc and retuning to this frequency range is accomplished by adjustable shorting sections in the resonant transmission line elements. The oscillator has high inherent frequency stability so that further stabilization is omitted in the experimental equipment.

A calibrated, frequency meter mounted on the control panel is provided for monitoring purposes, and oscilloscope jacks are available for examining the pulse output characteristics. An output power detector can be used in routine maintenance checks.

FIG. 1—Basic portions of Federal’s pulse time modulation system. Use of the omnidirectional transmitting antenna permits broadcasting services

FIG. 2—In the receiver, pulses are separated and sorted to provide eight 3,000-cycle audio channels and or audio, facsimile, and telegraph services
TOMORROW’S RELAYS FOR DESIGNS OF TODAY

Behind this view of typical Guardian Relays...designed for today and tomorrow...is a myriad of modern products that start, stop, count, time, see, hear, talk, fly, select, record...each controlled by Guardian Relays. Behind the scene at Guardian Electric, alert, experienced engineers are constantly thinking and planning ahead to benefit product designers in every branch of American industry.

Guardian Relays, specified by design engineers because of incredible responsiveness and dependability, operate day and night. Continuously. Unfailingly. Basic in type, the majority of Guardian Relays are adaptable to an almost endless number of variations. Where "specials" were formerly deemed necessary, variations of Guardian basic type relays have proved better qualified on performance—price—delivery. Yet, if a "special" unit or complete control assembly is needed, Guardian's expert engineering is at your command. Write for Bulletin TR-9.

GUARDIAN ELECTRIC
1625-M W. WALNUT STREET CHICAGO 12, ILLINOIS
A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY
ceiving direction. The receiver is fixed tuned and, as shown in Fig. 2, its circuit is conventional in the front end with a local oscillator, a mixer, and an i-f amplifier. To these are added a pulse detector and limiter, a marker pulse separator, a pulse time selector, and a time demodulator that acts as the audio detector. A type 1N28 crystal is used in the mixer, and a broad i-f bandwidth is provided to pass the pulse frequencies. This also aids in stability requirements and minimizes regeneration.

The pulse detector is of the conventional amplitude type and includes clipping and shaping of the pulses for further signal-to-noise improvement. The pulses are then passed on to the audio detector which performs two functions, time selection of the desired pulse channel, and its demodulation to give the audio program output.

Delayed Marker Pulse

The marker pulse is separated from the channel pulses by means of its double pulse characteristic and fed to the pulse time selector. Here it is delayed in timing, by an amount which depends upon the setting of the selector switch, so as to coincide with the desired channel pulse sequence. The delayed marker pulse is then fed to the time demodulator along with the combined program pulse sequences. Operation of the time demodulator or audio detector tube is controlled by the delayed marker pulse so that it functions only at those instants of time corresponding to the arrival of the desired program pulse sequence. The detected program signal is then fed to the audio amplifier and loud speaker or associated terminal gear in the case of special services.

Eight time demodulator sections connected to the different switching points in the pulse time selector section permit all programs to be received simultaneously and distributed for ultimate selection by a number of audio speaker sections, and/or terminal equipment for facsimile and various types of telegraphic services.

Since each channel has a bandwidth of 9,000 cycles, and since telegraph circuits require only about 200 cycles for 60 word-per-minute transmission, the use of tone filters enables the number of sub-channels for such use to be multiplied. Therefore either the whole width of each channel may be used for high-fidelity sound, or a considerable number of telegraphic services may be sent over it.

In last year's demonstration of 24-channel ptm, electronic switching involving cyclophon cathode-ray tubes was used to assemble the pulses in correct sequence at the transmitter and sort them out at the receiver. The nonelectronic LC delay lines used in place of switching tubes in the latest demonstration utilize techniques developed during the war for radar pulse circuits, and illustrate emphatically that the efficiency and success of pulse time modulation does not hinge on specially designed switching tubes. Still other ways of assembling and sorting pulses are being tried by I.T.&T. engineers, with many offering promise of future useful application.

Reactance Comparator

Rapid comparison of inductors, capacitors, or combinations of the two is accomplished by the Mervyn reactance comparator. Basically it consists of two similar circuits containing inductance and capacitance. One circuit forms part of a very stable oscillator while the other is a high-Q resonator, the two being very loosely coupled.

The natural frequency of the resonator is varied about the mean figure in synchronism with a pointer vibrating in front of a scale. At the instant when the resonator's natural frequency equals that of the oscillator, the scale is illuminated by a brief flash of light from a neon lamp. This action is repeated at the line frequency so that when the two circuits are equal the pointer appears to remain still due to the stroboscopic effect.

The basic circuit of the instrument is shown in Fig. 1. A dynatron oscillator is used as the standard since it will oscillate readily with any combination of inductance and capacitance, has high dynamic resistance at its resonant frequency, and does not require a tapped or double-wound coil because it is a negative-resistance oscillator. The natural stability of the output is increased by coupling it to an amplitude limiter consisting of a diode which rectifies some of the dynatron output and uses it to reduce the oscillator's cathode current to a level determined by the setting of the delay bias on the diode.

The resonator circuit is similar to that of the oscillator except that the amount of negative resistance supplied by the dynatron tube is controlled manually to a point where the Q of the LC circuit is high, but is below the self-oscilla-

![Fig. 1—Essential stages of the reactance comparator. Within its useful range, inductance can be checked against a standard with an accuracy better than one percent, and capacitance within 0.1 percent.](https://www.americanradiohistory.com)
INTER-OFFICE MEMO
To: Harry A. Ehle, Vice-pres., Sales

Production capacity on all types and ranges of All-Metal Rheostats has now been increased to provide additional production for scheduling during last week of May and following months, as per your request.

From: [Signature]
Works Manager

**All Metal RHEOSTATS**

... Increased Quantities Now Available on Short Delivery Cycle!

**TYPE PR-25—**25-watt rating. Temperature rise, 140°C. Standard resistance values, 1 ohm to 5,000 ohms. Diameter, 13/4". Depth behind panel, 3/8".

**TYPE PR-50—**50-watt rating. Temperature rise, 170°C. Standard resistance values, 0.5 ohm to 10,000 ohms. Diameter, 23/8". Depth behind panel, 13/8".


**TYPE PRT-50—(AN3155-50).** 50-watt rating. Same construction as PRT-25, to AN3155 specifications. Standard values, 5 ohms to 200 ohms. To 10,000 ohms on special order. Temp. rise, 170°C.

All IRC Rheostats operate at about half the temperature rise of equivalent units and can be operated at full load on as little as 25% of the winding, with only a slight increase in temperature rise.

**INTERNATIONAL RESISTANCE CO.**
401 N. BROAD ST., PHILADELPHIA 8, PA.

Canadian Licensee: International Resistance Co., Ltd., Toronto
This new, basic Model "M" ACRO Switch is the ultimate in compactness, with overall dimensions only 15/32" x 15/32" x 3/4". Four 5/32" mounting holes. Built with ACRO's patented Beryllium Rolling Spring and used by scores of the nation's leading manufacturers of electrical products. Approved by Underwriters' Laboratories. Rating: 10 amps, 125 volts A.C. Contact arrangements, single pole, normally open, normally closed or double throw. Furnished with standard leaf bracket actuators or made to special design. For quicker reply on special actuators or characteristics please give full engineering details.

ACRO ELECTRIC COMPANY
1316 SUPERIOR AVENUE • CLEVELAND 14, OHIO

ATTENUATORS by TECH LABS

"Midget" model is especially designed for crowd-ed apparatus or portable equipment.

- Solid silver contacts and stainless silver alloy wiper arms.
- Rotor hub pinned to shaft prevents unauthorized tampering and keeps wiper arms in perfect adjustment.
- Can be furnished in any practical Impedance and dB loss per step upon request.
- TECH LABS can furnish a unit for every purpose.
- Write for bulletin No. 431.

TECH LABS
Manufacturers of Precision Electrical Resistance Instruments
337 CENTRAL AVE. • JERSEY CITY 7, N.J.

ALLOY "A"
Nickel-Chromium alloy, resists oxidation at elevated temperatures; up to 2100 F. Also used for fixed non-magnetic resistors. Resists chemical corrosion by many media. Specific resistance 650 Ohms/C.M.F.

ALLOY "C"
Nickel-Chromium iron, 15% Chromium, balance iron. High resistance to oxidation and corrosion. Widely used for resistors for radio, electronics, industrial equipment and domestic appliances. Operating temperatures up to 1700° F. Specific resistance 675 Ohms/C.M.F.

ALLOY "45"
Copper-Nickel alloy with constant resistance over wide range of temperatures. Specific resistance 294 Ohms/C.M.F.; temperature coefficient 0.00002 Ohms per deg. F; 32-212 deg. Used in winding of precision resistors, rheostats, and electrical measuring devices.

KANTHAL Exclusive manufacturers and distributors of KANTHAL wire, ribbon, and strip. An alloy containing Iron, Chromium, Aluminum and Cobalt... for operating temperatures up to 2462° F. Three grades, A1, A2, DS; resistivity 872, 837, 812 Ohms/ C.M.F., respectively, at 68 F.

As fine as .0006", for alloys "A", "C", "45."

THE C. O. JELLIFF MFG. CORP.
123 PEQUOT ROAD, SOUTHPORT, CONNECTICUT
WIRE CLOTH DIPPING BASKETS LEKTROMESH

IN Tungsten, Molybdenum, and OTHER METALS AND SPECIAL ALLOYS; ALL MESHES IN STANDARD WIDTHS, OR WIRE-MESH PARTS FABRICATED TO ORDER.

ELECTRONICS
November, 1946
TRUARC helps Sargent produce superior lock at lower cost!

"TRUARC helped make this lock possible" says Sargent & Company, New Haven, Conn., leading lock manufacturers for 74 years.

IN DESIGN: "Waldes Truarc Retaining Rings permit closer tolerances; result in more compact design; provide full circumferential bearing at vital points; help to make possible a 30% reduction in moving parts."

IN PRODUCTION: "Truarc reduces machining operations, cuts assembly time, helps eliminate the grub screw hitherto universally deemed essential."

IN SERVICE: "Truarc maintains accurate, unvarying relationship of parts, simplifies disassembly and reassembly, reduces possibility of damage in making repairs."

IN COSTS: "The many advantages provided by Truarc have contributed to the great economies that enable us to produce this finer-lock at a new low cost for a quality product."

Whatever your product, whether old and basic, or a comparative newcomer, there's a Waldes Truarc Retaining Ring that will make it simpler, more economical to make and repair. For Truarc, with its never-failing grip and patented design assuring constant circularity, gives you a new approach, a superior solution to fastening problems. Send us your drawings; Truarc engineers will be glad to show how Truarc can help you.

Waldes Kohinoor, Inc.,
47-10 Austel Place
Long Island City 1, N.Y.
Please send Booklet on Truarc Retaining Rings to
Name & Title_________________________
Firm_______________________________
Address____________________________
City_________________ Zone_ State_
DELIVERIES FROM STOCK

on all standard items—
Specials in less than a week if necessary

MOUNTING STYLES
to match any need

PHYSICALLY PROTECTED
to specifications

HERMETICALLY-SEALED
and TROPICALIZED TYPES
for exacting applications

ACURATE
to 0.05% when required

BULLETIN R
tells what you want to
know about precision
resistors. Write for your
copy today.

SHALLCROSS
AKRA-OHM PRECISION RESISTORS
Electrical Measuring Apparatus • Precision Switches
Electronic Engineering

TUBES AT WORK (continued)

tion point. The natural frequency
of the resonator is varied by a small
special capacitor, the moving ele-
ment of which is carried by a tuned
reed vibrating at the line fre-
quency. A pointer is attached to
the reed and moves over a short
scale. Its movement is magnified
by lenses.

Vanes as Capacitor Plates

The shape of the special capacitor
vanes is very important and is de-

Fig. 2—Different vane shapes determine
whether the scale of the special indicator
capacitor is linear in frequency and capaci-
tance or exponential
termined by the main use to which
the comparator will be put. Figure
2 gives some typical shapes. Shape
A gives a linear capacitance scale,
shape B gives a nearly linear scale
of frequency if capacitance values
are correctly chosen, shape C gives
an approximately exponential scale
and if used with negligible shunt
capacitance will give a linear fre-
quency scale, shape D gives an in-
ductance or capacitance scale which
is open in the middle and closed
at the ends so that large tolerances
can be indicated.

The oscillator is coupled to the
resonator so that an alternating
potential appears across the latter,
its amplitude varying as the reso-
nator is tuned relatively to the
oscillator by the indicator capacitor.

When the resonator frequency is
the same as the oscillator fre-
quency, the relative phase angle of
the alternating potentials in the
two circuits changes suddenly and,
as both circuits are connected to
the mixer tube, its anode current
is partially dependent on the two
phase angles and changes sharply
when the two frequencies are equal.

This change is differentiated to
Take this short route for answers to many

FASTENINGS PROBLEMS

Fill out the coupon below and mail it—for the shortest route to answers to many fastenings problems. Maybe you think that cold-forging wouldn’t save for you—but if you use large quantities of fastenings, get the facts on what Scovill can do. You may be surprised at what can be done—economically. For production efficiency, also contact Scovill for SEMS Washer Screw Assemblies, PHILLIPS Recessed Head Screws, and CLUTCH HEAD Screws. Mail the coupon today!

TELEPHONE—This special brass stud is an important part of a telephone transmitter. Do you use fastenings in mass production? Get the facts on Scovill.

RADIO—Special steel mounting stud used in radio work. Scovill cold-forging often means savings on mass production jobs. Consult Scovill before designing.

AVIATION—Heat treated alloy steel stud molded in plastic for special aircraft electrical use. Scovill cold-forging “know how” may be the answer for you. Take a look at your present fastenings!

HARDWARE—Adjusting screw on a hand plane. Cold-forged by Scovill at a savings to the manufacturer. Scovill may be able to save money for you. Mail the coupon below now!

POWER TRANSMISSION—Special copper transformer stud used in high tension power transmission. Another Scovill cold-forging job that solved a problem—saved money for a customer.

Please have your sales engineer call with more information on:

☐ Special Cold-forged Fastenings
☐ SEMS Washer Screw Assemblies
☐ PHILLIPS Recessed Head Screws
☐ CLUTCH HEAD Screws

NAME

COMPANY

ADDRESS

WATERVILLE SCREW PRODUCTS DIVISION
WATERVILLE 48, CONN.

SCOVILL MANUFACTURING COMPANY
WATERVILLE 48, CONN.

NEW YORK, Chrysler Building • DETROIT, 6460 Kercheval Avenue • CHICAGO, 135 South LaSalle Street • LOS ANGELES, 2527 South Soto Street • SYRACUSE, Syracuse-Kemper Insurance Building • CLEVELAND, Terminal Tower Building • SAN FRANCISCO, 434 Brannan Street

ELECTRONICS — November, 1946
Put ROBINSON TONE QUALITY TO WORK FOR YOU!

REVOLUTIONARY FEATURES IN THE ROBINSON PRECISION TRANSCRIPTION TURNTABLE

- With Robinson precision equipment you eliminate "wow," vibration and rumble.
- Many new features including right-angle belt-drive and patented "seismic" sub base motor mounting.
- New micrometer speed adjustment and patented planetary ball bearing transmission.

ROBINSON RECORDING LABORATORIES

CONSOLE $90
Chassis $299
Duplex Console $150

AMERICAN CAPACITORS

All standard types, Write for the new Amcon catalog.

Higher Vacuum (in the low micron range)
- High volumetric efficiency
- Low power requirement
- Complete discharge of air—no re-expansion
- Continuous dehydration of oil—no moisture to re-evaporate
- Discharges sudden slugs of liquid without injury
- Easily accessible, non-corrosive discharge valve
- Rugged, compact, simple construction
- Long life... negligible maintenance
- Five sizes—from 10 to 235 cu. ft. per min.

F. J. STOKES MACHINE CO.
6046 Tabor Road Philadelphia 20, Pa.

November, 1946 — ELECTRONICS
In addition... "National" graphite has exceptional purity... great strength... fine grain structure... high resistance to erosion... is a good conductor, especially at high frequencies... is free from dust and loosely held particles... provides low electron emission... and can be machined into intricate shapes to very close tolerances.

Yes... anodes of graphite have everything you need to turn out finer tubes. For more facts, write National Carbon Company, Inc., Dept. E.

"National" graphite is almost an ideal black body, making it a nearly perfect heat radiator. Thus, anodes of "National" graphite operate at lower temperatures for a given amount of energy dissipated. All tube parts therefore operate at lower temperatures, resulting in less distortion of other parts and more uniform tube characteristics.

"National" graphite has no melting point! It cannot melt or soften. This, plus the fact that graphite has a low coefficient of expansion and a high heat transfer rate, is the reason graphite will not warp or distort, regardless of operating temperature.

Because "National" graphite has a higher thermal conductivity than other anode materials, it provides greater protection from excess surface temperature—a cause of secondary or back electron emission. It also lessens the danger from local hot spots so often found in other anodes—the result of thin spots or concentrations of the electron stream.

"National" graphite has exceptional purity... great strength... fine grain structure... high resistance to erosion... is a good conductor, especially at high frequencies... is free from dust and loosely held particles... provides low electron emission... and can be machined into intricate shapes to very close tolerances.

Yes... anodes of graphite have everything you need to turn out finer tubes. For more facts, write National Carbon Company, Inc., Dept. E.

"National" graphite has no melting point! It cannot melt or soften. This, plus the fact that graphite has a low coefficient of expansion and a high heat transfer rate, is the reason graphite will not warp or distort, regardless of operating temperature.

Because "National" graphite has a higher thermal conductivity than other anode materials, it provides greater protection from excess surface temperature—a cause of secondary or back electron emission. It also lessens the danger from local hot spots so often found in other anodes—the result of thin spots or concentrations of the electron stream.

"National" graphite is almost an ideal black body, making it a nearly perfect heat radiator. Thus, anodes of "National" graphite operate at lower temperatures for a given amount of energy dissipated. All tube parts therefore operate at lower temperatures, resulting in less distortion of other parts and more uniform tube characteristics.

"National" graphite has no melting point! It cannot melt or soften. This, plus the fact that graphite has a low coefficient of expansion and a high heat transfer rate, is the reason graphite will not warp or distort, regardless of operating temperature.

Because "National" graphite has a higher thermal conductivity than other anode materials, it provides greater protection from excess surface temperature—a cause of secondary or back electron emission. It also lessens the danger from local hot spots so often found in other anodes—the result of thin spots or concentrations of the electron stream.

"National" graphite is almost an ideal black body, making it a nearly perfect heat radiator. Thus, anodes of "National" graphite operate at lower temperatures for a given amount of energy dissipated. All tube parts therefore operate at lower temperatures, resulting in less distortion of other parts and more uniform tube characteristics.

"National" graphite has no melting point! It cannot melt or soften. This, plus the fact that graphite has a low coefficient of expansion and a high heat transfer rate, is the reason graphite will not warp or distort, regardless of operating temperature.

Because "National" graphite has a higher thermal conductivity than other anode materials, it provides greater protection from excess surface temperature—a cause of secondary or back electron emission. It also lessens the danger from local hot spots so often found in other anodes—the result of thin spots or concentrations of the electron stream.

"National" graphite is almost an ideal black body, making it a nearly perfect heat radiator. Thus, anodes of "National" graphite operate at lower temperatures for a given amount of energy dissipated. All tube parts therefore operate at lower temperatures, resulting in less distortion of other parts and more uniform tube characteristics.
produce a positive and negative pulse, one of which is clipped, shortened and then used to fire the thyratron, which in turn passes current to produce a flash in the neon lamp of about 50 microseconds.

It might appear that by utilizing both pulses on the forward and return traces, a brighter indication could be obtained with a given scheme of illumination. In practice, however, this has not been found to be successful, since small phase shifts occurring in the various circuits are liable to cause double images to be produced.

A tuning eye indicator is used to check that the oscillator is working to set the magnification of the resonator. To do this the magnification control is turned until the indicator tube shows that the resonator is actually oscillating, then the control is reversed until oscillation stops.

Under production conditions the instrument permits a comparative check of inductance against any standard from 100 µh to 100 mh, with an accuracy better than one percent. Resonant circuits can be checked and preset for frequency; coils with short-circuited turns and broken strands in Litz wound coils are clearly indicated, thereby giving a ready production check for minimum Q. In addition, a comparative check of capacitance can be made up to 0.001 µf. The capacitance difference, plus or minus, can be read directly in µf to an accuracy of 0.1 µf or 0.1 percent, whichever is the greater. The instrument is made in England.

Modulated Arc Lamp

A caesium vapor lamp for modulated infrared-ray communication was ready for use at the end of the war for convoy duty and troop landing operations. For peacetime use, it may prove useful for confidential ship-to-shore conversations, plane-to-ground or plane-to-plane communications, or in disaster areas where telephone wires are down and static makes radio communication impractical.

As accepted by the Navy, the
To insure continuous, accurate temperature control, the controlling thermostat should be tamper proof. Unauthorized tampering with the thermostat mechanism or changes in setting may be dangerous and can slow up production and impair quality. The contact assembly of the Fenwal THERMOSWITCH Control is completely protected by the temperature sensitive outer shell. It is impossible to tamper with the internal mechanism of the THERMOSWITCH Control. The only means of changing the temperature setting is by turning the adjusting sleeve. Tampering with the adjusting sleeve may be eliminated by the addition of a tamper proof cap with wire and lead seal.

Illustration shows a THERMOSWITCH Control with tamper proof cap and wire and lead seal. Combining this feature with the completely enclosed electrical assembly of the THERMOSWITCH Control insures all-around protection from unauthorized tampering with the control unit.

Investigate the modifications and special features available for your use with the Fenwal THERMOSWITCH Control. Study the "Fourteen Facts in Fenwal's Favor" in our Thermotechnics Booklet. Write for your copy.

---

FOURTEEN FACTS IN FENWAL'S FAVOR

1. Fast reaction time
2. Large heat sensitive area, small heat storage
3. Short heat transfer path
4. Small temperature differential
5. Built-in temperature anticipation
6. Enclosed assembly
7. Minimal vibration effects
8. Tamper-proof and sealed
9. Rugged construction
10. Adjustable over wide temperature range
11. Minimum size
12. Directly responsive to radiant heat
13. Uniform sensitivity over adjustable temperature range
14. Readily installed

#8 of "14 Facts in Fenwal's Favor"

FENWAL INCORPORATED
43 PLEASANT STREET
ASHLAND MASSACHUSETTS
Thermotechnics for Complete Temperature Regulation
Temperature coefficient less than 2 cycles per megacycle per degree centigrade. Calibrated within .005 per cent of frequency. Gasket sealed, contamination and moisture free. Octal mounting. Weighs less than 3/4 ounce.

Type Z-1 PR RADIO CRYSTALS are ideal for conversion of military aircraft transmitters to civilian frequencies. Frequencies of 3105 and 6210 KCS are IN STOCK AT YOUR NEAREST JOBBER. They meet FCC and CAC requirements fully. Precision made for utmost in stability, dependability, high activity, trouble-free operation and low drift. Unconditionally guaranteed.

PR CRYSTALS for AIRCRAFT
3105 KCS and 6210 KCS

PETERSEN RADIO COMPANY
2800 WEST BROADWAY—TELEPHONE 2760
COUNCIL BLUFFS, IOWA

PLASTIC FABRICATING ...O.K!
BAKELITE SHEETS, RODS, TUBES
FABRICATION PARTS

Eleven Years of Experience
ELECTRICAL INSULATION CO., INC.
12 VESTRY ST., NEW YORK 13, N. Y.

"HARD TO GET" ELECTRONIC AND RADIO SUPPLIES
At Great Saving

We have on hand, a large stock of "hard-to-get" electronic and radio supplies, made to high specifications and at a fraction of manufacturers' cost. Some of the items are as follows:

Ferranti interstage transformers
60 to 9000 cycles 1 Idb.
Impedance ratio
25 or 10,000 to 25,000 or 100,000
Pr. ind 133 Hys 2VAC
60 cycles

Micro Switches, yellow back, S.P.S.C. Potentiometers; all ohmages; slotted and long shafts

4 Conductor—black plastic covered cable—suitable for intercomms

Motors 24 Volts; D.C. 1/10 H.P. Mica Sheets 36 x 36

Transmitting condensers; a variety of capacities and voltages

Bathtub condensers; variety of capacities and voltages

Resistors insulated carbon—all ohmages and wattages

Resistors wire wound—all ohmages and wattages

Meters—a large stock of volt and millimeters

We Invite your Inquiries for Requirements

EDLIE ELECTRONICS, INC.
135 Liberty St.
Dept. 1
New York 6, N. Y.
Phone BARclay 7-4859

November, 1946 — ELECTRONICS
Model 315 Signal Generator, Designed down to the most minute detail for highest accuracy, greatest stability, minimum leakage, and good wave form $67.25

Model 305 Test Tester, Tests all tubes. Provides for filament voltages from 5 volts to and including 120 volts. Spare sockets for future tube developments...$46.25

Model 260 High Sensitivity Set Tester. 20,000 ohms per volt. D.C. Voltage range to 5,000 volts A.C. and D.C. Resistance ranges to 20 megohms. Current ranges to 500 milliampere...$38.75

This Simpson "Big 3"

gives servicemen a real profit-making set-up

- The successful radio serviceman today must have the finest in test instruments for a very practical reason—that's his only hope of present and continued profits. To meet the tremendous volume of business available he must be able to "trouble-shoot" fast and accurately every time. Only thus can he correct trouble speedily, with satisfaction to the customers.

Simpson offers you, in three basic test instruments, the accuracy and advanced electronic engineering which have given Simpson the proudest name in the industry. They are tried-and-tested examples of the kind of instruments Simpson has always built. Their use will demonstrate that from Simpson alone can you expect "instruments that stay accurate" with construction and design that lead the field.

To dealer and to serviceman alike, Simpson offers today the assurance of continued profits that only quality can give. No Simpson instrument is ever marketed, or ever will be, unless its makers feel that, of its kind, nothing finer can be produced.
TUBES AT WORK (continued)
lamp produces its radiation from an arc stream three inches long and more than an inch in diameter. The inner bulb contains the arc in an

at ARNOLD THERE IS NO CEILING ON QUALITY

We are not satisfied merely to offer you magnets which come up to the proposed R.M.A. standards . . . this is our minimum requirement. A quality floor below which we refuse to go.

Nor are we satisfied that ordinary production and inspection methods offer you adequate quality protection . . . we individually test each Arnold magnet in a loud speaker structure before shipment.

Another "individual touch" which has contributed to winning industry-wide customer acceptance for Arnold magnets is our established minimum standard of 4,500,000 BHmax for Alnico V material.

Over five million Arnold loud speaker magnets of the R.M.A. type have been produced since V-J Day under these quality safeguards. Continued adherence to them assures you of long-lived, dependable product performance.

In the mass-production of magnets, the Arnold "individual touch" does make a difference. Let us give you the whole story.

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION
147 EAST ONTARIO STREET, CHICAGO 11, ILLINOIS

Specialists in the manufacture of ALNICO PERMANENT MAGNETS

Cooperative Two-Station Antenna System

BY LINDSAY McMANUS
Installation Engineer
Canadian Marconi Company
Montreal, Canada

A BROADCAST STATION that is probably unique has just been completed by Canadian Marconi Company at Sherbrooke, Quebec. It is, in fact, a combination of two stations—CHLT and CKTS.

CHLT has been operated by the

Norman C. Beese, research engineer at Westinghouse Lamp Division, demonstrates the caesium vapor lamp he designed for talking over an invisible infrared light beam

atmosphere of argon and caesium vapor. Space between this bulb and an outer bulb is evacuated. The life of the lamp is about 100 hours.

Direct current is used to maintain the arc in the Westinghouse lamp. Modulation of 100 percent is possible at some points in the audio range from 200 to 3,000 cycles. The lamp is mounted in a parabolic reflector on a ship's mast and a similar parabolic unit contains the photoelectric cell used in the receiver. The beam spread is about 25 degrees.
Amphenol is known, and relied upon, by amateurs and professionals in every branch of radio and electronics. The encyclopedic array of more than 8,000 different Amphenol components completely serves the entire range of frequencies in use today. Amphenol engineers steadily are helping to pierce the veil of the unknown in the higher television and FM frequencies. They have been among the pace-setters in achieving the higher standards of mechanical efficiency and electrical correctness upon which progress in these fields depends.

Teamed with top-flight production facilities, Amphenol research has continuously developed new products to keep the Amphenol line of cables, plugs, connectors, fittings, sockets, antennas and plastic components the most complete available from any one source in the world today.

Wherever you find electrons at work, you'll find Amphenol components recognized as the standard of performance.

PHENOLIC CORPORATION, CHICAGO 50, ILLINOIS

In Canada - Amphenol Limited - Toronto

For Efficient Radio/ Electronic Arteries...

Choose Amphenol Components!

Amphenol

AMPHENOL

CRANIAL CABLES AND CONNECTORS - INDUSTRIAL CONNECTORS, FITTINGS AND CONDUIT - AMTERNAS - RF COMPONENTS - PLASTICS FOR ELECTRONICS

ELECTRONICS — November, 1946

155

manufacturing costs, it adds to product quality as well...and to consumer satisfaction. Here's how:

• Saves space — only 1¼ x 1¼ x 1½ inches — fits where tube won't
• Costs less than tube and socket it eliminates
• Long life — built to last the life of the set
• No warm-up period — starts instantly, runs cooler
• Installed in less time than tube — only two soldering jobs
• Sturdy, all-metal construction — not easily damaged
• Withstands overloads — even when charging deformed electrolytic condensers

Every one of Federal's line of "Center Contact" Selenium rectifiers is designed to give the full measure of performance that have made them the standard of the industry. A Federal engineer will show you how to put this latest model into your circuits. Write for details to Department P 413.

Federal Telephone and Radio Corporation

In Canada—Federal Electric Manufacturing Company, Ltd., Montreal

Export Distributors—International Standard Electric Corporation, 67 Broad St., N.Y.C.

ELECTRONICS — November, 1946

157

Replacement for these Tubes:

- Set 1:
  - 6L6G
  - 6BQ5
  - 6SL7

- Set 2:
  - 6L6G
  - 6BQ5
  - 6SL7

Electrical Characteristics:

- 110 VAC
- 110 VDC
- 110 VDC

Maximum RMS Voltage
Maximum Average Voltage
Maximum Peak Current
Maximum DC Output
Maximum Surge Capacitor
Amperage Rating
Power Rating
Two-Facet Monitoring Register in a means for detecting this tube when installed in AC power meters.
How Radio Manufacturers Use Cellusuede FLOCK


4.2 VOLTS OUTPUT*!!
DIRECT CONNECTION TO PENTODE OUTPUT TUBES!
... and only 1/8 oz. needle force

WITH THE NEW SHURE W56A Lever-Type Crystal Pickup Cartridge
List Price $4.45

THE NEW SHURE 96A Crystal Phonograph Pickup
List Price $6.10

MADE POSSIBLE THROUGH THE SHURE LEVER SYSTEM • HERE'S HOW IT WORKS:
The crystal is driven by a lever which improves the transmission of needle chuck torque into the crystal. This results in higher output and greater needle compliance. High needle compliance gives a "freedom of action" flexibility to the needle that means faithful tracking, and cleaner, fuller tone qualities.
The lever arrangement absorbs the full impact of sudden jere in the cartridge or needle, this in turn gives relative shock immunity to the crystal—minimizing stray or breaks.

WHAT THE 96A DOES FOR YOU; It makes possible the saving of one stage of amplification, and it permits the use of a long-life precision-tip needle with a high-output pickup. Such a lightweight, free-travel means that the records and needles will be less affected by the vibrations of electrical power lines, valves and room temperature fluctuations, and that output will be constant whether used in the studio, the living room or in any other room where there may be interference. The crystal is driven by a lever which improves the transmission of needle chuck torque into the crystal—minimizing stray or breaks.

WRITE FOR NEW CATALOGS 155 and 156

TUBES AT WORK (continued)
French-language daily newspaper, La Tribune, on 1,240 kc. An associated English-language weekly paper, Teleguide, has now taken over this station and the call letters have been changed to CKTS. The La Tribune, still retaining its call letters, CHLT—has expanded to 1,000 watts and moved along the dial to 900 kc.
The original CHLT studio has been dispersed with and modern combined studio have been constructed for the two stations. Each station has its own control room facing the main studio with a master control room in between. Local programs and remote pickups are led through the master control room and thence to either or both transmitters via the separate control rooms.

When CHLT was assigned its new frequency, it was with the proviso that two other stations on the same frequency be protected at night. Daytime operation could be at 1,000 watts, omnidirectional, but it was necessary to change to directional operation at sunset.

Common Antenna System

It was desirable to use the existing transmitter building for the two transmitters, having them and their associated audio and monitoring equipment in the same room, and to use the same antenna system for both stations. These plans presented problems in meeting all requirements and regulations and particularly to avoid any interaction or cross modulation through the entire audio and radio frequency circuits. Adequate shielding of audio components and lines would take care of this section, but r-f interaction between the two transmitters in the same room and using a common antenna could not be so easily avoided.

A new ground system for a two-tower array was put in and a new 196-foot tower was erected. The existing tower of the same height was moved to a new location to form the directional array. The towers were spaced 120 degrees apart at 900 kc, and it was decided that the desired directional pattern could be obtained by a phase difference of plus 141 degrees with a 1.5 to 1 current ratio in the towers. During the entire process of

November, 1946—ELECTRONICS
EVERY DE MORNAY-BUDD WAVE GUIDE is Electrically Tested, Calibrated and Tagged

When you use any De Mornay-Budd wave guide assembly, you know exactly how each component will function electrically. You avoid possible losses in operating efficiency through impedance mismatches, or breakdown and arcing caused by a high standing wave ratio. (See chart below.)

De Mornay-Budd wave guides are manufactured from special precision tubing, and to the most stringent mechanical specifications. Rigid inspection and quality control insure optimum performance.

NOTE: Write for complete catalog of De Mornay-Budd Standard Components and Standard Bench Test Equipment. Be sure to have a copy in your reference files. Write for it today.

The curve shows the manner in which the reflected power increases with an increase in the voltage standing wave ratio. The curve is calculated from the following equations:

\[
\% \text{ Power Reflected} = \left( \frac{V_{\text{max}}}{V_{\text{min}}} \right)^2 - 1
\]

De Mornay-Budd, Inc., 475 Grand Concourse, New York 31, N. Y.
don’t use rectifier tubes...

USE THIS

• IT COSTS LESS
• IT’S SMALLER
• IT’S LABOR-SAVING

NEW

Seletron 5M1
MINIATURE
SELENIUM RECTIFIER

O NE STUD, two quick soldered connections and it’s in! Usually costs less than the tube and socket it replaces. Compact—less than 1 cubic inch! Instant starting, cooler operation and longer life.

Radio Receptor, famous for Seletron built-on-aluminum selenium rectifiers now offers this MINIATURE unit to replace rectifier tubes in radio sets, amplifiers and other electronic devices.

Clicks with radio users because it has no fragile parts... eliminates rectifier tube replacements... helps batteries last longer.

Submit your problems. Write for details.

TUBES AT WORK (continued)

stalling the new ground system, new antenna and shifting of the existing antenna, the transmitter on 1,240 kc continued daily operation without interruption.

Precise measurements were made of the self and mutual impedances of the new array and from these measurements the operating impedances were calculated. Impedances of the various units and tower lighting transformers were measured and included in the calculations and the network component values were set up. Three conditions had to be satisfied simultaneously for the directional pattern; proper matching to coaxial lines, correct current ratio between the towers and the desired electrical separation between the currents. Any one improper condition would throw the others out.

For instance, the self impedance of tower 2 changed radically when the phase difference between towers changed and if the phase difference were not correct the current ratio could not be obtained and the coaxial lines would also be mismatched. Only by precise measurements and careful setting up of the tuning unit components by r-f bridge method could the system be properly adjusted. The final arrangement of the various units is shown in Fig. 1.

Circuit Arrangement

Tower 1 is used during the daytime for both transmitters. CKTS, the 1,240-ke, 250-watt station is fed to this tower through a coaxial gas-filled line, a 1,240-ke antenna tuning unit (ATU1 in diagram) and

Fig. 1—Two transmitters on different frequencies feed one antenna system.
INFINITELY LONGER LIFE FOR FLUORESCENT LAMP CAPACITORS...

thanks to SPRAGUE VITAMIN Q

Greatly increased production facilities now permit the application of Sprague's famous Vitamin Q impregnant to ballast capacitors for fluorescent lamps—with truly outstanding results. The tables below tell the story—on severe tests that leave nothing open to question as to the remarkable superiority of these Sprague units. NO Sprague Vitamin Q Capacitors failed during the life of the tests. ALL of the competing units did!


LIFE TEST NO. 1
Tested at 490v. A.C. 85°C in circulating air

<table>
<thead>
<tr>
<th>No. Units Tested</th>
<th>Maker</th>
<th>Hours Life at Failure of each unit tested</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>SPRAGUE</td>
<td>1st 124 3rd 339 4th 498 5th 516</td>
</tr>
<tr>
<td>5</td>
<td>Mfr. 1</td>
<td>2nd</td>
</tr>
<tr>
<td>2</td>
<td>Mfr. 2</td>
<td>107 243</td>
</tr>
</tbody>
</table>

VITAMIN Q Impregnant

SPRAGUE Mfr. 1

POWER FACTOR
550 v. A.C. 85°C.
(as measured on a Schering bridge)

Sprague .................. 0.27%
Mfr. 1  .................. 0.62%
Mfr. 2  .................. 0.45%

LIFE TEST NO. 2
Tested at 575v. A.C. 85°C. in still air

<table>
<thead>
<tr>
<th>No. Units Tested</th>
<th>Maker</th>
<th>Results</th>
<th>Impregnant</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>SPRAGUE</td>
<td>NO FAILURES AFTER 750 HOURS</td>
<td>Chlorinated diphenyl Oil</td>
</tr>
<tr>
<td>3</td>
<td>Mfr. 1</td>
<td>&quot; &quot; &quot; &quot;</td>
<td>&quot; &quot; &quot; 4</td>
</tr>
<tr>
<td>3</td>
<td>Mfr. 2</td>
<td>&quot; &quot; &quot; &quot;</td>
<td>&quot; &quot; &quot; 4</td>
</tr>
<tr>
<td>3</td>
<td>Mfr. 3</td>
<td>&quot; &quot; &quot; &quot;</td>
<td>&quot; &quot; &quot; 4</td>
</tr>
</tbody>
</table>

ELECTRONICS — November, 1946

www.americanradiohistory.com
Developed prior to World War II for standardization purposes, the AN (Army-Navy Specifications) Connector type series remains as one of the most versatile and widely known lines of electric multi-contact fittings. The large range of shell sizes, insert arrangements, interchangeable parts and accessory fittings make the Cannon Electric "AN" a desirable, all-purpose connector. Cannon Electric's "Quality Control" from diecasting to assembled fitting produces a dependable product used extensively not only in aircraft but also in radio, radar, instruments and countless general electrical applications.

Thousands of aircraft and radio technicians worked with these "Cannon Plugs" during the war; the same thousands are still demanding Cannon quality in peacetime because they know it served them well when the perfect operation of every electrical part of the war machine meant the protection of lives and more efficient prosecution of the offensives.

Cannon Electric
3209 Humboldt St., Los Angeles 31, Calif.
IN CANADA (and British Empire except)
CANNON ELECTRIC COMPANY, LTD., TORONTO
SINCE 1915

162

November, 1946 — ELECTRONICS
The Sylvania Type R4330 Flash Tube, used with suitable equipment, gives a brilliant flash of excellent photographic quality with a duration of only 1/5000th second.

A major application of the Type R4330 is in newly developed electronic flash units for photographic purposes. Here it permits taking pictures without the need for replacing flash bulbs. Its short flash duration "stops" motion, enabling the photographer to take sharp, clear pictures of moving subjects. Excellent edge quality permits use with color film.

Each time the circuit switch is closed, the tube emits a single flash. The tube has a life of several thousand flashes.

Other uses of the R4330 are in beacons, obstruction markers, airport boundary markers and signaling devices. See your Sylvania Distributor.
Keep your Business ♫ Humming ♫ with Air Express ♫

a money-making tool for every business

When critical materials, tools, dies, parts or machinery are needed fast to prevent costly production delays in your business — GET IT BY AIR EXPRESS and let this fastest delivery service pay its way many times over.

Rates are drastically down from pre-war days — a new economy that makes this service a greater money-making tool than ever, for thousands of firms throughout the nation.

Specify Air Express—a Good Business Buy

Shipments go everywhere at the speed of flight between principal U. S. towns and cities, with cost including special pick-up and delivery. Same-day delivery between many airport towns and cities. Fastest air-rail service to and from 23,000 off-airline communities in the United States. Service direct by air to and from scores of foreign countries in the world's best planes, giving the world's best service.

TUBES AT WORK (continued)

at sunset in approximately one second during a station break for identification. The tuning units at the towers are so adjusted that the coaxial line impedances at the transmitter for the two modes of operation are identical and no transmitter adjustment or retuning is necessary.

As a visual check on the shape of the night pattern, two field indicators have been installed. These consist of small receivers, containing a diode rectifier and d-c amplifier, set up in the field about 400 feet from the towers, one on each side of a low signal zone. The units are mounted on posts and are powered by a 110-volt a-c line. The output of each unit is taken by cable to d-c microammeters in the control unit on the desk at the transmitter building. Changes in the reading of the meters outside of a predetermined operating tolerance indicate to the operator that the pattern shape has altered. Cables also carry the antenna currents to remote meters in the desk control unit and provide a constant check on the currents in the towers for both transmitters.

To uncover any signs of interaction between the two stations, various tests were carried out. It was found that any switching on or off of one transmitter in no way affected the meter readings or field intensity of the other. Either carrier, fully modulated, did not affect the unmodulated carrier of the other transmitter and no signs of cross modulation could be detected with both stations fully modulated with individual or similar programs.

Microwave Wattmeter

POWER OUTPUT of transmitters and oscillators operating at frequencies from 20 to 1,500 mc and 50-ohm coaxial output terminals is measured by a wattmeter whose wide-band impedance constancy is realized by employing a length of attenuating 50-ohm coaxial cable terminated in a resistor. The basic idea is that the resistor determines the impedance at the lower frequencies and the line determines it

Write Today for the Time and Rate Schedule on Air Express. It contains illuminating facts to help you solve many a shipping problem. Air Express Division, Railway Express Agency, 230 Park Avenue, New York 17. Or ask for it at any Airline or Railway Express office.

Phone AIREXPRESS DIVISION, RAILWAY EXPRESS AGENCY
Representing the AIRLINES of the United States

November, 1946 — ELECTRONICS
SPECIAL DESIGN DIVISION HAS IT... or will ENGINEER AND BUILD IT!

3-Phase or 1-phase, induction or even synchronous, self-cooled or not; our engineering department has turned out a wide range of custom-built, war proven, high frequency motor designs which are now available for your needs. Many speeds, horsepowers and voltages as well.

Or perhaps, you want a stator and rotor to be designed into your own equipment. Whatever your needs, let us hear from you. We shall be happy to advise and assist you.

EASTERN AIR DEVICES, Inc.  5.  130 FLATBUSH AVENUE  BROOKLYN 17, NEW YORK, N. Y.

ELECTRONICS — November, 1946

Model J33
115 volts, 400 cycles, 8000 R.P.M. Synchronous, 3-phase.

Model J31A
115 volts, 400 cycles, 1/100 H.P., 7200 R.P.M. 1-phase.

Model J72
115 volts, 400 cycles, 1/15 H.P., 5500 R.P.M. 1-phase.

Model M6B
200 volts, 400 cycles, 3-phase, High torque actuator motor. Total weight 12 oz.

Model J37
115 volts, 400 cycles, Motor-generator set. 2-phase servo-motor drives induction generator. 400 cycle output voltage varies with frequency. Used for anticipatory control of electronic servo system.
Single shaft passes through and locks with rotor of each unit.

Each unit can be wound to precise circuit requirements, as to resistance, taper, tap, hop-off.

Interlocking resistance ratios provide any desired voltage or current at given degree of rotation.

Note dual unit with screw - driver adjustment. Such assemblies are serving in the most intricate electronic assemblies.

For three or more controls in tandem, Clarostat Type 42 is the logical choice. The bakelite cases of these rheostats or potentiometers nest and lock together for a virtually solid casing. Metal end plates and tie rods insure a rigid assembly—even up to 20 units in tandem. This unit is the solution to your multiple - circuit control. Back - lash is completely eliminated. And it is typical of that Clarostat "know - how" which provides the answers to all your resistor, control or resistance - device problems.

Submit your problem!

TUBES AT WORK

(continued)

at the higher frequencies, with a smooth transition. Distribution of power loss changes in the same manner in the instrument made by Bird Electronic Corporation of Cleveland.

In all attenuating coaxial cables so far made, the attenuation increases with frequency. A length of such attenuating line furnishes a constant input resistance equal to its characteristic impedance, regardless of termination of the line. For frequencies sufficiently high so that the reflections produced by an imperfect termination can be neglected.

Constant Resistance

In general, the constant resistance termination over a wide frequency range is obtained in the Bird wattmeter by using the Z, of the attenuating lines at the higher frequencies. In order that low frequencies may be handled with a reasonable cable length, the line is terminated in a specially designed coaxial resistor.

As the attenuation of the line increases with frequency, a "transfer of power loss" occurs gradually from the 20-mc condition, in which about 25 percent of input power is dissipated in the terminating resistor, to the 1,000-mc condition, in which 90 percent of the input power is lost in the initial 25 feet of line. The frequency 200 mc may be stated roughly as the upper limit of effects from the terminating resistor and at higher frequencies the line alone determines input resistance.

The wattmeter uses one hundred feet of a synthetic rubber dielectric, copper-conductor type of line. The average characteristic impedance of this line is 47 ohms and this fixes the load resistance presented to a thermocouple. The calibration of the individual wattmeter is made so as to include the effects of variation of individual lengths of line from the 47 ohm nominal value.

Measuring Equipment

The coaxial termination is blower cooled and rated 500 watts. A d-c millivolt-meter is used as the power indicator.

Plug-in thermocouples are provided to cover desired portions of the power range from 1 to 500 watts. The thermo junctions of the

CLAROSTAT MFG. CO., Inc. 285-7 N. 6th St., Brooklyn, N.Y.
HOW TO FORM PLAX POLYSTYRENE ROD

Plax crystal polished polystyrene rod can be heat formed without difficulty into many shapes and intricate bends. Correct forming techniques should be closely observed.

Any conventional heating method may be used. Either a liquid bath or a circulating air oven, at 250°F to 265°F, is satisfactory. Actual heating time depends on rod diameter. A few simple preliminary timing tests should provide data for use on a production basis, using the table shown below as a guide.

Well sanded and polished hardwood forms serve the purpose of maintaining correct shape until the bend has cooled sufficiently. Preheated forms are even better because polystyrene must be cooled slowly to prevent thermal shock and subsequent crazing due to sudden chilling. The best temperature for a preheated form is about 165°F.

Wiping bent sections after cooling, with an emulsified water-base wax, will restore their original high lustre. Any surface blemish on the finished shape can be removed by buffing.

If possible, machining operations should be performed prior to forming. When necessary to machine after forming, Plax machining instructions should be carefully followed. These instructions call attention to the fact that petroleum base materials, such as oil and kerosene, are deleterious to polystyrene. They name proper coolants and give other helpful information.

Heating Time Guide

<table>
<thead>
<tr>
<th>Rod Diameter</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4&quot;</td>
<td>5-7 min.</td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>15-18 min.</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>18-20 min.</td>
</tr>
<tr>
<td>1&quot;</td>
<td>22-25 min.</td>
</tr>
<tr>
<td>2&quot;</td>
<td>35-40 min.</td>
</tr>
</tbody>
</table>

Wiping bent sections after cooling, with an emulsified water-base wax, will restore their original high lustre. Any surface blemish on the finished shape can be removed by buffing.

If possible, machining operations should be performed prior to forming. When necessary to machine after forming, Plax machining instructions should be carefully followed. These instructions call attention to the fact that petroleum base materials, such as oil and kerosene, are deleterious to polystyrene. They name proper coolants and give other helpful information.

OTHER POLYSTYRENE DATA AVAILABLE

Bulletins on how to machine, what to tell machinists, how to use coolants and how to cement — all on Plax Polystyrene products — are available on request, along with information on standard and special forms of polystyrene offered by Plax.

Literature is also available on Plax Cellulose Acetate, Cellulose Acetate Butyrate, Methacrylate, Polyethylene and other products — including one on plastic bottles. Engineering help covering nearly all plastics materials and methods is available from Plax and the Shaw Insulator Company, Irvington 11, N. J. For literature mentioned above ... write Plax.

133 WALNUT STREET ★ HARTFORD 5, CONNECTICUT
Millen "Designed for Application" components are different! As a designer and manufacturer for many years of complex electronic and communication equipment, we are our own best customer for component parts. Consequently, we have to perform an outstanding job of designing and manufacturing such parts in order to satisfy our own applications. Our parts are "different", also, because as symbolized by the "Gear wheel" of our registered trade mark, they are designed by mechanical engineers working in close cooperation with our electronic circuit group. Below are illustrated a typical half dozen of the thousand-odd items we manufacture.

Illustrated above, left to right: Top row: The No. 10007, 8 and 9 group of nickel silver plain dials with specially designed matching knobs having accurately reamed brass bushings to insure concentricity, the No. 10035 Vernier dial and the No. 10030 multi-revolution Counter-dial. Bottom row: The No. 10012 multi-application right angle drive unit, the No. 59001 panel marking decalcomanie kit, and the No. 10050 dial lock.

JAMES MILLEN MFG. CO., INC.
SALES OFFICES
IN ALL
PRINCIPAL CITIES

MAIN OFFICE AND FACTORY
MALDEN
MASSACHUSETTS

CANADIAN SALES
ASTRAL ELECTRIC CO.
SCARBORO BLUFFS (TORONTO)

November, 1946 — ELECTRONICS
thermocouples form a short portion of the center conductor of the coaxial line, are heated by the r-f current therein and generate, in series with the center conductor, a d-c voltage proportional to r-f power level. The thermocouple d-c output is proportional to current squared and hence to power, but convenience dictates direct calibration in terms of power.

[Diagram of wattmeter]

Complete circuit of the wattmeter for use from 20 to 1,500 megacycles

The wattmeter may be used to measure the power output on transmitters designed for 72-ohm loads. It is preferable to use 50-ohm cables and connectors between wattmeter and transmitter, in the case of 72-ohm transmitters also. The idea here is that the standing wave ratios existing on the cables are determined by the wattmeter impedance and the $Z$ of the cables, and are independent of the transmitter. With 50-ohm cables, the impedance presented to the transmitter terminals will depend very little on cable length.

New Station Techniques

AS A RESULT OF CONDITIONS forced upon it by the war, the British Broadcasting Corporation has developed new conceptions of studio organization which it intends to retain.

Before 1939 the broad tendency was to use a number of simple studios for different classes of programs or scenes in a dramatic production and to centralize in a single control room all technical equipment. Now, however, this has been superseded by general purpose studios, each having its own technical

TURNER COLORTONE MICROPHONES

New crystal and dynamic microphones in a choice of rich, gem-like colors

Modern as tomorrow ... packed with new performance features that give more accurate pick-up and higher fidelity reproduction of voice and music ... Turner Colortone Microphones bring the beauty of matching color to microphone applications. Styled of rich, long lasting, shock resisting plastic in a choice of color finishes, they are especially adapted to orchestras, night spots, home recorders, and television studios. Green, orange, yellow and ivory models are now in production for limited delivery. Ask your dealer or write for details.

TURNER COLORTONE CRYSTAL

- Highest quality Metalised, moisture proofed crystal.
- 90° Tilting head. Semi or non-directional operation.
- Wind and blast proofed.
- Barometric compensator. Turner precision diaphragm.
- Choice of color finishes.
- Impedances: 50, 250, 500 or high.

TURNER COLORTONE DYNAMIC

- Heavy duty dynamic cartridge.
- Alnico V Magnet for increased sensitivity.
- Mu metal transformer shield eliminates possibility of extraneous pick-up.
- 90° Tilting head. Semi or non-directional operation.
- Wind and blast proofed.
- Choice of color finishes.
- Turner precision diaphragm.
- 20 ft. removable cable set.
- Impedances: 50, 250, 500 or high.

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

Electronic - November, 1946
Among the technical points changed is the abandoning of mixing of microphone circuits at microphone level. This was done because the high-quality microphones in universal use today are relatively insensitive. When several are mixed, the level is low enough to demand series faders and so the signal level varies according to the number of circuits faded up at one time. Furthermore, the necessary equalizer circuits still further depress the level until it is very near the Johnson noise background and other extraneous noises. The modern practice now is to give each microphone its own amplifier and then to mix after amplification.

Group faders are used as well as individual faders and this facility allows the program engineer to fade out any given combination of microphone channels in one movement, to fade up a single microphone for an announcement, and then to revert to the original arrangement immediately.

**Echo Room**

All microphone channels are passed through splitting transformers so that some of the program can be passed into an “echo” room and then reintroduced into the “direct” half of the outgoing circuit. Suitable attenuators are introduced and thus a radio play may use several microphones in one studio (as is now common) for various scenes, yet individual outputs can be adjusted for varying degrees of echo.

The program output of a studio is monitored by a program meter and loudspeakers and phones.

The various auxiliary circuits include remote switching of spare amplifiers, loudspeakers in studios for playback apparatus for introducing line-up tone, all interlocked with the microphone circuits to prevent the wrong material being radiated or howling set up.

The control desks associated with each studio are made for use by two persons, a program engineer and a producer. The controls, which are on the inclined face of the desk, are divided among three panels. These panels are arranged to swing forward for maintenance
A deservedly popular 50 wattter

The Collins 32RA was introduced several years ago as a quality designed, quality built radio communication transmitter, broadly adapted to most applications within its power and frequency scope.

It and the d-c version, the 32RB, were immediately put into service by airlines for control towers, by oil pipelines for emergency systems, by fishing companies for fleet control, and by other widely different types of industrial users.

The 32RA was found to be rugged, simple to operate, easy to service, and so thoroughly and universally satisfactory that a rising commercial demand was halted only by the war.

Now it is again available for peacetime applications. A large number of orders have already been received and filled, and we are able to ship from stock. If you would like specifications and design data, write us for an illustrated descriptive bulletin.

COLLINS 32RA—Power source: 115 volts alternating current. Power output, 50 watts phone; 75 watts CW. Frequency range, 1.5 to 15 mc. Four frequencies instantly selected by panel control.

COLLINS 32RB—Power source: 12, 24, 32 or 110 volts direct current. Dynamo motor, self-contained. Otherwise identical with 32RA.
Tubes at Work (continued)

and are quickly demountable. The division of the controls on the panels has been done on a functional basis; thus, the central panel carries all the important controls and is operated by the program engi-

eer, while the right-hand panel carries such controls as the “talk-
back” key and others which the producer might want to use. The
left-hand panel carries purely tech-
nical controls associated with
switching on the equipment, echo
mixture, and keys operating relays
controlling spare amplifiers. The
circuits of the last mentioned have
been designed with extreme care
and it is virtually impossible to
detect that an amplifier has been
replaced.

Frequency Modulation

In this regard, the British
Broadcasting Corporation has for
some time been interested in fre-
quency modulation and has now
summarized the results of extensive
field trials. On the whole, the
engineering executives appear to
be pleased with f-m but they are
by no means accepting it as perfect.
There are so many dependent fac-
tors. For example, the actual noise
level at the receiver depends, among
other things, on any motor vehicles
passing the premises being fitted
with efficient interference suppres-
sors. Again, the f-m system offers
an increased range of modulation
but this advantage is cancelled if
the receiver does not have sufficient
a-f power-handling capacity to
utilize the benefit. Similarly, it is

A program engineer and a producer at a
new B.B.C. control console. The panel at
the right is for use by the producer, the
center and left-hand panels contain more
technical controls.

Whether you are recording for broadcast,
rebroadcast, audition, or movie playback, it
is a satisfaction to know that the disc you
use will not fail.

Soundcraft’s great disc names:
- ‘Broadcaster’
- ‘Playback’
- ‘Audition’
are your guarantee of highest professional
quality.

WRITE FOR THE
SOUNDCRAFT STORY.
With the home television set, much of the attenuation and distortion of images that sometimes occurs on the screen may arise in the lead-in cable from the antenna to the instrument. But not with the new Type ATV cable shown here. With this cable, attenuation is minimized... images are strong and clear.

The unusual design of this new lead-in line deserves much credit for its high effectiveness. But note—what makes this design possible is the excellent electrical properties of the insulation, of Du Pont polythene.

Because of polythene's remarkable dielectric strength, a thin coating of it is all that is needed. Polythene's low power factor makes it unusually effective in every type of high-frequency circuit. Credit also polythene's light weight (specific gravity 0.92) and its ability to retain its toughness and flexibility over a wide range of temperatures.

For complete data sheet on polythene, write to E. I. du Pont de Nemours & Co. (Inc.), Plastics Dept., 1511, Arlington, N. J.

Du Pont manufactures polythene molding powder. Commercial extruders convert polythene into the form of TUBES, RODS, FILAMENTS, etc.

Type ATV two-wire polythene-insulated cable, for use as television lead-in line between antenna and receiver, made by Anaconda Wire & Cable Co. (Photo 2.5 times actual size.) This rugged, flexible cable, one of the lightest of its type, has an attenuation of 0.75 db/100 feet, and an impedance of 300 ohms at 50 megacycles.
well known that f-m offers the possibility of really high fidelity but what is this worth if the loudspeaker designer ignores what the transmitter engineer can give him?

The question of preemphasis at the transmitter and deemphasis at the receiver has been examined very carefully by the B.B.C. and the judgment is that a preemphasis of 50 $\mu$sec would be best for use. But here too the whole matter is tied up with loudspeaker design. Preemphasis, incidentally, is defined as the time constant of a circuit having the required frequency characteristic.

**Interference Ratio**

Concerning the matter of mutual interference between stations having a common service area, it was found in trials that 10 db(3:1) between two stations gave no intelligible interference. There was just a rasping sound. But to make a substantial reduction in this, 20 db(10:1) was the figure required and to eliminate completely all mutual interference a 30 db(30:1) difference was wanted.

The tests, however, brought out the immense superiority of f-m in this respect since 30 db gives complete freedom from interference whereas with a-m even 46 db(200:1) does not produce the condition of no interference.

The frequency deviation of an f-m transmitter is judged to be adequate at $\pm$ 75 kc and once again dependent factors arise since a narrow deviation band demands receivers with very stable oscillators although it has the advantage of permitting more channels in a given ether space. The amount of deviation is also tied up with the "capture" effect.

The field trials discussed above not only included measurements but a number of tests by ear. From these last tests a certain amount of disappointment emerged—f-m did not seem to some people to produce the expected background of silence.

Alternatives to f-m and a-m have also been tested by the B.B.C. and it has been found that f-m is definitely superior to pulse modulation systems for high fidelity working and high fidelity has always been
We have designed many cables which have solved a multitude of problems. When you come to Ansonia for something original in cables, our engineers will turn out a product to meet your specific requirements.
a main consideration with the Corporation, which strives to keep its transmitters ahead of receivers.

Both these summaries of recent B.B.C. technical work have been made with the permission of the Corporation and fuller details are contained in its new journal, B.B.C. Quarterly. — J.H.J.

Speeding up the Return Trace

BY A. H. TAYLOR

IN THE CONVENTIONAL sawtooth sweep circuit used in cathode-ray oscilloscopes, the speed of the return trace is limited by the permissible peak current of the gas tube.

Usually the gas tube is fired at 50 volts or less when charging from several hundred volts, to use only the initial, nearly linear part of the exponential voltage curve. The type 884 thyratron is particularly suitable for this because of its linear control characteristic, extending even to low plate voltages. Unfortunately, its permissible peak plate current is but 300 ma. Type 2050, on the contrary, will handle a peak of one ampere but has at low plate voltages an excessively curved control characteristic that makes for unsteady operation.

Sawtooth oscillator circuit combining advantages of 884 and 2050 to obtain rapid return trace of beam in c-r tube

The circuit shown combines the good triggering characteristic of the 884 with the high peak current of the 2050. Other types might be used. Resistor R, limits instantaneous peak current through the 884 and supplies a tripping pulse to the 2050; R₂, limits instantaneous peak current through the 2050; R₆, R₇, R₈, limit the grid currents. The combination of R₆C₇ is the sweep circuit.

Wires

made by engineers

for engineers

CORNISH WIRE CO., INC.

15 Park Row • New York City, 7
Here is an example of precision molding a critical component in G-E mycalex and supplying it by the million. The aircraft engine spark plug terminal sleeve had the advantage of being "self-healing" after exposure to prolonged arcing. It lent itself to ground crew maintenance of our warplanes.

This is but one of the many parts molded in G-E mycalex by General Electric during the war. Why not consult G-E engineers, who have perfected G-E mycalex molding techniques, about your insulation problems? You may heighten the efficiency of your product and save on over-all insulation costs by using a G-E mycalex precision molded part.

G-E mycalex, a stone-hard, gray-colored material that is produced by fusing special glass with powdered mica, is now available to you in standard rods and sheets...fabricated parts...or molded to your own design. A new bulletin tells the whole story of unique G-E mycalex—send for it today. Plastics Divisions, S-15, Chemical Department, General Electric Company, 1 Plastics Avenue, Pittsfield, Massachusetts.
INDUSTRIAL CONTROL
Edited by VIN ZELUFF

Testing Automobile Engines .......................................................... 178
Radarrange for Cooking ................................................................. 178
Phototube Sees X-Rays .................................................................. 180
Electronic Heating Conference ......................................................... 184
High-Speed Counter ...................................................................... 190
Industrial X-Ray Building .............................................................. 192

Testing Automobile Engines

At the Dodge automobile main plant, electronically controlled dyna-
mometer test stands provide a new automatic means of testing and ad-
justing car engines. A novelty of the setup is that each engine drives a
generator that feeds electric current into the plant's power line. In
one hour, 510 kilowatts are generated by the engines on test.

The dynamometer test stands take the place of the old block test
which required an hour and a half, and the old dynamometer test,
which took an additional ten minutes, not counting time to transfer
the engines between stands. The time required for fully testing an
engine has been reduced to 20 minutes. A saving is accomplished
also by eliminating the bank of engines manufactured ahead of as-
sembly line needs to offset the uncertainty of the former method of
engine testing.

The engine conveyor delivers fin-
ished engines directly to the new
dynamometer room where sixty
dynamometer test stands are ar-
ranged in two rows alongside the
conveyor line of moving engines.
Virgin engines are lifted by over-
head cranes directly from the line
to the dynamometer stands.

Test Cycle

One of the test stands is shown
in the illustration. The upright
cabinet contains a generator and
electronic controls that operate an
instrument panel. Adjoining it is
the base on which the engine is
mounted. Fuel, water, oil, and ex-
haust-gas lines are concealed under-
ground. A hydraulically operated
throttle adjusts automatically as
the engine runs from idling speed
up to full load. Practically no hu-
man error can enter into the testing
procedure.

The engine operates for five
minutes at an idling speed of 500 rpm,
with filtered oil constantly flushing
through the crankcase. Then the
electronic controls apply a half load
on the generator, the throttle opens
up, and the engine runs for 12 min-
utes at half load. During the first
seven minutes at half-load, oil con-
tinues to flush through the crank-
case, while a filtering system takes
out any metallic traces remaining
from the manufacturing process.
The oil drain is then closed auto-
matically, the crankcase is filled to
operating level, and the last five
minutes of the half-load test is run
with oil circulating within the
 crankcase.

The engine is stepped up to full
load at 1250 rpm for the final three
minutes of the test. During the
run, the operator of the stand gives
all connections and cylinder head
studs' a final tightening, and an in-
spector checks each engine for
power output and every engineer-
ing specification.

On the dynamometer instrument
panel, flashing lights show instantly
that the oil pump, water pump, and
thermostats are functioning, and
that the ignition timing is correct.
At the end of the 20-minute run
the engine is shut off and oil and water
are drained automatically. Five
minutes later, the engine is back on
the conveyor, on its way to be in-
stalled in a new Dodge.

The technique developed as an
outgrowth of experience in testing
more than 18,000 engines for B-29
Superfortresses at Chrysler Cor-
poration's wartime-operated Dodge-
Chicago plant.

Radarange for Cooking

Microwave cooking using a magne-
tron and a horn antenna to direct
r-f energy into food is the latest de-
velopment in the field of electronic
heating. Called the Radarange by
Raytheon Manufacturing Co., the
equipment bakes biscuits and gin-
gerbread in 29 seconds, cooks ham-
burgers with onion in 35 seconds,
and grills a frankfurter and roll in
eight to ten seconds. A package of
frozen food can be placed in the
range, defrosted in a few seconds,
and cooked in a few more seconds.

The equipment, shown in the pho-

Dynamic testing of Dodge automobile engines is being accomplished by sixty
electronically controlled test stands. Above, an inspector checks meters showing rpm,
 horsepower developed, and 14 other indicators.
FRANKLIN AIRLOOPS now covered by basic patent #2,401,472

FRANKLIN AIRLOOPS NOW COVERED BY BASIC PATENT

Patent No. 2,401,472 covering the new loop antenna, known as the AIRLOOP, has just been issued by the U. S. Patent Office. The claims issued are basic in scope as is evidenced in claim No. 1 which is typical and follows:

1—An air dielectric inductance comprising a panel of insulating material and a continuous metal strip formed from a metal sheet and attached to one face of said panel in the form of a spiral, the planar width of said strip being equal to the pitch of said spiral and said strip being in channel form to provide a free air space between adjacent turns of said spiral.

In addition to the above, other patents are pending, domestic and foreign, covering the methods of manufacture and items such as stamped electrostatic shields, stamped disc type commutators, stamped inductance coils, stamped wiring circuits and for the molding of loops and creative metal designs in cabinets which are of plastic or inert materials.

The Franklin Airloop Corp., which has the rights to the use of this patent, offers its experimental laboratories to assist in the development of any item which can be manufactured by the stamping method covered in these patents.

Illustrated are but a few of the items that can be manufactured by the method covered in this patent . . . many others are now in development . . . you, too, may conceive a use for this patented method and in such case the Franklin experimental laboratories will be glad to assist in its development.

FRANKLIN AIRLOOP CORPORATION

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

ELECTRONICS — November, 1946
MOLDITE IRON CORES
Supplied to your exact specification!

STANDARD IRON CORES—National Moldite molded cores can be supplied for any size coil with or without inserts, if desirable. New formulae make higher Q values possible, and accurate powder control assures uniform density. Cores are currently produced in quantity for ultra high, high, medium and low frequencies. Modern facilities permit rigid adherence to critical mechanical and electrical specifications.

PERMEABILITY TUNING CORES—National Moldite is one of the largest producers of tuning cores in the country. This leadership and large scale production result in efficiency and economy that has proven important to customers. Any size run, with the most critical specifications, can be handled with exact uniformity of all pieces.

PRODUCTION
With vastly expanded production facilities, National Moldite is in a position to meet your immediate iron core requirements. Quality, economy and dependability are assured, without sacrificing assembly schedules or delivery deadlines.

SAMPLES
National Moldite sample iron cores will be submitted for design, test and pre-production purposes upon receipt of your request. Use Moldite material grade designations to insure prompt and exact duplication of the required cores. Specify "MOLDITE" for "QUALITY!"

NATIONAL MOLDITE COMPANY
25 MONTGOMERY STREET HILLSIDE, NEW JERSEY

INDUSTRIAL CONTROL (continued)

Food to be cooked in the Raytheon Radarange is placed in the ventilated "oven" and inserted in the cabinet where r-f is squirted into it from the horn antenna the cooking area to practically beam the r-f output into the food being cooked. The only controls are two pushbuttons and a timer setting. In operation the timer is set for the desired cooking time and the button pressed. When cooking is completed, the timer automatically shuts off and the food is ready to eat. The power supply is located in the base of the cabinet. It is planned to produce several sizes of equipment to meet specific applications, such as in aircraft where space is an important factor.

Phototube Sees X-Rays
Automatic x-ray inspection of parts for internal defects is made

November, 1946 — ELECTRONICS

www.americanradiohistory.com
When power lines fail...

One-hundredth second after strike, automatic oscillographs start recording...

One-third second later, circuit breakers stop current flow...

and then quick computations, based on overload current and voltage, give distance along line to trouble.

Oscillogram made on Kodak Recording Paper 697

When windstorms damage power lines... when animals or birds "short" a circuit to ground... automatic oscillographs click into action and record the current and voltage changes. In less than one-half second it may be all over—the circuit breakers will have opened to stop the flow of current.

Tremendous speed of instrument response, of recording, is essential... and moving mirror oscillographs with photographic recording papers are more than equal to the task—because they can start operating in a hundredth of a second.

In service such as this, and in many other applications of oscillographs to studies of transient phenomena, the quality and dependability of photographic papers and films are factors which control the usefulness of trace data. There is a suitable Kodak paper or film for every type of oscillograph, and Kodak engineers will be glad to help with any work you may be doing with photographic instrument recording.

Instrument Recording

...another important function of photography

Eastman Kodak Company
Industrial Photographic Division, Rochester 4, N. Y.
THE "4 FOR 1" APPLICATION ADVANTAGE OF
Marion Glass-to-Metal Truly Hermetically Sealed
2\(\frac{1}{2}\)" and 3\(\frac{1}{2}\)" Electrical Indicating Instruments

ONE INSTRUMENT...FILLS THESE FOUR NEEDS

Interchangeable Round and Square Colored Flanges

...which are the key to the "4 for 1" Advantage. With these, it is possible to order a minimum number of instruments in the most popular ranges, and apply either the round or square flange according to usage. This feature simplifies ordering and inventory procedures for the manufacturer...and stocking and selling for the jobber. Besides black, the flanges are available in 12 iridescent colors—including red, blue, green, gold and silver. The use of color has been found to add to the eye-appeal and, consequently, to the sales value of otherwise drab equipment.

100% GUARANTEED

for six months—after that, regardless of condition and provided the seal has not been broken, we will replace any instrument from 200 microamperes upward for $1.50, and 2\(\frac{1}{2}\)" and 3\(\frac{1}{2}\)" type with sensitivity greater than 200 microamperes for $2.50.

A multiplier phototube replaces the usual film for high-speed automatic inspection of parts for internal defects. The thyatron operates a marker and warning light.

INDUSTRIAL CONTROL

possible in the accompanying circuit by placing a type 931 multiplier phototube in the position normally occupied by film during inspection by the x-ray absorption method, and by using an appropriate phosphor to convert the incident x-radiation into radiation of longer wavelength that can be measured by the phototube. The phosphor, such as silver-activated zinc sulphide or CaWO\(_4\), may be applied to the glass envelope of the phototube or to a fluoroscopic screen positioned between the tube and the part being inspected.

Negative pulses from the 931 anode are resistance-capacitance coupled to one grid of the 6SN7 tube. The amplified positive pulses are then coupled to the other triode section, which is operated as a cathode-follower impedance converter to supply a comparatively low impedance network. The output of the cathode-follower is rectified by a 6H6 diode and the d-c output is used to trip a 2051 thyatron and relay to operate a marker and warning light when output reaches a certain value. The d-c current also operates a photoelectric recorder of the x-ray intensity.

In one application of the circuit, described by H. M. Smith of General Electric Co., defective fuzes had part of their powder charge missing, and they therefore allowed greater x-ray penetration than...
ERIE RESISTOR has developed and manufactured a complete line of Ceramic Condensers for receiver and transmitter applications; Silver-Mica and Foil-Mica Button Condensers; Carbon Resistors and Suppressors; Custom Injection Molded Plastic Knobs, Dials, Bezels, Nameplates and Coil Forms. Complete technical information will be sent on request.
SPEED UP with KESTER Cored SOLDERs

- On hundreds of reconverted production lines throughout industry, Kester Cored Solders are Specification No. 1 for fast, failure-less soldering and permanently trouble-free solder-bonds.
- Fast, because Kester Cored Solders end guesswork. Flux and alloy—right kind and right quantity—are applied in one simple, easy operation.
- On assembly lines for electrical equipment, you'll find Kester Rosin-Core Solder making connections tight, for years of freedom from corrosion and terminal resistance. Electrical circuits operate with a minimum of service difficulties when they're protected with Kester Rosin-Core Solder.
- Kester Acid-Core Solder, for general work, is the ideal all-purpose solder.
- Kester Cored Solders come in a wide range of flux and alloy combinations, strand and core sizes, one of which is exactly suited to every application. Kester engineers, backed by 47 years of laboratory research and practical solder experience, will gladly work with you on any solder problem, at no obligation to you. Write them fully, any time.

KESTER SOLDER COMPANY
4204 Wrightwood Avenue, Chicago 39, Ill.
Eastern Plant: Newark, N. J.
Canadian Plant: Bramford, Ont.

Electronic Heating Conference

Industrial applications of high-frequency heating equipment that ranged from dielectric baking of foundry cores to inhibition of mold on Boston brown bread were discussed recently at a two-day conference of engineers in San Francisco.

Baking of foundry cores was a cooperative venture between Induction Heating Corp. and E. F. Houghton Corp., suppliers of the...
TINNERMAN NEWS EXTRA

WEATHER

Clear with diminishing costs.

TINNERMAN PRODUCTS, INC. • 2106 FULTON ROAD • CLEVELAND 13, OHIO

BUYERS GET HOT TIP

Shrewd, alert, cost-conscious John Buyer, speaking today for American Industry, admitted wide affect of latest Tinnerman Announcement. He predicted that, "The new C7000 Series Speed Nuts, costing less than threaded nuts plus lock washers, will save hundreds of thousands of dollars, as well as give impetus to better and faster assembly of mass production products". From Cleveland comes word that large stocks are on hand for immediate delivery. Prices and samples of the new Speed Nuts can be had for the asking.

www.americanradiohistory.com
FINCH TELEFAX

IS REALLY "PRINTING
BY REMOTE CONTROL"

Finch Telefax equipment transmits and records—by radio or telephone—exact facsimiles of written or printed messages, as well as drawings, photographs, signatures, typewriting, etc. Finch Telefax is really “printing by remote control.” It is the fastest known and most accurate system of communication.

Write for particulars.

FINCH TELECOMMUNICATIONS, INC.
Address all inquiries to Sales Office
10 EAST 40th STREET • NEW YORK 16, N. Y.

Makers also of Facsimile Broadcast Transmitting Equipment, Facsimile Home Recorders, Facograph Duplicating Machines, and Finch Rocket Antenna for FM stations.

INDUSTRIAL CONTROL

(continued)

binder materials used. Where the old oven method required time in the order of hours and produced cores with irregular texture, the new development cut the operation on one particular core to 30 seconds and produced uniform cores with ideal color and texture.

The wet cores were carried through a dielectric heating tunnel by belt and timing was thus removed from the responsibility of the operator. Because of the drying curves, as shown in the accompanying illustration, it became impossible to burn the cores even by repeated passes through the tunnel. The knee in the solid curve, representing the wet pass, is created by the presence of moisture. On a subsequent pass approximately the same ultimate temperature is reached.

It has been found possible to pour alnico and Stellite around cores produced by the electronic process. The reported cost for power is about $1.25 per ton of sand treated and tube cost is eight cents per hour.

R-F Sterilization

In a discussion on r-f treatment of foods and agricultural products, it was mentioned that such treatment could be uniform only in homogeneous materials where a constant voltage gradient could be expected. Contrary to common expectations, even foods like potatoes present structures organized into discrete areas which make this difficult. Unsolved problems in this field include use of higher frequen-

Drying curves for dielectric heating of foundry cores show that same ultimate temperature is reached by second pass through heating unit. Knee in solid curve is produced by moisture in initial core. Dashed curve is that of subsequent pass.
Cut design costs and maintenance expense

with CONSTANT VOLTAGE protection

What happens to YOUR product when input voltage varies 10-15% from the value specified on your label?

Commercial line-voltages vary that much—and more! But you will be blamed if your product fails to perform at its best, regardless of those variations.

Be on the safe side. Build a SOLA Constant Voltage Transformer into your equipment and regardless of supply line variations as great as ±15% the voltage that reaches your equipment will be maintained within ±1% of the limits specified on your label.

SOLA Constant Voltage Transformers do their job automatically. There are no tubes or moving parts—nothing that requires manual supervision. Standard designs are available in capacities from 1VA to 15KVA or special units can be built to your design specifications and cost limitations.

Write for Bulletin DCV-102
Here you’ll find the answer to a problem that confronts every manufacturer and user of electrical or electronic equipment.

SOLA ELECTRIC COMPANY, 2525 Clybourn Avenue, Chicago 14, Illinois

Manufactured in Canada under license by FERRANTI ELECTRIC LIMITED, Toronto
Astatic
NYLON 1-J
CRYSTAL PICKUP
CARTRIDGE

- Improves performance with respect to needle life and frequency response.
- Improves tracking at low needle pressure and reduces record wear.
- Employs Nylon Chuck and matched, sapphire-tipped, knee-action, replaceable Nylon Needles.
- Assures phonograph manufac- turer that the quality of reproduction remains CONSTANT, regardless of needle replacement... because the Nylon Needle is MATCHED to the cartridge and is the only needle that can be used with it.
- Assures phonograph owner of unalterable quality of reproduction.
- MANUFACTURERS and ENGINEERS interested in improving the quality of phonograph reproduction and the MAINTENANCE of such quality during the life of the instrument, will find such possibilities in the use of Astatic's new Nylon 1-J Crystal Cartridge. A descriptive, informative and generously illustrated folder, including cartridge specifications, is now available. Write for it today.

INDUSTRIAL CONTROL

The Magic of Nylon
Now contributes to Finer Reproduction of Phonograph Recordings

Astatic

The Astatic Corporation
Conneaut, Ohio

in Canada: Canadian Astatic Ltd., Toronto, Ontario

Astatic Crystal Devices Manufactured
under Bush Development Co. patents.

products was stated, in one of the 14 papers delivered, to result in destruction of all spoilage microorganisms except a few of the thermophilic bacteria and inactivation of all the well-known enzymes. This may be achieved more readily with acid products than non-acid which require a considerable length of treatment in the range 240 to 260°F to destroy the heat-resistant spores of spoilage bacteria.

One speaker contrasted the possibility of using a lethal effect from electronically produced radiation without heat against the practice of using electronic means to generate heat within the product. The latter he dismissed as economically infeasible, stating that necessary equipment might very well approach in investment the entire cost of a conventional cannery. Admitting that the prospect of achieving sterilization by radiation without heat is most attractive to the industry because it would permit the production of fresher foods with uncooked characteristics, he questioned the present possibility of gaining commercial sterilization in this way.

Research Needed

Naming as possible types of radiation, ultraviolet, x-rays, electromagnetic radiation, and cathode rays, he listed barriers to the application of research work referred to in the current literature. For instance, where r-f radiation has been shown to be 100 per cent effective in killing E. coli, this was only possible in a salt-free medium. Presence of only a few hundredths of one percent of sodium chloride prevented such action and indicated that the presence of electrolytes in many foods would make them unsuited to such treatment. His conclusion was that the canning industry would find it necessary to await the outcome of further research being conducted at a number of institutions before going further in this development.

In another paper, it was disclosed that work conducted in the microbiological laboratory of the University of Southern California may indicate that there is an r-f effect on microorganisms beyond the

November, 1946 — ELECTRONICS
Here is another application where this improved Irvington formulation... Fibron #5373... solves an electrical insulation problem involving high temperatures. Hot cement, used to seal the #5373-covered heating elements, has no effect on the flexibility of this unusual plastic. When the heater is in use, the tubing withstands continuous operating temperatures as high as 85° C. #5373 possesses the electrical, mechanical, and chemical properties which distinguish all Fibron tubings. Some of these are:

- **Dielectric Strength**: (.020" wall) wet 1000 V.P.M.  
  dry 1000 V.P.M.
- **Tensile Strength**: P. S. I. 3000
- **Life at 105° C.**: 2000 hours

Fibron #5373 tubing is available in all standard B & S wire gauge sizes, in six brilliant colors, in heavy wall thicknesses if required—in 36" lengths, coils, or cut pieces.

Test this unusual product now. Generous samples and additional technical information gladly sent on request.

**IRVINGTON**  
Varnish and Insulator Company  
IRVINGTON 11, NEW JERSEY, U.S.A.

Authorized distributors in: BALTIMORE - BLUEFIELD, W. VA. - BOSTON - CHARLOTTE - CHICAGO - CLEVELAND - DALLAS - DENVER - LOS ANGELES - MINNEAPOLIS  
NEW HARTFORD, N. Y. - NEW YORK - NEW ORLEANS - PHILADELPHIA - PITTSBURGH - ST. LOUIS - SAN FRANCISCO - SEATTLE - HAMILTON, ONT., CANADA

ELECTRONICS — November, 1946
Tight clinching
already didn't
back insulation riveting perforated Rivets
self Cherry
hollow type Cherry Blind Blind Rivet -plugging
OS Angeles
were Rivets. THEIR MANUFACTURE been run.

A CONTROLLED PULL instead of a pound. There's no hammering or bucking because Cherry Blind Rivets are installed with a controlled pull from one side of the work only.

A SIMPLE ONE-HAND OPERATION vs. a tough two-man job. Installing a Cherry Blind Rivet is a fast, one-hand operation requiring only three simple steps: (1) inserting rivet in hole; (2) engaging the rivet; (3) actuating the gun.

SPECIAL CHARACTERISTICS establish Cherry superiority over all other blind fasteners: (a) Greater shank expansion; (b) Greater allowable variance in material thickness for a given rivet-length. These factors mean uniformly tight, strong joints under actual production conditions where hole sizes and sheet thicknesses cannot always be controlled closely.

FAMILIARITY BREEDS RESPECT wherever Cherry Blind Riveting is used. This simplified, speed-up fastening technique is finding more and more friends in more and more industries by providing secure, permanent fastening... while cutting production costs.

INDUSTRIAL CONTROL (continued)

purely thermal one and that the mechanism of cell destruction under such conditions where the walls are punctured has been observed. That there is a specific frequency for each organism or group seems probable. As a practical application of the laboratory activities, successful inhibition of the growth of mold on the surface of commercial Boston brown bread with a treatment by r-f induction heating was described. The conference was sponsored by fifteen local organizations, including IRE, AIEE, and the West Coast Electronic Manufacturers Association.

High-Speed Counter

COUNTING OBJECTS at rates as fast as 1,000,000 per second, the RCA time interval counter is now for the first time being produced in quantities for science and industry. The unit was developed by RCA during the war and used for measuring projectile velocities at the Army's Aberdeen Proving Grounds. Redesigned for peacetime applications, it can be used to measure velocities and accelerations for intervals up to one second in steps of one microsecond, or to count at

Neon-lit figures on the panel of the time interval counter can show velocities and accelerations for intervals up to one second in steps of one millionth of a second speeds as high as 1,000,000 per second.

For industrial control, the instrument may be used as an integral
A NEW

VACUUM-TUBE
VOLTMETER

- INCREASED SENSITIVITY — with the addition of a 0 to 0.5 volt scale, sensitivity is extended by a factor of 3
- CALIBRATED FOR DC AS WELL AS AC
- WIDER VOLTAGE RANGES — 0.1 to 150 volts for ac; 0.01 to 150 volts for dc; both in six ranges
- ACCURACY OF ±2% FOR D-C AND SINUSOIDAL A-C VOLTAGES
- EXTENDED FREQUENCY RANGE — as low as 20 cycles with error of less than 2% up to 300 Mc maximum error is ±12% — useful for voltage indication up to 2,500 Mc
- IMPROVED PROBE — much smaller — natural frequency increased to 1050 Mc — much better shielding — can be used with a variety of standard probe fittings, three of which are supplied
- A SINGLE ZERO ADJUSTMENT GOOD FOR ALL SIX RANGES
- NEW METER — easier to read — mirror for greater precision — no parallax — knife-edge pointer for upper scales, broad pointer for lower — face illuminated to eliminate reflections from glass
- EFFECTIVE INPUT RESISTANCE 25 MEGOHMS AT LOW FREQUENCIES
- VERY LOW PROBE INPUT CAPACITANCE — about 3.1 micromicrofarads
- PLATE VOLTAGE SUPPLY EQUIPPED WITH ELECTRONIC STABILIZER
- INSTRUMENT CAN BE USED WITH PANEL VERTICAL, INCLINED OR HORIZONTAL

TYPE 1800-A VACUUM-TUBE VOLTMETER - $305.00

- Write for complete information

THE Type 1800-A Vacuum-Tube Voltmeter is a new instrument based on the fundamental designs of the Type 726-A, introduced by G-R in 1927. With greater sensitivity, increased ranges, improved probe construction, both d-c and a-c voltage calibrations, and housed in a much more compact and convenient-to-use cabinet, the useful upper-frequency limit of this meter is extended just about as far as present-day vacuum-tube construction will permit.

GENERAL RADIO COMPANY

Cambridge 39, Massachusetts

90 West St., New York 6 326 S. Michigan Ave., Chicago 5 950 N. Highland Ave., Los Angeles 38

ELECTRONICS — November, 1944

www.americanradiohistory.com
unit of selective counting machines, which automatically start, stop, or shift operations when a prede
termined number of items has been counted. By this means, any
process can be controlled on the basis of a preselected figure. A
dial is set, and when the preselected figure is reached, the counter trig-
gers an electrical impulse which stops the operation, shifts the pack-
age to another conveyor, and starts the counting operation all over
again.

Time intervals longer than one second can be measured by using
an external timer to record the number of times the counter re-
peats its operation.

**Industrial X-Ray Building**

**First Reported** use of a 2,-
000,000-volt x-ray machine for
examining welds in pressure
vessels will be that at Babcock
and Wilcox Company of Barberton,
Ohio. The company manufactures
steam generating equipment and is
a pioneer in the use of x-ray to
detect flaws in pressure vessel
welds, having 11 such machines
now in use.

A special building to house the
new machine will be erected adja-
cent to the location of a present
1,000,000-volt x-ray unit.

The building will be 35 feet wide
by 31 feet high, and 81 feet in
length. Double walls of 42 inches
of sand solidly packed between
quarter-inch steel plates will pre-
vent radiation from the unit. An
overhead floor-operated crane will
support the x-ray unit and move it
around within the building.

The building will accommodate
drums up to 13 feet in diameter and
75 feet in length, which are the
dimensions of the largest vessel
likely to be shipped by rail. Vessels
that weigh up to 150 tons can be
tested. Two cars with drum turners
will bring the drums into the
building. One car and one drum
turner will be motorized.

The equipment was purchased
from General Electric X-Ray Cor-
poration, and is capable of operat-
ing at any voltage from 1,000,000
to 2,000,000.

---

**RINGS THE BELL FOR ASSEMBLY**

"Yes sir," says Felsy, who holds his
Degree from the School of Experience,
"I can really ring the bell on big and
complicated assembly jobs.... The kind
that involve a lot of operations, a lot of
parts, a lot of processes, a lot of work."

Correct! In addition to the experience
and the manpower, we have a complete
set-up for

SCREENING  ENGRAVING  PRINTING  FORMING
HEAT SEALING and
DOZENS OF OTHER FABRICATING OPERATIONS

All in one plant—all under one roof—
all under one responsible management.

Write for booklet 3-A on your letterhead. It
illustrates scores of parts and products made to
blueprint specification by Injection Molding,
Laminating, and Fabricating.
A Triumph in
COMMUNICATIONS ENGINEERING

The New Improved
KP - 81
Receiver

DESIGNED by Karl E. Pierson, creator of the famous PR series of receivers, the new KP-81 is now in production. We promise you this receiver will establish new standards of excellence in the field of radio communications. KP-81 incorporates many of the advanced features born of wartime research, and is years ahead in design, engineering and performance.

New Automatic Noise Silencer
Two Pre-Selector Stages
Turret Band Change
Four Gang Tuning and Band
Spread Condensers
Series Parallel Crystal Filter
Calibrated Band Spread
Built-In Crystal Calibrator
Single Signal At All Times
Variable Hi and Lo Pass Audio
Filters
550 Kilocycles to 40 Mega-
cycles

We are making every effort to meet the heavy demand for the new KP-81 receivers. However Pierson Electronic Corporation will adhere to their policy of precision construction, and suggest that you place your order well in advance.

PIERSON ELECTRONIC CORP.
533 EAST FIFTH STREET - LOS ANGELES 13, CALIF.
Manufacturers of Communication and Commercial Radio Equipment
"Export Department: FRAZAR & HANSEN, 301 Clay St., San Francisco 11, Calif., U. S. A."

ELECTRONICS — November, 1946
193

www.americanradiohistory.com
Analysis of Linear Sweep Generator
By Eugene L. Langbergh
Randal Morgan Laboratory
University of Pennsylvania

The circuit herein described is designed to take advantage of current feedback to cause a capacitor to charge very linearly through a vacuum tube. The basic circuit is shown in Fig. 1. Capacitor C is charged by current flowing through V1 and R from the B-supply. Tube V1 is a switch used to discharge C.

In this case a gas tube as in the usual relaxation oscillator. Current feedback upon which the circuit's linearity depends occurs in resistor R.

Mathematical Analysis

For considering the circuit mathematically, it can be simplified to that shown in Fig. 2A. From this circuit we can draw the equivalent circuit shown in Fig. 2B. We will take as t = 0 the time at which the switch opens and consider what happens for one cycle, all others being the same.

Assuming that negligible current is drawn by the load on the output, the mesh equation for the circuit is

\[ E_{sb} - \mu E_s = r_s i + r_i + f(i/C) \ dt \]

but \( E_s = R_i \) so we have

\[ E_{sb} = \mu R_i + r_s i + r_i + f(i/C) \ dt \]

Transposing, multiplying through by \( C \) and gathering terms, we have

\[ CE_{sb} = C(R + \mu R + r_s) i + f(i/C) \ dt \]

Because \( i = dq/dt \) and \( i f dt = q \), we can write an equation in \( q \), the charge on the capacitor

\[ CE_{sb} = C(R + \mu R + r_s) dq/dt + q \]

Let \( C(R + \mu R + r_s) = A \) and rewrite the foregoing equation as

\[ dq/dt + q/A = CE_{sb}/A \]

This equation is in the well-known form

\[ dy/dx + Py = Q \]

the solution of which is

\[ y e^{\int P \ dx} = \int e^{\int P \ dx} Q \ dx + C_1 \]

We have \( P = 1/A \), \( Q = CE_{sb}/A \), \( y = q \), \( dx = dt \). Making the proper substitutions and carrying out the indicated integrations, we have

\[ q = CE_{sb} + C(E_s - E_{sb}) e^{-t/A} \]

at \( t = 0 \), \( q = E_s C \) where \( E_s \) is the voltage at which the gas tube goes out, therefore \( C_1 = C(E_s - E_{sa}) \) and the solution is

\[ q = CE_{sb} + C(E_s - E_{sb}) e^{-t/A} \]

Taking the derivative, we have

\[ dq/dt = -C \ (E_s - E_{sb}) e^{-t/A} \]

Putting in the value of \( A \), our result becomes

\[ dq/dt = E_{sb} - E_s \ exp \left\{ -t/(R + \mu R + r_s) \right\} \]

It is evident that for \( dq/dt \) to be constant, \( C(R + \mu R + r_s) \) must be large. This fact controls the selection of the tube \( V_1 \). It should be a high-\( \mu \) tube with large \( r_s \). High-\( \mu \) pentodes fulfill this condition best. However, the circuit worked fairly well even with a low-\( \mu \) triode but large \( R \).

Degree of Nonlinearity

The question of just how badly nonlinear the sweep may become can be answered in the following manner. The maximum value of \( t \) per cycle will be the period of the sawtooth determined by the potential at which the gas tube ignites. If \( E_s \) is the voltage on the capacitor at ignition, then \( q = CE_s \). Putting this value into the equation for \( q \) and solving for the maximum value of \( t = T \)

\[ CE_t = CE_{sb} + C(E_s - E_{sb}) e^{-T/A} \]

\[ (E_{sb} - E_s) = (E_{sb} - E_s) e^{-T/A} \]

\[ E_t = E_{sb} - E_s \]

\[ T = -A \ ln \frac{E_{sb} - E_s}{E_{sb} - E_s} \]

Note that \( \ln (E_{sb} - E_s)/(E_{sb} - E_s) \) is always negative because \( (E_{sb} - E_s)/(E_{sb} - E_s) \) is always less than unity, hence \( T \) is always positive.

Solving for \( A \) gives

\[ A = \frac{\ln (E_{sb} - E_s)}{E_{sb} - E_s} \]

\[ T = \frac{E_{sb} - E_s}{E_{sb} - E_s} \]

\[ \frac{\partial q}{\partial t} = C \ (E_{sb} - E_s) \ exp \left\{ \frac{T}{t} \ ln \frac{E_{sb} - E_s}{E_{sb} - E_s} \right\} \]

The maximum value of \( t/T \) is unity at \( t = T \). The charging rate at \( t = T \) is

November, 1946 — ELECTRONICS
FREE OF AIR... in a high vacuum so many of the familiar liquids and gases, so many heretofore "undistillable" substances react to various treatments in entirely new—often strange—but potentially useful ways. Despite the years of research and the solid accomplishments made to date, the field for new commercially valuable discoveries through high-vacuum technique remains virtually untouched.

The D.P.I. Glass Two-Stage Fractionating Pumps provide basic versatile tools for laboratory investigations in high vacuum. Beyond this important function, their economy and efficiency have furthered their wide industrial use in conjunction with trolley exhaust machines in the production of electronic tubes and parts.

GF-20A and GF-20W offer a choice of either an air- or water-cooled pump, capable of producing a vacuum of better than 10^{-6} millimeters in a closed system of moderate size. Its controlled flow of oil through the three boilers makes this efficiency possible—without employing a cold trap.

If either your laboratory studies or your commercial processes involve high-vacuum technology, the D.P.I. Glass Two-Stage Fractionating Pump may be the tool you need to further your present and future work.
Unbalanced rectifier stock conditions are both annoying and costly. Now, however, you can avoid having surplus inventories on some items and "out of stock" entries on others with Conant's new Balanced Inventory Buying plan.

As a result of a study of instrument rectifier sales to test equipment manufacturers, Conant is now able to offer you 3 rectifier package assortments for balanced buying. Whatever your volume of business, one of these assortments will enable you to purchase instrument rectifiers with the assurance that your stock on hand will always be properly proportioned.

Prices of the new "packages" run from $28.78 to $120.48. Send a postcard today for full information about quantity and type of rectifiers in each unit. Reply will be prompt and include a FREE copy of the Conant Instrument Rectifier Replacement Guide... the handiest reference book available on replacements for most test equipment.

Electron Art (continued)

\[ \frac{d}{dt} = \frac{C}{A} (E_{35} - E_0) \exp \ln \frac{E_{35} - E_i}{E_{35} - E_0} \]

which represents the worse possible condition of nonlinearity. Because it is reasonable to expect the sawtooth to be amplified before being placed upon the cathode-ray tube, the sweep generator need put out a voltage no greater than 10 volts. This condition means that \( E_i - E_0 = 10 \) volts. Using reasonable values of \( E_{35} = 350 \) volts, \( E_i = 15 \) volts, and \( E_i = 25 \) volts, \( \exp \ln \frac{E_{35} - E_i}{E_{35} - E_0} \) has a value of 0.970 at the most nonlinear part of the cycle. For all practical purposes then, the charging current is linear through the whole cycle.

Returning to the period of oscillation and putting in the value of \( A \), we have

\[ T = -C(R + \mu R + r_f) \ln \frac{E_{35} - E_i}{E_{35} - E_0} \]

the \( \ln \frac{E_{35} - E_i}{E_{35} - E_0} \) is a negative constant so we can write \[ T = C(R + \mu R + r_f) \cdot k \]. It is evident that we can change \( C \) for coarse frequency selection and vary \( R \) for fine frequency control. However, because of the large current feedback, good values of \( \mu \) are not easily obtainable, hence the period cannot be accurately calculated. It is also evident from the circuit that synchronization can be accomplished in the normal fashion by applying synchronizing voltage to the grid on the gas tube \( V_0 \).

Laboratory Sweep Generator

The circuit put into use is shown in Fig. 3. The 50,000-ohm resistor

![FIG. 3—Complete circuit of laboratory sweep generator whose output is linear](image)
FOR HIGH EFFICIENCY -

SEALEX BUSHINGS

GUARANTEED HERMETIC SEALS: Sealex Bushings are available in a diversity of standard types capable of meeting most equipment design requirements. For unusual applications, special types can be produced on short notice to exact specifications.

SPECIAL BONDING: The steatite dielectric is chemically bonded to the metal electrode and collar, matched coefficients of expansion assure the permanency of the bond through a wide range of temperature. All metal parts are heat-tinned to reduce wiring and installation time on the job.

INDIVIDUALLY PRESSURE TESTED: Each bushing is subjected to an air pressure test of 50 psi prior to shipment, a test that has proven effective in disclosing even microscopic defects in the seal.

GENERAL CERAMICS AND STEATITE CORP.
KEASBEY, NEW JERSEY

...specify General Ceramics steatite!

General Ceramics Steatite insulators and Sealex bushings are used by leading manufacturers of every type of equipment. This reliance upon steatite is due to the fact that design engineers are well aware of steatite’s physical and electrical characteristics...a short-cut to lower manufacturing costs and better equipment performance. For assistance in applying steatite insulators or bushings to your product, or for collaboration in the development of special types for unusual conditions, call or write our engineering department today. An informative 48-page catalog is available on request on company letterhead.
NOT ABSORPTION TYPE

GENERAL LABORATORY USE

ROLLIN
VHF-UHF RF WATTMETER
MEASURES POWER • IMPEDANCE • SWR
70 MC TO ABOVE 400 MC

- Measures power flowing through transmission line to antenna under wide range of standing wave conditions and antenna impedances.
- Direct reading meter with 4 calibrated ranges: 0.25-5, 5-15, 15-50 and 50-150 watts. Meter has adjustable reference pointer for noting any change in power.
- Precision 50 ohm slotted line with solid dielectric, type N connectors and centimeter scale.
- Accurate step type wire wound controls indicate standing wave ratio (SWR).
- Model 60 is a complete set of equipment for impedance measurements by slotted line method (only r.f. power source required).

Write for details...

THE ROLLIN COMPANY
2070 N. FAIR OAKS AVENUE - PASADENA 3, CALIFORNIA

ELECTRON ART

(continued)

range. Table I shows obtainable ranges. The 600-ohm resistor protects the 885 from excessive currents and improves the charging to discharging time ratio. It does so by developing a large negative bias on the 6AC7 during the discharge of C through the 885. This bias permits the voltage across C to drop more rapidly than it would if current were allowed to flow from the B-supply during discharge.

The fixed bias was so adjusted that the output voltage was about 10 volts. The generator was found to make possible very high sweep frequencies with good front to back trace ratio and little change in amplitude with frequency.

The circuit as described is a relaxation oscillator which generates a very linear sweep. However, the principle developed can be used to produce high-speed linear sweeps of low repetition rates or even sweeps for transient observation. If the gas triode V2 is replaced by a vacuum tube at zero bias, the vacuum tube will short the capacitor C. The sweep is then generated only when a negative pulse is applied to the grid of this vacuum tube thus cutting it off. The length of the sweep will be determined by the length of the pulse. The only precaution necessary is that the pulse should not be made so long that the sweep amplitude $E_\text{s} - E_\text{b}$ will become large and make $\exp \left( \frac{E_\text{b} - E_\text{s}}{E_\text{b} - E_\text{s}} \right)$ take on values so much less than unity that the sweep will become intolerably nonlinear.

**Table I—Frequency Ranges**

<table>
<thead>
<tr>
<th>Capacitance (µf)</th>
<th>Frequency range (cps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>40-165</td>
</tr>
<tr>
<td>0.1</td>
<td>70-450</td>
</tr>
<tr>
<td>0.2</td>
<td>300-1,900</td>
</tr>
<tr>
<td>0.005</td>
<td>1,200-7,500</td>
</tr>
<tr>
<td>0.001</td>
<td>4,000-25,000</td>
</tr>
<tr>
<td>0.0001</td>
<td>22,000-50,000</td>
</tr>
</tbody>
</table>

Instrumentation: State of the Art

The Instrument Society, youngest among those societies whose interests touch the field of elec-
You do not have to accept substitutes for Cardwell Capacitors. Dealers have been well stocked to cover a wide range of transmitter power needs and a large inventory of all catalog items is being maintained at the factory for immediate shipment. If a particular Cardwell Capacitor is temporarily sold out, your dealer can get it for you on short notice.

Cardwell Capacitors have been the "Standard of Comparison" since the early days of electronics. They are being used by all the leading companies in the electronics industry and by many progressive smaller companies, too. When you need capacitors for radio transmitters, for diathermy equipment, and for induction heating equipment, the correct Cardwell Capacitor is ready for you.

THE ALLEN D. CARDWELL MANUFACTURING CORP.
MAIN OFFICE & FACTORY
97 WHITING STREET, PLAINVILLE, CONN.
TORAUE RED

MICROTORQUE POTENTIOMETERS for Remote Recording

Solve remote control and position repeating problems by adapting Microtorque Potentiometers to your particular needs. Built like a fine watch, Microtorque Potentiometers convert mechanical movement into proportional electrical voltages without causing excessive drag in sensitive mechanical measuring systems. A simple yoke adaptation to the instrument pointer makes these tiny, ultra-low torque units ideal for take-offs from low torque indicating instruments. Microtorque Potentiometers may also be used as primary control elements in bridge type circuits to operate directly recorder controllers, recording galvanometers, oscillographs, polarized relays, and telemetering circuits.

FEATURES:
- Vibration-proof 4 to 55 cycles up to 6 G.
- Resistance values 100 to 2500 ohms.
- Higher ranges on request.
- Input torque less than .003 oz. in.
- Power dissipation of 2 watts.
- Linearity 1/2% or better.
- Weight less than 3/4 ounces.

Size 1" x 1 1/4".

One channel of the six channel, cathode-ray oscillograph developed at the Naval Ordnance Laboratory and described at the "Instrumentation for Tomorrow" conference of the Instrument Society of America. The two-inch cathode-ray tube is driven by a resistance coupled, balanced amplifier. Continuously moving film records trace the time the equipment is used to an appreciable extent. Although evaluations of the utility of electronic instruments differed from field to field, it was universally voiced that what is needed is a high gain, wide band, d-c amplifier that is free from all forms of drift.

The Donutron
A SQUIRREL-CAGE MAGNETRON, called a donutron, provides a simpler, less...
NON-METALLICS
...tuned to your problems

Whether you play the bagpipe or the radio ... you want the music to sound natural ... so do your customers. Your product must be able to compete for their ears, eyes and pocketbook.

C-D NON-metallics can help you attain those ends. C-D NON-metallics are engineered to meet specific design, production and performance problems, involving mechanical and electrical insulating properties.

The bagpipe valve-stopped tube illustrated is an excellent example of a C-D product designed to meet specific production and performance problems. It is made of Black Grade XX molded DILECTO tubing. In addition to the machining plainly visible, the inside diameter of the tube has three distinctly different stepped tapers. The tube must of course retain its dimensions in spite of moisture conditions.

The ease with which C-D Dilecto can be machined, its dimensional stability combined with its good electrical insulating properties, its light weight and its great strength make it a material that may be the answer to one or more of your “What Material?” problems.

C-D NON-metallics offer a wide combination of desirable properties. Booklet GF gives specific design and engineering data on all of them. Write for a copy today.

C-D PRODUCTS

The Plastics
DILECTO—Thermosetting Laminates.
CELORON—A Molded Phenolic.
HAVEG—Plastic Chemical Equipment, Pipe, Valves and Fittings.

The NON-Metallics
DIAMOND Vulcanized FIBRE
VULCOID—Resin Impregnated Vulcanized Fibre.

MICABOND—Built-Up Mica Electrical Insulation.

Standard and Special Forms
Available in Standard Sheets, Rods and Tubes; and Parts Fabricated, Formed or Molded to Specifications.

Descriptive Literature
Bulletin GF gives Comprehensive Data on all C-D Products. Individual Catalogs are also Available.

Continental-Diamond FIBRE COMPANY
Established 1895 Manufacturers of Laminated Plastics since 1911—NEWARK 16 DELAWARE

NEW YORK 17  •  CLEVELAND 14  •  CHICAGO 11  •  SPARTANBURG, S. C.  •  SALES OFFICES IN PRINCIPAL CITIES
WEST COAST REPRESENTATIVES: MARWOOD LTD., SAN FRANCISCO 3
IN CANADA: DIAMOND STATE FIBRE CO. OF CANADA, LTD., TORONTO 8

ELECTRONICS — November, 1946
The Right Speaker for Every Purpose

Perfectly matched to your circuit and cabinet requirements, Permoflux Speakers will faithfully translate the tone excellence of your design. They combine high sensitivity with wide frequency response and rugged mechanical construction. Manufactured in a wide range of sizes and power handling requirements under methods assuring unusual quality control, Permoflux PM and Electrodynamic Speakers provide the finest sound reproduction for every application.

FIG. 1—Squirrel-cage magnetron is tuned by varying the distance by which the two sets of interleaved bars overlap each other and the capacitively loaded re-entrant line modes are currently important. Further investigation of these and other modes may increase the realizable frequency and power output of the tube. In the re-entrant line mode, a standing wave forms circumferentially about the anode. In this mode, about 50 watts at 45 percent efficiency have been obtained; anode current ranges from 100 to 200 ma, static impedance from 700 to 1,500 ohms. The tube can be tuned over a 1.5 to 1.0 frequency range.

Field Pattern

The two end rings, from which the fingers of the squirrel-cage extend, form the re-entrant line. The fingers provide the capacitive loading. Thus the main radio-frequency currents in the rings themselves, only enough current flows in the fingers to charge them to the potential of the ring at their individual points of attachment. The wavelength is twice the electrical circumference of the anode ring.

The out-of-phase radio-frequency currents in the two rings are accompanied by magnetic fields that form closed loops interlacing the squirrel-cage bars as shown in Fig. 2. Voltage nodes appear where the maximum lines of magnetic flux pass between pairs of teeth. This
You are looking at a thermistor—a speck of metallic oxide imbedded in a glass bead hardly larger than a pinhead and mounted in a vacuum. The thermistor was developed by Bell Telephone Laboratories to keep an eye on the amplification in long-distance telephone circuits.

When a thermistor is heated, its resistance to electric current changes rapidly. That is its secret. Connected in the output of repeater amplifiers, it heats up as power increases, cools as power decreases. This change in temperature alters the resistance, in turn alters the amplification, and so maintains the desired power level. Current through the wire at the left provides a little heat to compensate for local temperature changes.

Wartime need brought a new use for this device which can detect temperature changes of one-millionth of a degree. Bell Laboratories scientists produced a thermistor which could "see" the warmth of a man's body a quarter of a mile away.

Thermistors are made by Western Electric Company, manufacturing branch of the Bell System. Fundamental work on this tiny device still continues as part of the Laboratories program to keep giving America the finest telephone service in the world.
In selecting the right gears for the job, it is important to know how they will be used — the conditions under which they must operate.

Beaver Gear Engineers, knowing what is expected, and trained to assist in details of fine-pitch gear applications, can tell you what will work best under various conditions and can specify the correct design.

Beaver modern production facilities and experienced craftsmen assure you of gears made correctly to specifications.

Write for latest bulletin describing Beaver Gear Facilities and Methods.

---

**Stenotrone**

A GAS TUBE having a stricture in the path of the discharge between cathode and anode produces high-frequency, high-powered oscillations. The tube is called a stenotrone. The electric discharge itself, independent of a resonant circuit, generates undamped electric oscillations. Under these conditions the tube becomes very hot.

**Characteristics**

Frequency, amplitude, and waveform of the generated oscillations are affected by the tube’s geometry, type and density of the gas, current, and external circuit. The oscillation consists of a periodic variation in current, during which
HOLLISTON Special Purpose Fabrics can be produced with almost any wanted properties: they can be made waterproof and resistant to certain solvents, acids and alkalis, or made to withstand moderately high temperatures; their dielectric characteristics can be tailored to your requirements. The wide range of tensile strength, stiffness, tear strength and caliper makes them ideally suited to a lot of very unusual manufacturing and industrial applications. And new uses are constantly being found. Perhaps your problem is another new use for a HOLLISTON Special Purpose Fabric — write our Research Department, we’ll gladly co-operate.

By filling, impregnating or coating various fabrics (from sheer cambric to coarse burlap) with plastics, resins, starch and pyroxylin we can produce a cloth with almost any wanted properties.

HOLLISTON Special Purpose Fabrics

THE HOLLISTON MILLS, INC., NORWOOD, MASSACHUSETTS

ELECTRONICS — November, 1946
FRANKLIN LAMITEX

(LAMINATED BAKELITE)
is so versatile!

Pictured below just a few of the many thousand various parts we at FRANKLIN FIBRE-LAMITEX have furnished completely machined to exacting specifications for countless uses.

SHEETS, RODS and TUBES,
FABRICATED OR MOLDED PARTS

FRANKLIN LAMITEX and VULCANIZED FIBRE are highly machineable. We will machine parts if you lack facilities—or furnish sheets, rods, and tubes. Both LAMITEX and FRANKLIN FIBRE can be drilled, tapped, turned, threaded, punched, shaved, bored, reamed, sawed, milled or completely fabricated into automatic screw machine parts.

Check these FRANKLIN LAMITEX characteristics

- High dielectric strength
- Low power factor
- Low moisture absorption
- Remarkable dimensional stability
- High mechanical strength
- Low co-efficient of thermal expansion
- Low in weight (about half that of aluminum)
- Unaffected by solvents and oils
- Unaffected by most organic acids, dilute mineral acids or salt solutions

SEND FOR CATALOG CONTAINING COMPLETE DATA.

ELECTRON ART (continued)

the current may become zero but never reverses. There is a maximum degree of pulsation for a critical vapor pressure, and for tube temperature. The greater the external resistance or the supply potential, the greater the strength of oscillations. The larger the aperture placed in the path of the discharge, the higher the upper limit to which the current swings. There is a critical position between cathode and anode for the aperture (which is necessarily a dielectric) at which weakest oscillations are produced — of significance for designing mercury rectifiers.

The observed phenomena can be explained as interruption of the current in the arc by rarefaction of gas in the neck of the discharge. Theory indicates that the current strength that causes interruption is proportional to the product of the aperture area and the gas pressure, which is confirmed by measurements.

To utilize the oscillations, a load can be either inductively or capacitively coupled to the external circuit, inductive coupling being preferred. Using mercury vapor at a pressure of about one millimeter of mercury and at a temperature around 20 C, oscillations between 15 and 100 kc were obtained. One kilowatt of output power was obtained at approximately 65-percent efficiency from a 240-volt source.

(The Generation of High-Power Electric Oscillations by a Low Pressure Discharge, by B. L. Granovsky and T. A. Suetin, Comptes Rendus, 1945 No. 6, p 410.)

Cathode Follower of Very Low Output Resistance

A POSITIVE SQUARE WAVE applied to the input of a conventional cathode follower has its leading edge well reproduced, but its trailing edge is badly distorted. A two-tube circuit that overcomes this fault has an output impedance of 30 ohms at frequencies up to 30 mc and an output voltage that is higher than with a single-tube circuit.

Circuit Operation

To develop the two-tube circuit, consider a two-stage, resistance-
One of the nation's largest producers, Stackpole offers a dependable source of supply for both fixed and variable resistors for a wide variety of applications. Fixed types include 1/2 and 1-watt insulated units in smallest sizes consistent with moccro performance demands. Variables include standard-size units, midgets, sealed designs and numerous special types. Write today for Stackpole Electronic Components Catalog RC6.
To date Blaw-Knox has furnished more than one million feet of Vertical Radiators and Antenna Towers. They range in size from sturdy rooftop supports to installations towering more than 1000 feet skyward.

This unequalled experience in the design, fabrication and erection of structures for every radio transmitting requirement is available at no added cost to you.

BLAW-KNOX DIVISION
OF BLAW-KNOX COMPANY
2077 Farmers Bank Bldg.
Pittsburgh, Pa.

FIG. 1—By rearranging a two stage feedback amplifier (A) the plate resistance of the second tube can serve as the cathode resistor in the stage of the first tube (B) not to unduly decrease the gain of the second stage. The cathode degeneration in the first stage is therefore large. If $R_c$ is of the order of the plate resistance of the tubes employed in the circuit, one of the tubes could be substituted for $R_c$ as at Fig. 1B, which is the new circuit under discussion.

The equivalent circuit for that of Fig. 1B is shown in Fig. 2. Analysis of this circuit indicates that the ratio of output to input voltages is

$$E_{out}/E_{in} = \frac{\mu^2 + \mu (r_p/R)}{(\mu^2 + \mu + 1) + (\mu + 2) (r_p/R)}$$

and the output conductance is

$$G_{out} = \frac{1}{R_{out}} = \frac{\mu + 1}{r_p + R} + \frac{1 + \mu (\mu + 1)}{r_p/R + 1}$$

When $R$ is large compared to $r_p$ the first term of the conductance equation becomes negligible and the second term becomes approximately equal to the product of the amplification factor of the tube and the transconductance

$$G_{out} = (\mu + \mu + 1)/r_p$$

The value of output conductance represents an improvement over
Don't Forget

The ELECTRONICS BUYERS' GUIDE
WHEN YOU'RE MAKING UP YOUR 1947 ADVERTISING BUDGET

The 1947 ELECTRONICS BUYERS' GUIDE, which will be distributed next June to over 30,000 readers of ELECTRONICS, will be the most complete, convenient, and feature-full year-round reference book ever published for use by buyers and specifiers of electronic components, equipment, and allied products.

The 1947 ELECTRONICS BUYERS' GUIDE, like the pioneering 1946 GUIDE, will be packed full of valuable editorial reference matter of permanent value: Charts, Bibliography, ELECTRONICS Index and Information, Directory of Manufacturers and Products, etc.; as well as catalog-type product information in the advertisements of the leading manufacturers in the electronic and allied fields. These features assure the GUIDE year 'round use by the men who purchase and influence the purchase of electronic equipment and allied products.

FULL DETAILS about the highlights of this outstanding ELECTRONICS advertising medium will reach you soon.

In the meantime, be sure to include ELECTRONICS BUYERS' GUIDE in your advertising budget for 1947. Space rates same as your contract scale.
Rejection "Mountains" make bad Scenery!

Of course in your particular industry they may only be "mole hills" but whatever their size they represent loss in manpower, time, money and material.

To meet the ever-growing need for exact materials-inspection the HYPersonic Analyzer* was developed to "see through solids with sound".

- For non-destructive testing of solid materials
- Detects flaws and faulty laminations in metals, plastics, and bonded assemblies
- Highly accurate-locates internal flaws and voids
- Wide frequency range permits inspection of more types of materials
- Reduces production costs by detection of faulty material early in processing

Brush engineers will be glad to talk over your particular problems. For complete information about this new non-destructive testing investigate the Hypersonic Analyzer.

*Trade Mark

Hypersonic Analyzer

a product of
THE BRUSH DEVELOPMENT CO.
3405 Perkins Avenue - Cleveland 14, Ohio

the conventional cathode follower by the factor $\mu$. However, in driving low load impedances from this circuit, the signal must be small enough not to overdrive the lower tube.

Circuit Characteristics

The circuit with the values shown in Fig. 1B was examined at various frequencies from 10 kc to 30 mc. The output approached unity as the output load approached 1,000 ohms. The output was essentially uniform to about 10 mc, but fell above that frequency, falling faster with lower load resistances. A pronounced rise in output (an actual voltage gain) was obtained with a capacitive load of 0.0001 $\mu$f at approximately 10 mc. The rise occurred at lower frequencies as the capacitive load was increased. With 0.01 $\mu$f there was a slight rise at about 800 kc and practically no response at 1,000 kc. The fidelity of response to a pulse was definitely superior to that of a single-tube circuit and the effect on sine waves was also good. (Cathode Follower by Calvin M. Hammack, Report 469, Radiation Lab., MIT, Cambridge, Mass.)

Extending Thyatron Life

HYDROGEN CLEANUP in such hydrogen thyatrons as the 5C22 shortens the life of the tube. To reduce this loss of gas, tube parts are made from as pure nickel as is obtain-
"We need Precious Metal Performance...
But Low Cost too"

"Then the Solution is
GENERAL PLATE
LAMINATED METALS"

Economy... that is one of the many advantages
why General Plate Laminated Metals should be
given prime consideration whenever your designs call for
precious metal performance.

These permanently bonded laminations of precious to
base metal combinations give you actual precious metal
performance... yet their cost is a fraction more than
base metals.

In addition, General Plate Laminated Metals... sheet,
wire or tube... give you such advantages as better
workability, better spring properties, corrosion resistance,
better electrical conductivity, long life, ease of fabrica-
tion, ease of soldering and mechanical and structural
properties not found in single solid metals.

Better check into the advantages of General Plate Lami-
nated metals, today. Our engineers will gladly help you
with your problems. Write:

GENERAL PLATE DIVISION
of Metals & Controls Corporation
ATTLEBORO, MASSACHUSETTS

SHEET... Available with precious
metal on one side, both sides or wholly
covered, inlaid and edge laid in practi-
cally any combination of precious to
base metal. Base to base metal com-
binations also available.

TUBE... Solid precious metal, lined,
or covered in a wide range of diameters
and odd shapes.

WIRE... Shaped, solder filled, channel,
solder flushed, squares, flats, ovals and
irregular shaped.

50 Church Street, New York, N. Y.; 205 W. Wacker Drive, Chicago, Ill.; 2635 Page Drive, Altadena, Calif.; Grant Bldg., Pittsburgh, Pa.

ELECTRONICS—November, 1946
KINNEY
HIGH VACUUM PUMPS
FOR HIGH PUMPING SPEED AND LOW ABSOLUTE PRESSURE

In the new vacuum coating units now being developed by Distillation Products, Inc., Rochester, N. Y., two 110 cubic foot Kinney pumps are used for rapid pump down and backing the Distillation Products, Inc., diffusion pumps. The illustration also shows four Kinney Vacuum Tight Valves which are used on all types of systems where "no leakage" is of utmost importance. Everywhere... in this country and abroad... Kinney High Vacuum Pumps meet the heavy demands of large scale process operations—exhausting lamps and tubes, sintering metals, producing penicillin, and performing countless other operations in modern vacuum processing. Kinney Single Stage Vacuum Pumps produce and maintain low absolute pressures to 10 microns; Compound Vacuum Pumps to 0.5 micron.

Send for Bulletin V 45.

KINNEY MANUFACTURING CO.
3565 WASHINGTON ST., BOSTON 30, MASS.
NEW YORK • CHICAGO • PHILADELPHIA • LOS ANGELES • SAN FRANCISCO
FOREIGN REPRESENTATIVES
General Engineering Co. (Radcliffe) Ltd., Station Works, Bury Road, Radcliffe, Lancashire, England
Horrocks, Roxburgh Pfy., Ltd., Melbourne, C. I. Australia
W. S. Thomas & Taylor Pty. Ltd., Johannesburg, Union of South Africa
We also manufacture Liquid Pumps, Clutches and Bituminous Distributors

ELECTRON ART (continued)
able. However, as cleanup proceeds, the gas pressure is lowered and the tube characteristics change.

To maintain the gas pressure despite absorption by nickel parts, a titanium hydride powder hydrogen generator was developed. The powder is placed in a heated cap-
sule. As hydrogen is absorbed throughout the tube, the capsule makes up the loss, giving satisfactory thyatron operation for a life of at least 2,000 hours. In addition, the hydrogen generator enables the tube to be made of impure nickel (Hydrogen Generator for Electron Tubes, by Harold W. Gerlicher, Evans Signal Laboratory, Belmar, N. J.—Report of development, characteristics, and preparation of capsule, and tube characteristics obtained with its use).

Projection Television

TELEVISION IMAGE projection systems have been suggested by Manfred von Ardenne of Berlin, Germany (U.S. Patent 2,277,008 issued March 17, 1942; and U.S. Patent 2,297,443 issued Sept. 29, 1942—this patent is vested in the Alien Property Custodian, see ELECTRONICS, 1948, July, p 306), and by Karl Martin and Johannes
For men who like to have a complete supply of tools, yet dislike bulk and confusion, the Hallowell "Socket Screw" Kit is the answer. It is one of the neatest tricks of the year. The hollow Celanese* plastic handle holds interchangeable bits for most all purposes . . . Phillips, Hex and Flat. There is a swivel bit-chuck, which locks securely in position, and makes it possible to twirl a screw using the vertical position, and then snapping the chuck to an angle or ell position, to get the final tightening pull.

Not illustrated: "Socket Wrench" Kit; the "Auto" Kit; the "Home" Kit. Write for our 8-page booklet that fully describes these handy Tool Kits. Obtainable at Suppliers throughout the country.

If your Supplier does not carry these Kits, send his name to us, along with yours, and you will be taken care of promptly.

**AN IDEAL CHRISTMAS GIFT.**

*Handle is molded of sturdy Celanese® plastic; tools are of high grade alloy steel.*

---

**STANDARD PRESSED STEEL CO.**

JENKINTOWN, PENNA., BOX 311 :: BRANCHES: BOSTON :: CHICAGO :: DETROIT :: INDIANAPOLIS :: ST. LOUIS :: SAN FRANCISCO

ELECTRONICS — November, 1946
Sturdy construction (as shown in the accompanying diagram) is but one characteristic of Hi-Q Wire Wound Resistors. The others are precision winding, wide range of types, sizes and ratings and quantity production. Standard units are available in capacities from 5 to 200 watts with outside dimensions of 5/16” x 1” to 1-1/8” x 12” and resistance values up to 100,000 ohms. Where required, special units are engineered to specific jobs.

Other Ceramic Capacitors

S. I. Type
Durez Coated

C. N. Type

C. I. Type

Choke Coils

Stand-Off Condensers

Electrical Reactance

Corporation

Franklinville, N. Y.
METAL PLATES that serve a steady diet of sound

There are two oscillators in every Fathometer. Opened oscillating unit shows how the all-important Nickel lamination plates are mounted.

Both an indicating dial and recorder can be used with the Fathometer. Other components include an amplifier and a driver.

The "FATHOMETER"—the first practical application of "Sonar"—utilizes the magnetostriction of Nickel

One of the most practical uses of sonar is the Fathometer, manufactured by the Submarine Signal Co., Boston, Mass.

The Fathometer generates sonic vibrations, throws them at the bottom, and then listens for their echoes. With a Fathometer you can map the ocean floor... locate fish... safeguard navigation.

Like many other adaptations of sonar, the Fathometer depends upon Nickel to send and receive the sonic vibrations. Heart of each oscillator is a stack of thin Nickel plates, laced together with a winding of wire.

HOW THE FATHOMETER WORKS

When current is passed through these windings, a fluctuating magnetic field is created. That's when the magnetic-strictive property of Nickel goes to work!

For under the influence of magnetic force, Nickel contracts, snapping back to its original size only when the field goes dead. By maintaining a fluctuating magnetic field, a steady, powerful hum can be directed to the ocean floor.

Striking a target, the sonic waves bounce back to the Fathometer, where a second oscillator (acting as a receiver) goes through the same cycle in reverse to convert sound into electrical impulses. Other components then time the lag between transmission and echo, registering the depth on an indicator.

WHY NICKEL WAS CHOSEN

Nickel is used in sonar because it contracts more than any other commercial metal, contracting 32 units of length for every 1,000,000.

Magnetostriction is just one of the specialized properties obtainable with Nickel. When specifying metals for electronic or electrical use always consider Nickel and the INCO Nickel Alloys. They are strong, tough, rustless, corrosion-resistant and thermally durable.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 WALL STREET, NEW YORK 5, N. Y.

NICKEL ALLOYS:


NICKEL ALLOYS:

von Ardenne observes, in U.S. Patent 2,276,750 issued March 17, 1942, that flicker can further be reduced so that slower frame rates and hence narrower transmission bands can be used.

**UHF Measurement**

Standing waves are used to indicate the impedance match in high-frequency circuits. To measure these standing waves, a coaxial transmission line is formed into a circle, slotted, and combined with a probe. A probe is rotated around the loop of line and at the same time a sweep voltage is generated, by an auxiliary circuit. The rectified voltage detected by the probe, and the sweep voltage are applied to the plates of a cathode-ray tube. The tube display indicates the standing wave as a function of angular position along the line. The system can be used for continuously observing the standing waves on a transmission circuit while the circuit is adjusted. (No. 2,400,597, granted May 21, 1946 to Donald W. Peterson, Radio Corp. of America).

---

**ATOMIC TEST AMPLIFIER**

Signals from hydrophones on the hull of the target ship, increased by the Westinghouse preamplifier at the right, are transmitted by radio to a recorder miles away from Operation Crossroad. High-speed cameras in the recorder make a permanent record of pressure fluctuations.
ADDITIONS and CORRECTIONS to the JUNE 1946–1947 ELECTRONICS BUYERS' GUIDE

The following listings are to be used in conjunction with the June 1946–1947 ELECTRONICS BUYERS' GUIDE for information on manufacturers’ names, addresses, and products omitted or incorrectly listed in that issue. Product classification numbers and names are the same as used in the June Guide.

2. AUDIO FREQUENCY AMPLIFIERS
Cook Laboratories, 139 Gordon Blvd., Floral Park, N. Y.
Furst Electronics, 800 W. North Ave., Chicago 22, Illinois
Langevin Co., Inc., 37 West 65th St., New York 23, N. Y.
Rek-O-Kut Co., 146 Grand St., New York 12, N. Y.

5. BROADCAST STUDIO SPEECH INPUT CONTROL EQUIPMENT
Langevin Co., Inc., The, 37 West 65th St., New York 23, N. Y.

13. FACSIMILE COMMUNICATION SYSTEMS
The Western Union Telegraph Co., 60 Hudson St., New York 13, N. Y.

20. HEARING AIDS
Tayburn Equipment Co., 120 Greenwich St., New York 6, N. Y.

24. MEGAPHONES, ELECTRONIC
Tayburn Equipment Co., 120 Greenwich St., New York 6, N. Y.

25. MONITORS, BROADCAST
Langevin Co., Inc., The, 37 West 65th St., New York 23, N. Y.

31. ELECTRIC PHONOGRAPH AND RECORD PLAYERS
Rek-O-Kut Co., 146 Grand Street, New York 13, N. Y.

35. RADAR NAVIGATIONAL DEVICES
Sperry Gyroscope Co., Manhattan Bridge Plaza, Brooklyn, N. Y.

39. AM COMBINATIONS

42. AM TABLE MODELS

67. FACSIMILE RECEIVERS
The Western Union Telegraph Co., 60 Hudson St., New York 13, N. Y.

77. FILM RECODERS
Electronic Chemical Engineering Co., 1235 E. Olympic Blvd., Los Angeles 21, Calif.

81. RECORDING AND TRANSCRIPTION TURNSTABLES
Rek-O-Kut Co., 146 Grand St., New York 13, N. Y.

84. COMPLETE SOUND SYSTEMS
Audio Products Co., 2101 W. Olive Ave., Burbank, Calif.

90. U.H.F. TRANSMITTERS
Electronic Associates Inc., 61 Brighton Ave., Long Branch, N. J.

95. BROADCAST TRANSMITTERS
Western Electric Co., Inc., 120 Broadway, New York 6, N. Y.

99. FACSIMILE RECEIVERS
The Western Union Telegraph Co., 60 Hudson St., New York 13, N. Y.

101. FIXED STATION COMMUNICATION TRANSMITTERS
Western Electric Co., Inc., 120 Broadway, New York 6, N. Y.

102. FM TRANSMITTERS
Western Electric Co., Inc., 120 Broadway, New York 5, N. Y.

119. COUNTERS
Electronic Associates Inc., 61 Brighton Ave., Long Branch, N. J.
Furst Electronics, 800 W. North Ave., Chicago 22, Illinois

137. PHOTOELECTRIC CONTROLS
Furst Electronics, 800 W. North Ave., Chicago 22, Illinois

138. PHOTOGRAPHIC EXPOSURE CONTROLS
Electronic Mechanical Pros., Co., 13-15-17 N. Virginia Ave., Atlantic City, N. J.
Furst Electronics, 800 W. North Ave., Chicago 22, Illinois

144. SERVO CONTROLS
Electronic Associates Inc., 61 Brighton Ave., Long Branch, N. J.

145. SMOKE DENSITY COMBUSTION, AND CONTROLS
Furst Electronics, 800 W. North Ave., Chicago 22, Illinois

153. WELDING CONTROLS

174. INDUCTION AND DIELECTRIC HEATING

200. ELAPSED TIME METERS

207. ELECTRONIC MICRO-METERS

222. COMBUSTION RECORDERS
Furst Electronics, 800 W. North Ave., Chicago 22, Illinois

235. AUTOMATIC INTERVAL TIMERS
Electronic Associates Inc., 61 Brighton Ave., Long Branch, N. J.
Furst Electronics, 800 W. North Ave., Chicago 22, Illinois

246. WELDING TIMERS

274. CAPACITOR ANALYZERS
Cornell Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.

285. BRIDGES
Measurements Corp., Boonton, N. J.

294. CHRONOGRAPHS, INERTIALESS
Furst Electronics, 800 W. North Ave., Chicago 22, Illinois

298. CAPACITY DECADE BOXES
Cornell Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.

309. FM SIGNAL GENERATORS
Measurements Corp., Boonton, N. J.

317. GEIGER COUNTER INDICATORS
Condenser Products Co., 1369-1375 North Branch St., Chicago 22, Ill.

321. VOLUME INDICATORS
Audio Products Co., 2101 W. Olive Ave., Burbank, Calif.

326. AMMETERS
Rek-O-Kut Co., 146 Grand Street, New York 13, N. Y.

373. CATHODE-RAY INSTRUMENTS
Furst Electronics, 800 W. North Ave., Chicago 22, Illinois

392. INSULATION TESTERS
Measurements Corp., Boonton, N. J.

401. CURVE TRACERS

447. RAILROAD ANTENNAS
Buggie & Co., 1369-1375 North Branch St., Toledo 1, Ohio

450. TELEVISION & FM ANTENNAS
Buggie & Co., 1369-1375 North Branch St., Toledo 1, Ohio

Buggie & Co., 1369-1375 North Branch St., Toledo 1, Ohio

463. BELLBOYS
Cook Electric Co., 2700 Southport Ave., Chicago 14, Illinois

471. CARBON & GRAPHITE BRUSHES
National Carbon Co., Inc., 30 East 42nd St., New York 17, N. Y.

472. METAL-GRAPHITE BRUSHES
National Carbon Co., Inc., 30 East 42nd St., New York 17, N. Y.

477. METAL CABINETS
Water Co., 800 Madison Ave., New York 22, N. Y.

481. CABLE ASSEMBLIES
Buggie & Co., 1369-1375 North Branch St., Toledo 1, Ohio

494. FIXED CAPACITORS
Condenser Products Co., 1369-1375 North Branch St., Chicago 22, Ill.
Cornell Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.

496. MICHAJ TRANSMITTING CAPACITORS
Cornell Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.

499. OIL IMPREGNATED CAPACITORS
Condenser Products Co., 1369-1375 North Branch St., Chicago 22, Ill.

502. PLASTIC DIELECTRIC CAPACITORS
Condenser Products Co., 1369-1375 North Branch St., Chicago 22, Ill.

505. SMALL HIGH VOLTAGE CAPACITORS
Condenser Products Co., 1369-1375 North Branch St., Chicago 22, Ill.
Cornell Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.

511. WAX IMPREGNATED CAPACITORS
Condenser Products Co., 1369-1375 North Branch St., Chicago 22, Ill.
Cornell Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.
513. AUTOMATIC RECORD CHANGERS

517. ALUMINUM CHASSIS

519. FILTER CHIPS
Langevin Co., Inc., The, 37 W. 65th St., New York 23, N. Y.

520. HERMETICALLY SEALED CHIPS

522. TEST & TUBE CLIPS and CLAMPS
Fahnsteck Electric Co., Inc., 46-44 Eleventh St., L. I. City, N. Y.

529. POWER and A.F. COILS and WINDINGS
Burnell & Co., 10-16 Van Cortlandt Ave., East, Bronx 58, N. Y.

540. CERAMIC CABLE CONNECTORS
Buggie & Co., H. H., Madison Ave. & 22nd St., Toledo 1, Ohio

543. RECEIVING CONNECTORS
Buggie & Co., H. H., Madison Ave. & 22nd St., Toledo 1, Ohio

572. IF FILTER CRYSTALS

576. QUARTZ CRYSTAL ULTRASONIC

577. RECEIVER CONTROL CRYSTALS

579. SUPERCRYSTALS

599. BAND PASS FILTERS
Electronic Associates Inc., 61 Brighton Ave., Long Branch, N. J.

602. EQUALIZER FILTERS
Burnell & Co., 10-16 Van Cortlandt Ave., East, Bronx 58, N. Y.

609. COIL FORMS
Buggie & Co., H. H., Madison Ave. & 22nd St., Toledo 1, Ohio

621. WIRE HARNESS
Buggie & Co., H. H., Madison Ave. & 22nd St., Toledo 1, Ohio

622. HEADPHONES and HEADSETS
Tayburn Equipment Co., 120 Greenwich St., New York 6, N. Y.

623. HEADS, RECORDING
Rek-O-Kut, Inc., 164 Grand St., New York 13, N. Y.

633. SPEAKER PROJECTOR HORNS
Langevin Co., Inc., The, 37 W. 65th St., New York 23, N. Y.

637. PUBLIC ADDRESS SYSTEM HOUSINGS
Langevin Co., Inc., The, 37 W. 65th St., New York 23, N. Y.

650. INSULATING FOIL
Buggie & Co., H. H., Madison Ave. & 22nd St., Toledo 1, Ohio

654. MOLDED INSULATION PARTS
Buggie & Co., H. H., Madison Ave. & 22nd St., Toledo 1, Ohio

655. PLASTIC INSULATION PARTS
Buggie & Co., H. H., Madison Ave. & 22nd St., Toledo 1, Ohio

707. LUGS and TERMINALS
Patton-MacGuoy Co., 17 Virginia Ave., Providence, R. I.

716. METAL STAMPINGS, SMALL

724. MICROWAVE TRANSMISSION LINES and ACCESSORIES
Buggie & Co., H. H., Madison Ave. & 22nd St., Toledo 1, Ohio

726. FRACTIONAL H.P. MOTORS
Aini Corp., 10 E. 22nd Street, New York 14, N. Y.

729. SERVO MOTORS
Transco, Inc., 114 West St., New York 14, N. Y.

731. TIMING MOTORS

751. PANELS
Langevin Co., Inc., The, 37 W. 65th St., New York 23, N. Y.

754. FACSIMILE RECORDING PAPERS
The Western Union Telegraph Co., 80 Hudson St., New York 13, N. Y.

755. INDUSTRIAL PICKUPS
Rek-O-Kut Co., 146 Grand St., New York 14, N. Y.

758. TRANSCRIPTION and PHONOGRAPH PICKUPS
Rek-O-Kut Co., 146 Grand St., New York 13, N. Y.

761. PLUGS and JACKS
Buggie & Co., H. H., Madison Ave. & 22nd St., Toledo 1, Ohio

764. POSTS, RINDING
Fahnsteck Electric Co., Inc., 46-44 Eleventh St., Long Island City 1, N. Y.

765. POWER SUPPLIES
Audio Products Co., 2191 W. Olive Ave., Burbank, Calif.
Electronics Associates Inc., 61 Brighton Ave., Long Branch, N. J.
Furst Electronics, 800 W. North Ave., Chicago 22, Illinois

766. ELECTRONICALLY REGULATED POWER SUPPLIES
Furst Electronics, 800 W. North Ave., Chicago 22, Illinois

768. VOLTAGE REGULATED POWER SUPPLIES
Furst Electronics, 800 W. North Ave., Chicago 22, Illinois

771. RACKS, RELAY
Audio Products Co., 2101 W. Olive Ave., Burbank, Calif.

777. VOLTAGE REGULATORS and STABILIZERS
Audio Products Co., 2101 W. Olive Ave., Burbank, Calif.
Furst Electronics, 800 W. North Ave., Chicago 22, Illinois

785. GENERAL PURPOSE RELAYS
Adams & Westlake, Michigan St., Elkhart, Indiana

787. INDUSTRIAL CONTROL RELAYS
Adams & Westlake, Michigan St., Elkhart, Indiana

795. KEYING and BREAKIN RELAYS
Buggie & Co., H. H., Madison Ave. & 22nd St., Toledo 1, Ohio

802. SNAP ACTION RELAYS
Adams & Westlake, Michigan St., Elkhart, Indiana

804. TELEPHONE RELAYS
Adams & Westlake, Michigan St., Elkhart, Indiana

806. TIME DELAY RELAYS
Electronic Associates Inc., 61 Brighton Ave., Long Branch, N. J.

807. TRANSFER RELAYS
Adams & Westlake, Michigan St., Elkhart, Indiana

817. POTENTIOMETERS and RHEOSTATS
Electronic Associates Inc., 61 Brighton Ave., Long Branch, N. J.

818. WIRE WOUND RESISTORS
Audio Products Co., 2101 W. Olive Ave., Burbank, Calif.

829. HERMETIC SEALS
Buggie & Co., H. H., Madison Ave. & 22nd St., Toledo 1, Ohio
Hermetic Seal Products Co., 414 Morris Ave., Newark 3, N. J.

849. SOLENOIDS
Aini Corp., 10 E. 52nd St., New York 22, N. Y.

852. SPRINGS
Instrument Specialties Co., Inc., 254 Bergen Blvd., Little Falls, N. J.

PRODUCTS INCORRECTLY LISTED
The following firms have advised us that the products which are listed below are not manufactured by them.

230. STROBOSCOPES
Audio Products Co., 2101 W. Olive Ave., Burbank, Calif.

308. A.F. SIGNAL GENERATORS
American Radio History

450. TUBE BELLOWS
Technographics Inc., 1457 W. Diversity Blvd., Chicago, Ill.

551. RADIO REMOTE CONTROLS
Lancaster Co., Inc., 184-186 85th St., New York 23, N. Y.

774. TUBE RECTIFYING UNITS
Electronics Inc., 127 Sussex Ave., Newark, N. J.

912. RF and IF TRANSFORMERS

NAME and ADDRESS CORRECTION or CHANGE
Communication Products Co., Inc., Keyport, N. J.
Fairchild Camera & Instrument Corp., 108 Van Wyck Blvd., Jamaica 1, N. Y.
Franklin Airloop Corp., 43-26 34th St., Long Island City, N. Y.
Franklin Mfg. Corp., A. W., 43-20 34th St., Long Island City, N. Y.
Gulow Corp., 62 William St., New York 5, N. Y.

Hardwick, Hinde Inc., 40 Hermon St., Newark, N. J.

Instrument Resistors Co., 1036 Commerce Ave., Bloomfield, N. J.

Kay Electric Co., 47 North Grove St., East Orange, N. J.
King Laboratories, Inc., 127 Solar St., Syracuse 4, N. Y.

Robinson Aviation Inc., Teterboro Air Terminal, Teterboro, N. J.
Schneitzler Paper Co., 182 Cornell Ave., Jersey City, N. J.

Trefz Mfg. Co., 511 East 164th St., New York 60, N. Y.

United States Television Mfg. Corp., 3 West 61st St., New York 2, N. Y.


Westinghouse Electric Corp., Electronic Tube Sales Division, Pittsburgh, Pa.


ADDITIONAL CORRECTIONS WILL APPEAR IN THE DECEMBER ISSUE

November, 1946 — ELECTRONICS
The Superior Tube Company, Electronics Division, has spared nothing in its effort to bring to the Radio Tube Industry, through its highly specialized facilities, metal tubing in the form of cathodes, anode and grid cylinders, and all types of fabricated tubular parts. These products, used in all types of electron tubes, are the metallurgical and physical counterparts of your electronic expectations. Material control standards, otherwise unattainable, are now realities. Superior's Electronics Laboratory has made possible far-reaching research and development of electronic tubing, through the study of materials, processes and controls. Whatever your requirements in metal tubing for electron tubes, bring your problems to us. The Engineering Staff of Superior Electronics Division will welcome your inquiries and the privilege of working with you.

THE BIGGER NAME IN SMALL TUBING

SUPERIOR TUBE COMPANY
ELECTRONICS DIVISION
Post Office Drawer 191 • Norristown, Pa.
Telehane, Norristown 2070
NEW PRODUCTS
Edited by A. A. McKenzie

New apparatus, packaged units, and component parts are described. Services, catalogs, and manufacturers' publications are reviewed.

Noise Suppressor (1)
Technology Instrument Corp., 1058 Main St., Waltham 54, Mass. The new type 910-A Dynamic Noise Suppressor has been particularly designed for broadcast station use. It allows the playing of shellac and vinyl recordings, subject to the limits of their dynamic range, on the same program with high-quality transcriptions without the unfavorable comparison occasioned by the usual high background noise. An instantaneous gate circuit operates to let through musical passages with practically no impairment, but substantially eliminates noise. The equipment can also be used for such purposes as the presentation of shortwave rebroadcasts in which noise is often the limiting factor. Engineered for broadcast use, the equipment illustrated is arranged for quick operation or removal and standard monitoring procedures. Maximum suppression of high-frequency noise is 20 db and for low-frequency noise, 15 db.

Television Tube (2)
Zetka Laboratories, Inc., 131 Getty Ave., Clifton, N. J. The type Z-15DP4 television tube has a black and white screen 15 inches in diameter. Focus and deflection are magnetic. A feature of the new tube is its short overall length (about 20 inches). The face plate is substantially flat to provide a large useful screen surface. Typical operation includes anode voltage of 8,000 to 10,000 volts; grid no. 2, 250 volts; grid no. 1, minus 45 volts; and focusing coil current between 88 and 116 milliamperes.

F-M Antenna (3)
Radio Corp. of America, Camden, N. J. The Pylon antenna is a single-element f-m radiator that is self-supporting. When additional gain is desired, one unit can be stacked upon another and an additional feed run from element to element inside the tube that forms the antenna. A stack of four sections results in a power gain of six over a simple dipole. The same antenna structure operates over the whole f-m band (88-108 megacycles) and will handle maximum power granted to f-m stations. Each pylon is 13 feet high, with a diameter of 19 inches, and weighs 350 pounds. Each end is provided with a flange for mounting on a base, display of a beacon at the top, or addition of another element. Radiation is horizontally polarized.

Tri-Channel Oscilloscope (4)
Electronic Tube Corp., 1200 East Mermaid Ave., Chestnut Hill, Philadelphia 18, Pa. The E-3G47-S1 triple-channel oscilloscope comprises three separate channels operating into a type 5Z3P11 triple-gun cathode-ray tube. The equipment has been designed for encephalographic studies and is equipped with a General Radio 35-mm oscillograph recorder capable of film speeds between 5 and 35 feet a second. The tube has a low-persistence actinic blue screen. Vertical

November, 1946 — ELECTRONICS
You can get efficient, economical protection against moisture for higher temperature installations with **Lumarith Film Insulation**

Lumarith film is a moisture resistant thermoplastic with comparatively high heat resistance. In combination with heat insulating layers, it will give an insulation resistant both to heat and moisture.

Investigate the electrical possibilities of all Lumarith plastic materials: films, sheets, rods, tubes and molding materials. They may help cut down production time and cost. Write for booklet entitled, "Celanese Synthetics for the Electrical Industry". Celanese Plastics Corporation, a division of Celanese Corporation of America, 180 Madison Avenue, New York 16, N. Y.


---

**Lumarith**

A CELANESE PLASTIC
amplifiers have a uniform frequency response from 2 cycles to 100 kilocycles and the horizontal amplifiers have a uniform response from 1 cycle to 30 kilocycles. Each of the three channels is equipped with a marker generator, and various switching and interconnection means are provided to make the use of the equipment as flexible as possible.

**Coaxial Termination (5)**

**BIRD ELECTRONIC CORP., 1800 East 38th St., Cleveland 14, Ohio.**

The Termaline Model 81 coaxial resistor is designed to dissipate up to 50 watts of r-f power with a low voltage standing wave ratio. It consists essentially of a coaxial resistor immersed in a liquid coolant. It can be used as an impedance standard, non-reactive termination, dummy antenna and for the measurement of standing wave ratios.

**Wide-Band Amplifier (6)**

**HEWLETT-PACKARD Co., Palo Alto, Calif.**

The type 450A amplifier has been designed for general purpose or laboratory use with frequency response flat within 0.5 db between 10 and 1,000,000 cycles. Input impedance is 1 megohm shunted by 15 micromicrofarads. The equipment is stable at a gain of 20 or 40 db.

**Low-Frequency Q-Meter (7)**

**FREED TRANSFORMER Co., INC., 72 Spring St., New York, N. Y.**

The No. 1030 Q-meter contains an audio-frequency oscillator, precision tuning capacitor, power amplifier and two vacuum-tube voltmeters. Oscillator frequency range is continuously variable from 50 cycles to 50,000 cycles in four ranges. Accuracy of the Q measurement is approximately 6 percent.

**Permeability Tuners (8)**

**ELECTRONIC LABORATORIES, INC., Indianapolis, Ind.**

The E-L Vario-Tuner is a new permeability-type broadcast tuner consisting of r-f and oscillator sections covering the frequency range 540 to 1,620 kilocycles. The unit is manufactured particularly for experimenters and schools desiring to build a 6-tube receiver.

**Circuit Tester (10)**

**ROBSON-BURGESS Co., Omaha, Neb.**

The Meg-Lite is essentially a continuity tester consisting of a 115-volt a-c or d-c line, a neon lamp, series resistor and switch, and a pair of leads. It is conveniently packaged for continuity testing and sells for about $5.

**Air-Cooled Amplifier (11)**

**GENERAL ELECTRIC Co., Syracuse, N. Y.**

The type GL-5518 air-cooled transmitting tube has been designed for use in grounded-grid circuits. A pair of the tubes in an experimental transmitter operating at 108 megacycles showed a useful

---

*November, 1946 — ELECTRONICS*
PERMANENT MAGNETS MAY DO IT BETTER!

SINTERED ALNICO MAGNETS
NOW MADE BY INDIANA STEEL

With the recent expansion of plant facilities at both the Valparaiso and Stamford plants, The Indiana Steel Products Company has materially increased the total production of sintered Alnico magnets in the United States.

Sintered magnets fulfill a special need where lightness of weight and compactness of design are desirable. Although they are considerably less expensive than cast magnets only in sizes less than 1/20 lb., sintered magnets are also desirable in sizes where special shapes are difficult to cast. The sintering process in quantity production makes Alnico permanent magnets available for many uses which were not previously economically possible.

The Indiana Steel Products Company is well equipped for the production of sintered magnets of almost any standard shape from its available stock of dies without die charge. Because of die cost requirements in the production of sintered magnets of special design, a special charge is made. We invite those interested in the application of sintered magnets to consult our engineering department.

More than 24,000 applications of permanent magnets have been made by The Indiana Steel Products Company, the world's largest sole manufacturer of "Packaged Energy". Our engineers invite you to consult with them on any magnet problem. For complete information write for our free "Permanent Magnet Manual".

© 1946 The Indiana Steel Products Company
output of 12.9 kilowatts with a d-c plate voltage of 6,000 volts. Full ratings apply up to 110 megacycles. In typical operation, driving power per tube is 1,400 watts.

High-Speed Motor  (12)
JOHN OSTER MFG. Co., Racine, Wis. The type EU-450 series-wound motor operates with a speed of 4,000 to 8,000 rpm at a power of 1/15 hp. Utilizing either a-c or d-c, the motor can be used for a tube-cooling blower or in similar applications.

New Plastic  (13)
GENERAL ELECTRIC Co., Pittsfield, Mass. A new plastic material known as Textolite 1422 possesses a low power factor and machines readily, making it suitable for coil forms and insulators used at ultra-high frequencies.

Electronic Timer  (14)
GENERAL CONTROL Co., 1200 Soldiers Field Road, Boston 34, Mass. Promatic timers provide full automatic or semiautomatic control of industrial or radio equipment. Used in pairs or combinations they can control a number of operations in a predetermined sequence with either self or manual recycling. Five timing periods, depending upon the value of fixed capacitor plugged into the circuit, are available from ¼ to 60 seconds. The unit can also be modified for use as a sensitive control relay.

Dual Electronic Heater  (16)
INDUCTION HEATING CORP., 389 Lafayette St., New York 3, N. Y. The Ther-Monic M-285C electronic heating generator is a single dual-purpose unit suitable for both induction and dielectric heating operations. Full load output is about 285 Btu per minute or 5 kilowatts. The induction generator operates on 375 kilocycles and the dielectric on 20 megacycles. Change-over from one method to another merely involves replacing one radio-frequency unit with the other.

Plug-In Amplifier  (15)
RADIO CORP. OF AMERICA, Camden, N. J. A new line of plug-in amplifiers is now in production for broadcast station use. With this system, a whole amplifier assembly can be demounted and replaced by another as is done with a tube. The BR-2A shelf assembly mounts in a standard rack. At the rear of the shelf are rectangular socket assemblies into which contactor prongs fit when the amplifier unit is locked into place by one or two levers. A family of amplifiers used in various broadcast station functions is available in the proper dimensions for the new mounting. Six preamplifier chassis units, for instance, fit on a single shelf.

Transmitting Triode  (17)
GENERAL ELECTRIC Co., Syracuse, N. Y. The type GL-5C24 triode has
NEW FACTS . . . SPECIFICATIONS . . . RECOMMENDATIONS
You should know about Lock Washers

From the latest American Standards Specifications right on through to what to use and where. That's how complete this new Diamond G Lock Washer booklet is. On the right are shown some of the pages from this new book. In addition there are many other facts that every design engineer, production manager, purchasing agent and other executive should have at his fingertips when buying or specifying lock washers or other fastening devices.

This book is just part of the complete service the Diamond G man has to offer you. He is ready to help you with data and engineering advice . . . plus supplying you with a complete line of flat and lock washers—from No. 0 to 2" in all materials and finishes. For quick deliveries, high quality and product satisfaction write, wire or phone . . .

GEORGE K. GARRETT CO., INC.
1421 CHESTNUT STREET, PHILADELPHIA 2, PA.

GEORGE K. GARRETT CO., INC.
1421 CHESTNUT STREET, PHILADELPHIA 2, PA.
Please send me a copy of the NEW DIAMOND G LOCK WASHER book . . .

NAME
TITLE
COMPANY
ADDRESS
CITY
1. MAGNETS OF ALNICO, the most stable magnetic material available, are used in all DC instruments.

2. LARGE CLEARANCES, between core, moving coil, and magnet pole pieces assures freedom of movement by eliminating sticking due to moving element rubbing on adjacent parts.

3. JEWEL SUPPORTS are machined and assembled with aid of precision gauging fixtures to maintain perfect alignment.

4. CONTROL SPRINGS are fabricated from the highest quality phosphor bronze.

5. CERAMIC POINTER STOPS are used to prevent damage to the pointer due to accidental application of sudden overloads.

6. BALANCE WEIGHTS of helical type phosphor bronze are used to balance the moving element, so formed as to eliminate slipping or shifting.

7. MAGNETIC SHUNT is standard equipment on each DC instrument, insuring uniform damping characteristics.

All ranges AC and DC are available in 2½", 3½", 4½" sizes, both rectangular and round case styles. Inquiries for complete information and engineering service are solicited.

BURLINGTON INSTRUMENT COMPANY
113 Fourth Street
BURLINGTON, IOWA
To avoid damage from Oxidation...

protect with NITROGEN

LINDE Nitrogen provides an ideal means of protection against oxidation and corrosion by air. For packaging dehydrated foods; for deaerating, processing, storing and packaging fats and oils of all kinds; or for providing an inert atmosphere, free of impurities, for the complete protection of practically any material susceptible to oxidation, use LINDE Nitrogen.

LINDE Nitrogen is 99.7% pure, but is also available bone dry and at higher purity for special applications. It is supplied as a compressed gas in cylinders containing 224 cu. ft. each, or in bulk in tank-truck and tank-car lots as a liquid which is converted into gaseous nitrogen as required. LINDE Nitrogen in bulk offers remarkable savings in cost and eliminates cylinder handling.

Write or call the Linde office nearest you.

THE LINDE AIR PRODUCTS COMPANY
Unit of Union Carbide and Carbon Corporation

LINDE has offices in Principal Cities

Eastern States
Baltimore, Md.
Boston, Mass.
Buffalo, N. Y.
Charleston, W. Va.
New York, N. Y.
Pittsburgh, Pa.

Central States
Chicago, Ill.
Cincinnati, Ohio
Cleveland, Ohio
Detroit, Mich.
Indianapolis, Ind.
Milwaukee, Wis.
Minneapolis, Minn.
St. Louis, Mo.

Southern States
Atlanta, Ga.
Birmingham, Ala.
Jacksonville, Fla.
Memphis, Tenn.
New Orleans, La.

Southwestern States
Dallas, Texas
Denver, Colo.
Houston, Texas
Kansas City, Mo.
Tulsa, Okla.

Western States
Butte, Mont.
El Paso, Texas
Los Angeles, Calif.
Phoenix, Ariz.
Portland, Ore.
Salt Lake City, Utah
San Francisco, Calif.
Seattle, Wash.
Spokane, Wash.
This Flexible Tubing makes Radio Waves TURN CORNERS...

This American Seamless Flexible Wave Guide is made from thin-wall rectangular metallic tube... can be extended, compressed or bent in two planes to small radii and withstands a large number of flexures of moderate amplitude.

Other widely used American Flexible Wave Guides are the "Vertebra" type, consisting of a series of choke-plate wafers inserted in a synthetic rubber jacket, and the "Moldlock" type, made of spirally wound strip with fully interlocked joints, with (or without) a synthetic jacket.

These high precision units mate electrically and mechanically with the standard sizes of rigid guide for operation at wave lengths from 20 to less than 3 cm.

We will be glad to assist in selecting the wave guide best suited to the specific requirements of your installation. Write for our "Electronics Data Book."

<table>
<thead>
<tr>
<th>Forest Hill, Conn.</th>
</tr>
</thead>
</table>

This Metal Hose makes Radio Waves TURN CORNERS. It is seamless and flexible, making it ideal for use in areas where rigidity is not required.

American Metal Hose
THE AMERICAN BRASS COMPANY
American Metal Hose Branch
General Offices: Waterbury 88, Conn.
Subsidiary of Anaconda Copper Mining Company

November, 1946 — ELECTRONICS

NEW PRODUCTS (continued)

Tube Voltmeter (19)
TELEVISIO PRODUCTS Co., 7466 Irving Park Road, Chicago 34, Ill. The Series 270A vacuum-tube voltmeter uses a 0.5-volt full scale meter that allows accurate readings as low as 100,000 microvolts. The input tube is a plate circuit rectifier type that indicates rms values, rather than the usual diode type whose input admittance varies with frequency. Careful voltage regulation makes the circuit feasible. In addition, a source of 5 volts rms plus or minus 2 percent is furnished for calibration.

Ferromagnetic Analyzer (20)
ALLEN B. DU MONT LABORATORIES, Inc., Passaic, N. J. The Ferrograph provides a simple means for relatively unskilled personnel to identify or compare ferrous materials at a rapid rate. The basic principle of operation is the harmonic analysis of the induced voltage in the secondary of a test transformer in which the sample...
"It's a fact, John, those little TUNG-SOL Miniatures are actually doing a better job than the big tubes. Take radio frequency amplifiers for example. There's the TUNG-SOL 6BA6 for transformer and storage battery operated sets and the 12BA6 for series filament operation. It's only natural that you get greater rigidity with the shorter structure and the same grid cathode spacing . . . and to give you some idea of space saving, one of these little fellows occupies less than half the chassis area that a big tube requires. Think what this means in compact equipment like an auto set.

"With these miniature amplifiers it's possible to obtain the correct bias by means of a cathode resistor of 68 ohms for normal operating current. If unbypassed this gives partial compensation for variations in input capacitance due to changes in automatic volume control voltage. Almost complete compensation can be obtained with a 100 ohm unbypassed cathode resistor. Under this condition the effective transconductance is 2700 microhms. Excellent performance is obtained in the frequency modulation and television intermediate frequency bands. The stable gain figure of merit is about the same as for the large type tube while the broad band figure of merit is about 30% greater.

"I tell you, John, you should lay your tube problems before these TUNG-SOL Engineers. They'll help you select the miniature that'll be most efficient and they won't disclose your plans to others. You see they're tube manufacturers, not set builders."
Engineers, designers—send for your free copy of this valuable new guide, today. HAYDON'S 1947 Catalog is a storehouse of information and specifications of timing motors for every conceivable application. And it's all been revised—many new items! Every motor pictured...complete operational data and blueprint sketches shown...informative section on new special and optional features. Up-to-date items include AC timing motors and gear units, shift units, brake units, friction units, elapsed time indicators, fixed interval repeat cycle timers, fixed interval automatic reset timers and many others. Made in handy 8½'' x 11'' size to fit your files conveniently. Be sure to add this late edition to your files.

If you plan to use timers now or in the future, you'll find HAYDON'S 1947 Catalog one of your handiest references.

**NEW PRODUCTS (continued)**

is made the core. Amplitude and phase angles of the fundamental and third harmonic components are usually sufficient indication for identification. A cathode-ray tube is used for direct display of the phenomena. The complete testing equipment weighs 115 pounds.

**Strain Gage Amplifier (21)**

G. C. Wilson & Co., 2 N. Passaic Ave., Chatham, N.J. A new amplifier designed for vibration studies provides amplification of 25,000 between 1 and 30 cycles. Designed to couple directly to the plates of a cathode-ray oscilloscope, the unit includes its own regulated power supply.

**Audible Signal Tracer (22)**

Electronic Instrument Co., Inc., 926 Clarkson Ave., Brooklyn 3, N.Y. The Model 113 Electron Tracer
THE **SOLISTRAND**

for connecting—
SOLID WIRE
STRANDED WIRE
SOLID AND STRANDED WIRE COMBINATIONS
IRREGULAR SHAPED CONDUCTORS

The new AMP SOLISTRAND terminal—originally designed for solid wire—assures a superior connection for ALL types of conductors . . . terminal makes full surface area contact with the conductor.

The cross sections tell the story. Use the same Solistrand for ALL INSTALLATIONS.

For samples and full information—Write today!

AIRCRAFT-MARINE PRODUCTS Inc.
1521-53 NORTH FOURTH STREET, HARRISBURG, PA.
is a complete electronic volt-ohm-meter operating from socket power. It is also equipped with an audio-amplifier and loudspeaker for audible signal tracing through the various stages of a receiver.

Heavy-Duty Relay (23)

Signal Engineering & Mfg. Co., 154 West 14th St., New York 11, N. Y. A new heavy-duty relay with double-pole, single-throw contacts will break 50 amperes at 115 volts a-c or 24 volts d-c. A double-break feature of the contact mechanism eliminates pigtail connections. Coils can be supplied to operate at voltages up to 230 volts, a-c or d-c. Typical power consumption of the coils is less than 3.5 watts on d-c, 8 watts on a-c.

Helical Potentiometer (24)

Van Dyke Instruments, P. O. Box 696, Tarzana, Calif. The small size and weight of a new helical potentiometer make it useful for aircraft instrumentation and electronic cal-

NEW PRODUCTS (continued)
Every one of the tungsten and molybdenum products supplied by North American Philips is backed by the knowledge of processes and techniques developed by an organization with a background of over half a century in the electrical field. Every piece of material is controlled to your most rigid specifications.

We can supply you with most of the tungsten and molybdenum products you need—in rod, bar, wire, sheet or powder form.

When you want tungsten or molybdenum—write, wire or telephone North American Philips. And remember, the services of our application engineers are always at your disposal, their years of specialized experience are yours on call.

Products of North American Philips include: other fine wires, diamond dies, quartz oscillator plates, radio and television components, cathode ray tubes, industrial and medical x-ray equipment, tubes and accessories.
FOR SALE

PLANCOR 2189
PUNXSUTAWNEY, PENNA.

This plancor was erected in 1944 for producing cylindrical carbon electrodes (up to size 3½") used in the construction of dry cell batteries.

It is reasonable to believe that this plant represents the most modern of its type, and could be a low unit cost producer of electrodes with near capacity production. The output would vary between 45 and 60 million electrodes a month, depending upon their size.

With certain additions and changes in this facility, it is quite possible that other carbon products could be produced—such as brushes for motors, contacts for electrical switch gear, electronic tube anodes, carbon discs, molds for casting, etc.

This plancor consists of land, building, machinery and equipment briefly described as follows:

**LAND**: Approximately 10½ acres.


Furnace Building—12' x 233'. One story, with two supported floors at one end. Structural steel framing. Corrugated siding with continuous sidwall sash. Corrugated asbestos roof. Freight elevator to supported floors. Total area 34,060 sq. ft.


**MACHINERY and EQUIPMENT**: Production equipment, machine tools, laboratory and testing equipment, furniture and fixtures. These include carbon furnaces, grinders and accessories, extrusion presses, mixers, rotary dryers, cutting tables, etc.—drill presses, lathe, shaper, milling machine, etc.—micrometers, testing sieves, platinum crucible, etc.—lockers, office furniture, calculator, etc.

The furnace building has two, 3-ton girder cranes and there are four hoists—of 1, 2 and 3½ ton capacities.

Complete utilities, including natural gas, are supplied by local companies. There are sidings from the B & O R. R. on the site. And the community provides an excellent labor market.

**CREDIT TERMS** for the purchase of this property may be arranged. And if you can qualify as a small business concern you may obtain high priority for its purchase through the Reconstruction Finance Corporation.

Information contained herein is not intended for use as a basis for negotiation. The War Assets Administration reserves the right to reject any or all proposals.

**FOR SALE**

**NEW PRODUCTS**

(continued)

Flat Midget Capacitors (25)

CORNELL-DUBILIER ELECTRIC Corp., South Plainfield, N. J. A new line of flat midget capacitors, type 2N, is now available for pocket radio, hearing aid or similar use. The units are noninductively wound with Kraft paper and impregnated. Leads are securely anchored and the end-fill compound is not melted by a hot soldering iron. Capacitance values range from 0.001 to 0.1 microfarad in dc rated voltages from 150 to 600 volts.

Gas-Free Metals (26)

NATIONAL RESEARCH CORP., 100 Brookline Ave., Boston 15, Mass. Quantities of gas-free metals in melts up to several hundred pounds are now available for high-vacuum work and allied techniques. A partial list of metals already used in the field of vacuum metallurgy includes copper, nickel, iron, chromium, manganese and lithium.

Flash Tube (27)

HYTRON RADIO AND ELECTRONICS CORP., Salem, Mass. The HD72 flash tube operates from the discharge...
"Phillips Screws were a big help in working out methods of large scale production of the Yorkaire Room Conditioner," the plant superintendent of the York Corp. told the James O. Peck Co. investigator. "To get production we knew we'd have to use self-tapping screws and power drivers on our sheet metal assemblies, but that got us into a lot of trouble with slotted screws.

"The Phillips Recessed Head Was a Natural for Power Drivers and Self-tapping Screws. No trouble locating screws or keeping bits in the screw head. No damaged panels or other handicaps that slow down production. Since we adopted the Phillips Head in '37 it's been standard on all sheet metal assemblies.

"One-Hand Driving Is Easy With the Phillips 'Engineered Fit'. The precision recess snug right onto the bit of the power driver and sticks there, making it so easy for the operator to center the screw in the hole that he can hold the work with one hand and drive with the other.

"Eliminated the Tremendous Amount of Screw Driver Slippage. Panels were no longer chewed up, a stop was put to turned or burred screw heads and the whole assembly line speeded up the moment we changed from slotted to Phillips Screws."

"Eliminated the Tremendous Amount of Screw Driver Slippage. Panels were no longer chewed up, a stop was put to turned or burred screw heads and the whole assembly line speeded up the moment we changed from slotted to Phillips Screws."

Important Information for You is available in the unabridged report by this independent investigator of the York Corporation's experience with Phillips Screws. Other reports, covering assembly practices in 9 prominent plants making products of metal, wood and plastics, are yours for the asking ... FREE! Use the coupon NOW.

PHILLIPS Recessed Head SCREWS
Wood Screws • Machine Screws • Self-tapping Screws • Stove Bolts


26 SOURCES
Manufacturers Screw Products
Milford Rivet and Machine Co.
National Lock Co.
National Screw & Mfg. Co.
New England Screw Co.
Parker-Kalin Corporation

Pawtucket Screw Co.
Pholl Manufacturing Co.
Reading Screw Co.
Russell Burdick & Ward Bolt & Nut Co.
Sylvan Manufacturing Co.
Tekaproof Inc.
The Southington Hardware Mfg. Co.
The Steel Company of Canada, Ltd.
Sterling Bolt Co.
Wolverine Bolt Company.

Send me reports on Assembly Savings with Phillips Screws.

Name ____________________________
Company ________________________
Address _________________________

Phillips Screw Mfrs., c/o Horton-Nayes
2350 Industrial Trust Bldg., Providence, R. I.

10

Assemble Savings
with Phillips Screws

2350 Industrial Trust Bldg., Providence, R. I.

PHILLIPS Screw Mfrs., c/o Horton-Nayes
2350 Industrial Trust Bldg., Providence, R. I.

Send me reports on Assembly Savings with Phillips Screws.

Name ____________________________
Company ________________________
Address _________________________

2350 Industrial Trust Bldg., Providence, R. I.
In Electronics there is no “good enough” but the best!

There are no requirements of the Radio and Electronic Industries demand solders and fluxes of the highest quality. Solder bonds must be dependable and permanent—especially where extreme changes in conditions occur, or in close assembly work.

The outstanding quality of Glaser Solders and Fluxes is the result of scientific research extending over more than two decades.

Glaser Plastic Rosin Core Solders are standard with leading manufacturers of capacitors, resistors, transformers, relays etc. To insure your product against short life and poor performance use Glaser Plastic Rosin Core Solder, the “Quality Solder” of time-proven dependability.

Let the experience of leading Electronic and Radio Technicians guide you in making Glaser Solders and Fluxes YOUR choice.

Glaser Rosin Core Solders exceed government specifications in purity, and are guaranteed to meet A.S.T.M. Class A specifications for solder.

Speed Nut

(28)

Tinnerman Products, Inc., 2106 Fulton Road, Cleveland 13, Ohio. A new line of heat-treated spring steel speed nuts is available in sizes to fit the ten most popular sheet metal and machine screws. The C7000 series take less room and cost less than the conventional threaded nut and lock washer.

Synchroscope

(29)

Sylvania Electric Products, Inc., 500 Fifth Ave., New York 18, N. Y. A synchroscope designed for the visual examination of the fine structure of periodic waveforms encountered in television, pulse time

of a capacitor through a glass coil containing xenon gas. Anode potential can be varied between 5,000 and 3,000 volts. The flash exceeds 12 million peak lumens in intensity. The resultant light simulates that of the sun, making the device useful for color photography.
PLASTICON* ASG
Silicone-Filled
GLASSMIKES

FOR HIGHER VOLTAGES

Modern functionally designed capacitors. Metal ferrules are soldered to silver bands fused to each end of heavy-walled glass tubes. This vacuum tight assembly is fungus-proof and passes Signal Corps, Air Corps and Navy thermal cycle and immersion tests.

Applications

- For low and medium power coupling and bypass circuits where mica capacitors have previously been required
- Television and Oscilloscope Circuits
- Vibrator Buffer and Arc Elimination
- Geiger Counter and Instrument Capacitors

"PLASTICONS: Plastic-Film Dielectric Capacitors"

Order from your jobber: if he cannot supply you, order direct

Condenser Products Company

1375 NORTH BRANCH STREET • CHICAGO 22, ILLINOIS
SORENSEN Regulators straighten out weaving input voltages. It's done the electronic way... without moving a muscle. No moving parts assure you of quick response, low maintenance and longer life.

Protecting costly laboratory apparatus from overvoltages, speeding up assembly line testing or applied to any of your regulation problems, the SORENSEN Regulator can be counted on to do the job with precision and accuracy.

Write for more information.

Arrange for a demonstration today.

A LINE OF STANDARD REGULATORS FOR LOAD RANGES UP TO 5000 V.A.
SPECIAL UNITS DESIGNED TO FIT YOUR UNUSUAL APPLICATIONS.

NEW PRODUCTS

(continued)

modulation, sonic depth finders, geophysical exploration and loran equipments has recently been announced. Included is a 5-inch cathode-ray oscilloscope, trigger generator and adjustable time delay circuits. Sweep speeds up to 5 inches a microsecond are possible with the sweep triggered by either positive or negative pulses. Internal trigger outputs of 500, 1,000, 2,000 and 5,000 pulses per second are available.

Portable Sound System (30)

NEWCOMB AUDIO PRODUCTS CO., 2815 S. Hill St., Los Angeles 7, Calif. A new portable sound system contained in three carrying cases uses a 30-watt amplifier and two 12-inch speakers. Weight of the Model KX-30R12A equipment is 147 pounds.

Subminiature Socket (31)

INSTRUMENT SPECIALTIES Co., Inc., Little Falls, N. J. A somewhat un-
Put FLEXIBILITY into ELECTRONIC DESIGN

When you make a circuit diagram, you put variable elements where you want them to simplify the design. You can gain the same "flexibility" when you design the actual equipment. Here's how—

DO IT WITH S.S.WHITE FLEXIBLE SHAFTS

When you couple variable elements to their controls with S.S. White Remote Control Flexible Shafts you have complete freedom in locating the elements where they best satisfy assembly, wiring and servicing requirements—and at the same time you have equal freedom in placing the control dials for convenient operation and harmonious appearance. For details—

WRITE FOR BULLETIN 4501
It gives essential facts and engineering data about flexible shafts and their application.
Copy mailed on request.

S.S.WHITE INDUSTRIAL DIVISION
THE S. S. WHITE DENTAL MFG. CO.
DEPT. E. 10 EAST 40th ST., NEW YORK 16, N. Y.
FLEXIBLE SHAFTS • FLEXIBLE SHAFT TOOLS • AIRCRAFT ACCESSORIES
SMALL CUTTING AND GRINDING TOOLS • SPECIAL FORMULA RUBBERS
MOLDED RESISTORS • PLASTIC SPECIALTIES • CONTRACT PLASTICS MOLDING

One of America's AAAAA Industrial Enterprises
TWO NEW VACUUM GAUGES ARE NOW AVAILABLE.
FOR COMPLETE SPECIFICATIONS, WRITE FOR BULLETIN E-101
- No Outgassing of Gauges
- Stable Calibration
- No Electrical Leakage
- Interchangeable Gauges
- Gauges Guaranteed 1000 Hours
- Can Not Burn Out Due to Accidents
- Dual Range: 0 to 500µ—0 to 0.4µ
- Adaptable to All High Vacuum Processes
- Extremely Simple to Operate
- Accurate, Continuous Record Tells the Whole Story—Permanently

MODEL S TELEVAC FOR ACCURATE RECORDS DOWN TO .001 MICRON (10^{-6} \text{ mm MERCURY})

MODEL MR TELEVAC FOR ACCURATE RECORDS DOWN TO 1 MICRON
- Constant Calibration
- Interchangeable Gauges
- No Batteries—Uses 115V.A.C.
- Range: 0-500 Microns
- Adaptable to Automatic Exhaust Machines
- Can Operate Auxiliary Relays at Pre-determined Pressures

Manufacturers of Scientific Glassware and Precision Instruments for Over 10 Years

GEORGE E. FREDERICKS COMPANY
BETHAYRES PENNSYLVANIA
HIGH VACUUM TECHNICIANS • CONSULTING ENGINEERS

Regulated D-C Power Supplies (32)
SORENSEN AND Co., Inc., 375 Fairfield Ave., Stamford, Conn. Regulated d-c power is available at either 6 or 12 volts in current ratings between 5 and 15 amperes. Operating from conventional a-c power lines, these regulators maintain their d-c output with an accuracy of plus or minus 0.5 percent.

Dynamic Tube Analyzer (33)
WESTON ELECTRICAL INSTRUMENT CORP., 617 Frelinghuysen Ave., Newark 5, N. J. The Model 686 vacuum tube analyzer tests tubes under dynamic operating conditions. A large meter indicates mutual conductance in ranges of 3,000, 6,000, and 15,000 micromhos. A socket panel provides access to usual socket is now available for subminiature tubes having coplanar leads spaced 0.050 inch or more. The contacts, illustrated, are formed in an open U section then wedged into a square hole in a supporting insulating sheet. Tube-wires or miniature prongs pass through a hole and are seized on the other side by the spring metal. Connecting wires are soldered to the projections on the other side of the supporting insulator.
Today WILCO CONTACTS keep the power flowing in vital industrial applications through their built-in capacity for precision performance and longer service life. WILCO CONTACTS function dependably in frequency operations of every range by bringing to each operation requisite ductility, hardness, density, freedom from sticking, low metal transfer, high conductivity and arc-resistance.

You likewise can depend on WILCO CONTACTS to keep the power flowing in your products, because exclusive patented WILCO processes assure unequalled qualities. WILCO engineers will gladly help you select from a great variety of available WILCO contact materials the particular contacts suited to your needs—or develop new alloys for special purposes.

THE H. A. WILSON COMPANY
105 Chestnut Street, Newark 5, N. J. • Branch Offices: Chicago, Detroit, Los Angeles, Providence

SPECIALISTS FOR 30 YEARS IN THE MANUFACTURE OF THERMOMETALS • ELECTRICAL CONTACTS • PRECIOUS METAL BIMETALLIC PRODUCTS

ELECTRONICS — November, 1946
Specifications:

Input: 115 V, 50-60 cycle.

Regulation: Less than 1/10 volt change in output voltage with change of from 85 to 145 V.A.C., input voltage and from NO LOAD to FULL LOAD (over very wide latitude at center of variable range.)

Ripple: Less than 5 millivolts at all loads and voltages.

Fits any standard 19" rack or cabinet.

TYPE A: Variable from 210 to 335 V.D.C. at 400 M.A.

TYPE B: Variable from 535 to 915 V.D.C. at 125 M.A.

Designed by one of the foremost electronic communication laboratories in the country; constructed by its equally noted associate company; and built for the U.S. Army as Power Supply RA-ST-A to be used in conjunction with the microwave RADAR set SCR 547. Equipment was never used and was obtained in their original packing crates.

Adapted to civilian use by mounting on 12¼" x 19" panel, black crackle finish, and installing milliammeters, voltmeters, fuses, switches, pilot lights, terminals, power cords, and all other necessary auxiliary items.

Construction Features:

Weston Model 301 (or equal) Milliammeter and Voltmeter.

Separate switches, pilot lights, and fuses for FILAMENT AND PLATE VOLTS.

All tubes located on shockmount assemblies.

Fuses mounted on front panel and easily accessible.

Can vary voltage by turning small knob located on front of panel.

Can easily modify unit from positive to negative output voltage by changing two leads.

All individual components numbered to correspond with numbers on wiring diagram.

Rigid Construction: Individual components were designed to withstand the most severe military conditions—both physical and electrical—and were greatly under-rated.

Tube complement: Type A: 2-836; 5-6L6; 2-6S5s; 1-VR150; 1-VR105

Type B: 2-836; 2-5L6; 2-6S5s; 1-VR150; 1-VR105

Overall dimensions: 19" wide, 12¼" high, 11" deep.

Net weight: 80 pounds. Shipping weight: 95 pounds.

Some of the current users of these power supplies include nationally known electronic and communications measurement laboratories; aircraft, metallurgical and chemical research labs; technical schools; commercial radio, F.M. and television stations; amateurs; civilian RADAR installations; etc.

All units checked and inspected at 150% rated load before shipment.

NET PRICE: Type A: $175.00; Type B: $168.00 F.O.B. Baltimore

Prices subject to change without notice.

NEW PRODUCTS

Plastic Electrolytics (34)

SOLAR MFG. CORP., 285 Madison Ave., New York 17, N. Y. Type DS, DT and DH dry electrolytic capacitors are now being wrapped in a plastic film instead of Kraft paper liners before insertion in the cardboard housing. The film has been chosen to withstand the high potting temperatures and is said to increase the life of the capacitors materially.

Graphic Sketch Pad (35)

JIFFY SALES CO., 1879 East 37th St., Cleveland 14, Ohio. A pad of plain paper perforated for easy removal can be backed by one of three scales printed on cardboard flaps. Isometric, one-inch and tenths, or one-
Here are its characteristics. How can it fit your needs?

In a thermal relay, an electrical heater, rather than magnetic coil, is used to operate the contacts. This results in certain useful characteristics—inbuilt delay timing, insensitivity to transients, a non-inductive device that operates from AC or DC or interchangeably, and simple construction.

The design of the EDISON Model 501 Thermal Relay adds certain important features to these general advantages. Hermetic sealing in glass protects all parts, guarantees consistent long life, and makes operation independent of altitude. Contacts operate noiselessly in an arc-quenching atmosphere with consequent equal current ratings on AC or DC. A compensating bi-metal assures uniform response time at all ambient temperatures. The relay will operate in any position. A convenient tube-base mounting is available. Sound thermodynamic design assures consistent operation and permits a wide range of characteristics.

Delay or timing is only one of the many uses of this versatile new relay. Engineers are constantly finding new applications for a device with its unusual and useful characteristics—applications which simplify and improve control circuits of many types.

For instance, it protects vacuum tubes by delaying the application of plate current until cathodes are hot. It will indicate or control over and undercurrent, over and under-voltage. It carries heavy AC and DC loads and prevents chatter when actuated by delicate controls. It does dozens of other jobs better and more cheaply than any other type of relay.

The services of Edison Engineers are available to assist you in working out any problem in connection with Edison instruments and controls. A letter giving as much data as possible on the proposed use will receive prompt attention. Instrument Division, Thomas A. Edison, Incorporated, 21 Lakeside Avenue, West Orange, N. J.
NEW PRODUCTS  
(continued)

inch, half, quarter and eighth-inch scales are available. Electronic, power and welding symbols are printed on the back of the cover. Price is $1.65 each, or less in lots.

Ventilating Hose  
(36)
AMERICAN VENTILATING HOSE CO., 15 Park Row, New York 7, N. Y. A new neoprene-coated fabric hose is available in diameters from 1 to 24 inches. Reinforced by a spiral wire, it can be used for a variety of cooling or ventilating purposes.

Studio Recorder  
(37)
FAIRCHILD CAMERA AND INSTRUMENT CORP., Jamaica, N. Y. The No. 523 studio recorder for instantaneous or wax recordings accommodates 18-inch masters. A positive drive at 33.3 rpm from a synchronous motor makes the a-c line the only standard of frequency necessary for dubbing in sound. Uniform

JAMES MILLEN MFG. CO., INC. 
MAIN OFFICE AND FACTORY 
MALDEN 
MASSACHUSETTS

THERMADOR
THERMADOR ELECTRICAL MFG. CO
5119 District Blvd., Los Angeles 22, California

From out of the west . . . America's finest transformers

Thermador is a name remembered when the utmost in transformer quality is desired, and when exceptional engineering skill is required.

"Seven Leagues Ahead"

November, 1946 — ELECTRONICS

www.americanradiohistory.com
Here is a line of midget size Capacitors that will fit into those many inaccessible places encountered in electronic devices, radios and television sets.

These are hermetically sealed "Paper Dielectric" units—impregnated and filled with oil* or wax—in tubular containers of brass with a heavy tin dip.

They are particularly suitable where a high quality capacitor is required to function under conditions of excess humidity; where stability and long life also are vital factors. They are fungus resistant—excellent units to use in radionic and electronic equipment for operation in tropical or similar areas. In certain regions servicing may be a problem, consequently continuous and reliable performance is essential.

This line includes the following ranges: In WAX—.002 to .1 MFD, 100 VDC; .002 to .075 MFD, 200 VDC; .002 to .05 MFD, 400 VDC; .001 to .03 MFD, 600 VDC. In OIL—.002 to .05 MFD, 100 and 200 VDC; .001 to .04 MFD, 400 VDC; .001 to .02 MFD, 600 VDC. Somewhat higher capacities can be supplied without increasing the size abnormally. Below is a Representative list of "MIJAKONS" showing detailed dimensions.

Please note these units are not carried in stock. Due to the difficulty in obtaining brass shells and tubing deliveries cannot be made until the end of the 1st quarter of 1947. Plan to use "MIJAKONS" in your 1947 models. Samples may be supplied in four to six weeks. WHEN MAKING INQUIRIES or REQUESTING samples PLEASE SPECIFY whether "Wax" or "Oil" are required.

Standard or Special Units to Meet Every Need

FAST can supply practically any Capacitor of the "Paper Dielectric" type in OIL or WAX—impregnated and filled—or POLYSTYRENE FILM. Containers may be cardboard or metal, rectangular or tubular, in sizes from the smallest to the largest. CHOKE COILS of heavy wire (No. 12 to No. 18), Air or Iron Core, can also be made to your specifications.

"When You Think of Capacitors...Think FAST"

---

*MINERAL OIL
cutting is assured with a screw mechanism adjustable at any pitch from 80 to 160 lines, starting either from center or edge.

Radiating Connectors (38)
EITEL-MCCULLOUGH, INC., San Bruno, Calif. Type HR heat dissipating connectors are used to make electrical connections to the plate and grid terminals of power tubes, at the same time providing efficient heat transfer from the tube element and the glass seal to the air. The connectors are machined from solid dural rod and are supplied with necessary machine screws to insure a tight joint.

Multiwire Connectors (39)
ALDEN PRODUCTS Co., 117 North Main St., Brockton 64, Mass. A new series of multiwire connectors features a knurled locking ring that engages slots in the chassis member. In the locked position a rubber gasket protects the junction from vibration and moisture. A means is provided for fastening cable shielding to obtain positive ground and prevent strain on the cable.

W HF Receiver (40)
RADIO RECEPTOR Co., INC., 251 West 19th St., New York 11, N. Y. The RV-1-B vhf crystal-controlled receiver is designed for fixed frequency service over the frequency
YOU HELP ALL 3 WITH THE P.S.P.

- Participants in the Payroll Savings Plan benefit directly in terms of cash—because U.S. Savings Bonds at maturity pay $4 for every $3 invested.

  Your company, your community, and your country benefit indirectly in terms of security—because: (1) Employees with a solid stake in the future are likely to be stable, productive workers. (2) The Bond-buying habit of local citizen-employees means a reserve of future purchasing power—a safeguard for the stability of your community. (3) Every Bond bought temporarily absorbs surplus funds and helps check inflationary tendencies.

  You're doing everybody a favor—including yourself—by supporting the Payroll Savings Plan.

ARE YOU USING THESE BOOKLETS?

If not, or if you wish additional copies, just ask your State Director of the Treasury Department Savings Bonds Division.

The Peacetime Payroll Savings Plan—A booklet, published for key executives by the Treasury Department, containing helpful suggestions on the conduct of your payroll savings plan for U.S. Savings Bonds.

This Time It's For You—A booklet for employees...explaining graphically how the payroll savings plan works...goals to save for, and how to reach them with Savings Bonds.

The Treasury Department acknowledges with appreciation the publication of this message by

Electronics

This is an official U.S. Treasury advertisement prepared under the auspices of the Treasury Department and The Advertising Council

ELECTRONICS — November, 1946
magnetic iron powders

Uniformly high magnetic performance, exceptional Q and high permeability of the wide variety of Mepham magnetic iron powders (hydrogen reduced) suggest their use for high-frequency cores, core material, tele-communication and magnetic applications. Production is strictly controlled—prices are attractively low... Consult the Mepham Technical Staff—send for literature.

G. S. MEPHAM CORPORATION
Established 1902 • • East St. Louis, Illinois

TRACING CLOTH for HARD PENCILS

Imperial Pencil Tracing Cloth has the same superbly uniform cloth foundation and transparency as the world famous Imperial Tracing Cloth. But it is distinguished by its special dull drawing surface, on which hard pencils can be used, giving clean, sharp, opaque, non-smudging lines. Erasures are made easily, without damage. It gives sharp, contrasting prints of the finest lines. It resists the effects of time and wear, and does not become brittle or opaque. Imperial Pencil Tracing Cloth is right for ink drawings as well.

SOLD BY LEADING STATIONERY AND DRAWING MATERIAL DEALERS EVERYWHERE.
range 100 to 162 megacycles. The unit is rack-mounted for airline or other fixed station use but can be slid out of its dust cover and inverted while in operation. Further details are given in Bulletin 5007A.

Resonant Relays (41)

STEVENS-ARNOLD Co., 22 Elkins St., South Boston 27, Mass. The type 172 resonant relay uses a vibrating reed mechanism adjusted to respond to a narrow band of frequencies. The units are totally enclosed and based with octal-tube type connections. The on time of the contacts is 5 percent for all frequencies from 153 to 442 cps. An auxiliary relay or vacuum tube is used to control large currents that can not be handled by the vibrating contacts. The standard coil has an impedance of 500 ohms. Further details are given in Catalog 116.

Level Recorder (42)

SOUND APPARATUS Co., 223 Broadway, New York 7, N. Y. The type PS portable graphic recorder measures only 8 x 10 x 12 inches and

RADIO PARTS
SETS • AMPLIFIERS

COMPLETE CONCORD CATALOG FREE!

Revived! Up-to-the minute! Listing the newest, the latest and best in RADIO PARTS, RADIO SETS, AMPLIFIERS, AMATEUR GEAR, ELECTRONIC EQUIPMENT, SUPPLIES and ACCESSORIES! Hundreds of items for every Radio and Electronic need—Condensers, Resistors, Transformers, Tubes, Test Equipment, Tools, and Repair Replacement and Maintenance Parts of every kind.

All standard top quality, nationally famous makes, are fully represented in the great new Concord Catalog. Complete lines including new and hard-to-get parts and equipment at latest O.P.A. prices or lower. Thousands of items—and complete stocks ready for immediate shipment from CHICAGO or ATLANTA. Your copy of the new Concord Catalog is ready now—FREE! Mail the Coupon below.

SEE...

Complete showing of ham gear, equipment, supplies and accessories for amateurs, engineers, servicemen, soundmen, retailers.

SEE...

the first peaceetime Concord line of modern Radio Sets and Radio Phonograph Combinations—featuring a host of new, approved post-war developments...richer tone quality...super-selective tuning and reception...higher fidelity...new modern design cabinets.

SEE...

the thrilling new MULTIAMP Add-A-Unit Amplifiers, an entirely new revolutionary development in amplifier engineering with sensational new flexibility, power, fidelity and economy—EXCLUSIVE WITH CONCORD!

All in the new complete Concord Catalog...mail the coupon now.

Mail This Coupon Now!

CONCORD RADIO CORPORATION

Yes, rush FREE COPY of the comprehensive new Concord Radio Catalog.

Name
Address
City State
FOR SAFETY’S SAKE

Safety first for personnel is of the utmost importance. This protection can be guaranteed through the use of G-E Interlock Switches on radio transmitters, X-ray and therapeutic machines, burglar alarms, and signal controls for fire doors. Safety first for equipment is important, too. G-E Indicator Lamps give visual evidence of what is going on inside equipment, and circuit troubles can be corrected before they become serious.

Write: Electronics Department, General Electric Company, Syracuse, New York.

GENERAL ELECTRIC

Quality, not quantity is the tradition at Sillcocks-Miller.

Of course, we cannot make all the plastic dials industry requires, so we concentrate on producing only the best.

That’s why design engineers who need plastic dials fabricated to close tolerances have come to depend on Sillcocks-Miller craftsmanship through the years.

Our understanding of the problems, our ability to produce accurately and our thorough knowledge of all types of plastics enable us to supply your needs quickly and with a minimum of effort on your part.

That’s why we can say “It costs you less to pay a little more for Sillcocks-Miller quality.”

Write for illustrated brochure today.

THE SILLCOCKS-MILLER CO.

10 West Parker Avenue, Maplewood, N.J.
Shipping Address: South Orange, N.J.

SPECIALISTS IN HIGH QUALITY, PRECISION-MADE PLASTICS FABRICATED FOR COMMERCIAL, TECHNICAL AND INDUSTRIAL REQUIREMENTS.
includes an input potentiometer, paper gate and scriber, amplifier, motor, and power supply. The unit has a sensitivity of 10 millivolts for 0 db. Normal paper speed is 6 inches a minute. Recording speed is full scale in 0.6 second.

Stroboscopic Light (43)
KLUGE ELECTRONICS Co., 1031 North Alvarado St., Los Angeles 26, Calif. A new portable strobo-

scopic lamp with a bulb giving sunlight values for color work operates from any a-c outlet and retails for $79.50 without tax.

Compensating Attenuator (44)
DAVEN Co., 191 CENTRAL AVE., Newark, N. J. The type LAC-720

Here's How CREI Prepares You Now for a Better Job and a Secure Career in Radio-Electronics


Never before have men like you had so many chances to step into brand new jobs in brand new fields. FM, Television, Facsimile and other electronic communications systems for both government and industry will require thousands of highly trained expert radio communications engineers and technicians.

NOW is the time to take-the time to prepare yourself for these important career jobs. CREI home study training can show you the way by providing you with the "tools" with which to build a firm foundation of ability based on a planned program of modern technical training.

In our proved method of instruction you learn not only how but why! This is real, honest-to-goodness practical engineering training that leads to better jobs and more rapid promotions... the type of training for which many thousands of professional radiofmen have enrolled during the past 19 years. It costs you nothing to read the interesting facts. Write for free booklet today.

VETERANS! CREI training is available under the "G. I." Bill!

Capitol Radio Engineering Institute
E. H. RIETZKE, President
Dept. E-11, 16th and Park Road, N.W., Washington 10, D. C.

New York (17): 170 Broadway

Branch Offices:
San Francisco (2): 760 Market St.

MAIL COUPON FOR FREE 36-PAGE BOOKLET

If you have had professional or amate-

ur radio experience and want to

make more money, let us prove to you

we have the training you need to

qualify for a better radio job. To help

us intelligently answer your inquiry—

PLEASE STATE BRIEFLY YOUR BACK-

GROUND OF EXPERIENCE, EDUCATION

AND PRESENT POSITION.

GENTLEMEN: Please send me your free booklet, "Your Opportunity in the New World of Electronics", together with full details of your home study training. I am attaching a brief resume of my experience, education and present position.

Name
Street
City Zone State

CHECK □ PRACTICAL RADIO ENGINEERING

□ PRACTICAL TELEVISION ENGINEERING

□ I am entitled to training under the G. I. BILL.
PUBLIC ADDRESS

by

ACOUSTICAL

for the very best in

REPRODUCTION • DESIGN

WORKMANSHIP • SERVICE

We will gladly send you full details and specifications of the full range of ACOUSTICAL P. A. Equipment on request.

NEW SOLDERING GUN

Heats in 5 Seconds

SPECIAL SOLDERING GUN

ADVANTAGES

TIP STAYS TINNED

NO BURNING

SEE WHERE

YOU SOLDER

SOLDER AROUND

CORNERS

Service and maintenance men can save time by the fast heating of the Soldering Gun. By use of the new induction principle, 5 second soldering heat is supplied from a light weight built-in transformer.

The loop type tip gives you other advantages that are important in soldering. Good balance with weight close to your hand makes it easier to use. The narrow tip gets in between a lot of wiring with ease. Connections can be made without burning insulation. The tip can be formed readily to work in tight places.

See your radio parts distributor for a demonstration, or write direct for descriptive bulletin.

* 100 Watts
* 115 Volts
* 60 Cycles
* Intermittent Operation With Trigger Switch
* Can't Overheat or Burn Out
* Impact Resisting Case
* Handle Stays Cool
* Good Balance—Weight Close To Hand

510 NORTHAMPTON ST.

WELLER MFG. CO. Easton, Pa.

You'll build smoother performance into your phonographs, recorders and record-changers when you equip them with GI Smooth Power Motors.

Every unit in our wide line provides that combination of quick pick-up, unvarying speed and velvety operation which pleases customers and makes your selling job easier.

For smooth running and smooth selling, standardize on Smooth Power Motors.

THE GENERAL INDUSTRIES CO.

Dept. ME Elyria, Ohio

November, 1946 — ELECTRONICS
tone-compensating attenuator has been developed to facilitate authentic reproduction of the musical spectrum at any reasonable level. The device is essentially a ladder network designed so that the lower frequencies have a smaller loss than the middle register to compensate for the nonlinear response of the human ear. Six different characteristics, including a flat frequency response, can be chosen by proper connection to lugs on the unit.

Timing Motor

A. W. HAYDON ENGINEERING CO., Waterbury, Conn. The Circle B timing motor can be supplied in 1 and 5 rpm speeds, operating from 110, 220, and 24 volts, 60 cycles. It will fit in a 2-inch circle, has through holes for mounting, solder terminals, and no projecting ears or leads.

Vacuum Gage

RADIO CORP. OF AMERICA, Camden, N. J. The type EMG vacuum gage used in the electron microscope is now available as a separate assembly consisting of thermocouple, ionization tube and control unit. Rough pumping pressures are indicated by the thermocouple, whereas the tube is connected after the diffusion pump has been started. A feature of this tube is its cold cathode. There is no filament to burn out with accidental increase of air pressure. The tube is also enclosed in an oval metal shell surrounded by a strong magnetic field. The anode consists of a rectangular loop of wire embracing the maximum position of the

An Advertisement about TRANSFORMER DESIGN

...Directed to those who manufacture electronic equipment that must be MOISTURE PROOF and/or FAILURE PROOF

Chicago Transformer's

HERMETICALLY-SEALED TERMINAL CONSTRUCTION

is...

1. Permanent Proof Against Moisture
2. Impervious to Temperature Changes in the Unit or Surrounding Air
3. Unaffected by Heat Transfer from Soldering of Terminal Connections
4. Cushioned Against Mechanical Shock

These qualities stem from Chicago Transformer's use of special neoprene rubber gaskets in conjunction with ceramic bushings to seal and insulate terminals where they extend through the steel base covers or drawn steel cases. Under constant pressure, imposed by the terminal assembly itself, the gaskets are forced into and retained by specially-designed wells in the bushings.

By this method, a non-deteriorating, highly resilient seal is obtained. Its protection of the vital parts of the transformer against moisture and corrosion is equally effective in extreme heat or cold and against corrosive fumes or liquids.

As components of Army and Navy electronic apparatus, Hermetically-Sealed Chicago Transformers gained an outstanding reputation for durability and dependability under the most severe wartime operating conditions. Today, this same basic design is available to manufacturers who are building electronic equipment to comparable standards of peacetime excellence.

CHICAGO TRANSFORMER

DIVISION OF ESSEX WIRE CORPORATION

3501 ADDISON STREET · CHICAGO, I L
Specializing in the production of highest quality Alnico Magnets in all grades including new triple strength No. 5.

Production material checked to assure highest uniform quality of product.

Castings made to customer's special order on the basis of sketches or blueprints furnished.

Information and suggestions furnished on request.

MANUFACTURERS OF HIGH-COERCIVE MAGNETIC ALLOYS

The FINEST MICROPHONES for P.A. and RECORDING!

AMPERITE VELOCITY MICROPHONE WITH PATENTED ACOUSTIC COMPENSATOR

New P.G. DYNAMIC WITH NEW SUPERIOR ELIPSOID PICK UP PATTERN!

AMPERITE KONTAK MIKES IDEAL FOR AMPLIFYING STRINGED INSTRUMENTS USED WITH ANY AMPLIFIER AND WITH RADIO SETS.

ASK YOUR JOBBER...WRITE FOR FOLDER

SILICONE FLUIDS AS LIQUID DIELECTRICS—DC 200 Fluids are used in liquid filled condensers because of inherent stability, inertness to moisture, and a dielectric constant and power factor which change very little over a wide frequency spectrum. For additional data on DC Silicone Fluids, write for catalog No. N 11.

DOW CORNING CORPORATION MIDLAND, MICHIGAN


In Canada: Dow Corning Products Distributed by Fiberglas Canada, Ltd., Toronto

254 November, 1946 — ELECTRONICS
magnetic field. The gage units are provided with standard threaded fittings, and leads with plugs to attach to the appropriate jacks in the control unit. Pressures as low as 0.1 micron can be accurately measured.

**V-T Voltmeter** *(47)*
FREED TRANSFORMER CO., INC., 72 Spring St., New York, N. Y. The No. 1040 vacuum-tube voltmeter has a range from 0.001 to 100 volts with an accuracy of 2 percent for sinusoidal voltages. Frequency range is 10 to 200,000 cycles with 0.1 db variation. The power supply is contained in the metal cabinet.

**Miniature Phototubes** *(48)*
CONTINENTAL ELECTRIC Co., Geneva, Ill. Cetron tubes CE-58 and CE-60 measure 1½ inches in length and have a diameter of 25/64 inch. The former tube is gas filled, has a red-sensitive surface and is available in two sensitivities, 80 or 150.
FOR RADIO AND ELECTRONICS
PARTS • SETS • EQUIPMENT
ask NEWARK they'll have it!

IF YOUR NEEDS in radio or electronics parts, sets or equipment are available

anywhere, you'll save time by phoning or wiring Newark Electric. Tremendous, up-to-the-minute stocks are maintained in all three stores.

COMPETENT TECHNICAL MEN handle your inquiries intelligently and promptly and can quote prices and delivery dates on specific merchandise. Orders shipped same day. When writing address Dept. R-2

NEW YORK CHICAGO

N.Y.C. Dept. B-2
P. A. Dept. in all stores. Set & Appl. Deps. in N. Y. C.

NEWARK ELECTRIC COMPANY, INC.

Please send informative literature on the following:

NAME: ____________________________________________
ADDRESS: ________________________________________
CITY: _____________________________________________
STATE: ___________________________________________

A TR

LOW POWER INVERTERS
FOR INVERTING D.C. TO A.C.
Another New ATR Model... designed for operating small A.C. motors, electric razors, and a host of other small A.C. devices from D.C. voltages sources.

STANDARD AND HEAVY DUTY INVERTERS
FOR INVERTING D.C. TO A.C.
Specially designed for operating A.C. radios, television sets, amplifiers, address systems, and radio test equipment from D.C. voltages in vehicles, ships, trains, planes, and in D.C. districts.

WRITE FOR NEW CATALOG—JUST OFF THE PRESS!

AMERICAN TELEVISION & RADIO CO
Quality Products Since 1911
ST. PAUL, MINN., U.S.A.

November, 1946 — ELECTRONICS

www.americanradiohistory.com
NEW PRODUCTS (continued)

microamperes per lumen. The CE-60 is blue-sensitive with either standard commercial sensitivity of 14 microamperes per lumen, or 25 for experimental use. Detailed specifications are available.

Core-Loss Tester (49)

GENERAL ELECTRIC CO., SCHENECTADY, N. Y. A new instrument to measure a-c permeability and core loss in steel samples is a self-con-

ained, desk-type unit. The apparatus meets ASTM specifications for measurements at commercial power frequencies and inductions up to 18 kilogausses.

F-M Antenna Coupler (50)

E. F. JOHNSON Co., Waseca, Minn. Broadcasters desirous of using existing a-m transmitting towers for

initial f-m antenna installations are often faced with the problem of feeding the new antenna without short-circuiting the a-m radiator or

HERE'S THE TROUBLE!
Rotobridge indicates defective circuits by number, enabling a service man to examine the numbered inspection tag, and find the defect without the use of conventional measuring equipment.

SPEED — Rotobridge makes bridge-type measurements, comparing completed units against your engineering standard. Tests are made right on the assembly line at the rate of a circuit a second.

ACCURACY — Rotobridge automatically checks wiring errors, resistance and reactance values on all types of communication, electrical and electronic equipment. It can be operated by unskilled labor—and since the human element is almost entirely eliminated, specified tolerances are absolutely maintained.

VERSATILITY — Rotobridge is adaptable to several small sub assemblies, or a complete set comprising as many as 120 circuits. Two or three Rotobridge units working simultaneously will inspect a 30 or 40 tube set-up—in five minutes.

WRITE TODAY FOR BULLETINS

COMMUNICATION MEASUREMENTS LABORATORY
120 Greenwich St., New York 6, N. Y.

SALES OFFICES
CHICAGO: 612 N. Michigan Ave.
WASHINGTON: 924 19th St. N. W.
PHILADELPHIA: Ridge & Crawford
Big Savings with PALNUT
Coil Tube Fasteners

DOES 3 JOBS!

1. Provides required tension on iron core adjusting screw to maintain accurate setting, thru use of specially designed Palnut thread form.

2. Provides support for the RF or IF coil tube. All coil tube length above chassis is usable electrically, as fastener does not extend above chassis.

3. Snap the assembly into chassis, shield can or terminal board. Provides absolute security and rapid assembly.

SAMPLES of this new, speedy, efficient Palnut Coil Tube Fastener, plus engineering data, sent upon request on your business stationery.

The PALNUT Co.
17 CORDELL ST., IRVINGTON 11, N. J.

NEW PRODUCTS
introducing crosstalk on the f-m frequency. The iso-coupler allows operation of 10-kilowatt f-m transmitters on 50-kilowatt a-m towers, matching 50-ohm lines from the f-m transmitter. The unit is furnished in a 94 x 37 x 24 inch outdoor cabinet.

Composition Resistors (51)
GENERAL ELECTRIC CO., Wolf St. Plant, Syracuse, N. Y. Composition resistors in standard RMA values capable of operation at full rating up to 168 F have been announced. They are humidity-resistant and have strong pigtail leads that are heavily tinned. Up to 350 volts rms can be continuously applied across the half-watt unit and 1,000 volts across the two-watt resistor.

Welding Sequence Timer (52)
GENERAL ELECTRIC Co., SCHENECTADY, N. Y. A new line of sequence timers using electronic timing circuits has been developed. Quick change of welding sequence, easy inspection and remote operation are features of the units that utilize...
A MOST COMPACT RHEOSTAT

Type 2462F is designed for relatively low wattage, and it fits into an exceptionally small space. From the back of the panel it measures only 3/4 of an inch.

Its terminals are ideal for easy, rapid crimping and soldering.

The shaft and bushing are fully insulated from the contact mechanisms, so the rheostat can be mounted on a metal panel. And this little 10 watt rheostat is tested for 1500 volt breakdown.

Other types of Hardwick-Hindle rheostats, and our many resistors offer you valuable exclusive advantages also.

Write us today. Our engineers are always at your service.

HARDWICK, HINDLE, INC.
RHEOSTATS and RESISTORS
Subsidiary of THE NATIONAL LOCK WASHER COMPANY
NEWARK 5, N. J.  ESTABLISHED 1886  U. S. A.

Telemchron uses PARAMOUNT PAPER TUBES

PARAMOUNT Paper Tubes are used for coils in the field assembly of the motor in this Telemchron electric clock, the "Telechron, Jr.," as in all electric clocks made by Telemchron, Inc., Ashland, Mass.

This is typical of the wide use of PARAMOUNT paper tubes by leading manufacturers of electrical, radio and electronic products. With over 15 years of specialized experience, PARAMOUNT can produce exactly the shape and size tubes you need for coil forms or other uses. Square, rectangular, or round. Hi-Dielectric, Hi-Strength. Kraft, Fish Paper, Red Rope, or any combination, wound on automatic machines. Tolerances plus or minus .002". Made to your specifications or engineered for you. Samples and prices on request.

Write for Arbor List of over 1000 sizes INSIDE PERIMETERS FROM .592" TO 19.0"

PARAMOUNT PAPER TUBE CORP.
616 LAFAYETTE ST., FORT WAYNE 2, INDIANA
Manufacturers of Paper Tubing for the Electrical Industry

**Rotary Stylus Record** (53)

**CONNECTICUT TELEPHONE AND ELECTRIC DIVISION, Meriden, Conn.**

A new inkless recorder has been designed particularly for plotting 48 complete stress-strain diagrams at one time. The size of each diagram is 5 x 2½ inches. The number of scanning cycles for 48 gages is 8 per minute with a maximum sensitivity for full diagram height of 1,000 microinches per inch.

**Literature**

(54)

Receiver Information. Howard W. Sama & Co., 2924 East Washington St., Indianapolis, Ind. Photo Fact Folder Set No. 3 has recently been received by subscribers to the service. Each 4-page leaflet contains complete servicing information, photographs and a wiring diagram of a single broadcast receiver. When bound together, the leaflets form a complete service encyclopedia.

(55)

Fidelity Recorder. Electronic Chemical Engineering Co., 443 So. La Cienega, Los Angeles 36, Calif. The Electrone-Tone uses motion picture film for recording up to five tracks on a 16-mm strip. Other widths give a corresponding increase or decrease in the number of tracks. Film is developed in the conventional manner. A four-page booklet illustrates the equipment that is said to record up to 10,000 cycles.

(56)


**NEW PRODUCTS**

(continued)
FOR THE MOST EXACTING APPLICATIONS

Where dependability and economy are vital, leading manufacturers specify Westfield nuts of special design.

Send us your drawings and specifications for recommendations and prices.

WMP
WESTFIELD METAL PRODUCTS CO. Inc.
WESTFIELD, MASS.

Custom Made Nuts In Brass, Steel and Various Alloys

MICRO-MIKER

A new type of instrument for the measurement of small capacities

1. Measures capacities from 1 to 230 Micro-Micro-
Farads by direct substitution.
2. This capacity is measured at the end of a shielded cable, thereby eliminating connection errors.
3. Wiring capacity in an amplifier may be measured without disconnecting the load resistor. Condensers as small as 1 MMF may be measured when shunted by a 1500 ohm resistor.

WRITE FOR BULLETIN 4B

KALBFELL LABORATORIES

441 ROSECRAINS ST. • SAN DIEGO 6, CALIF.
Manufacturers Representatives are invited to reply.
are well known. A new technical bulletin presents the uses and characteristics of "dag" solutions.

(57)

Technical Publication Resumed. Collins Radio Co., Cedar Rapids, Iowa. "The Collins Signal" will shortly resume publication after a lapse of several years. Engineers desiring the free publication should write the editor.

(58)

Diffusion Pump Fluids. Dow Corning Corp., Midland, Mich. A pamphlet describes a method of obtaining high vacuums up to $5 \times 10^{-4}$ by use of silicone fluids DC702 and DC703 to eliminate breakdown of pumps formerly using low-vapor-pressure fluids.

(59)


(60)

Rectifier Ratings. General Electric Co., Schenectady, N. Y. The industrial phonatron FG-32 is a low-frequency, low-voltage, high-current rectifier tube. Increased temperature ratings have just been announced and are listed in a publication of the Tube Division.

(61)


(62)

Ship-to-Shore Radiophone. Radio-Marine Corp. of America, 75 Varick St., New York 13, N. Y. Model ET-8027 radiotelephone equipment has six crystal-controlled channels and a power output of 25 watts. It operates in the frequency range...

---

SELECT THE NEW G-E CALROD SOLDERING IRONS WITH THE "NON-FREEZING," EASY-TO-REPLACE, COLORIZED COPPER TIPS. THEY SIMPLIFY MAINTENANCE IN YOUR SHOP. GENERAL ELECTRIC COMPANY, SCHENECTADY 5, NEW YORK.
TERMINALS for ELECTRIC WIRES

Condenser Plates
Small Metal Stampings
  - in accordance with Customer's Prints

• ACCURACY
• PRECISION
• REASONABLE DIE CHARGES

Modern Equipment and Factory
No Screw Machine Parts

PATTON-MACGUYER COMPANY
17 VIRGINIA AVENUE PROVIDENCE, R. I.

BOOKS FOR THE ENGINEER

UNDERSTANDING MICROWAVES
(Chapter Heads)
The Ultra High Frequency Concept
Stationary Charge and its Field
Magnetostatics
Alternating Current and Lumped Constants
Transmission Lines
Poynting's Vector and Maxwell's Equations
Waveguides
Resonant Cavities
Antennas
Microwave Oscillators
Radar and Communication

Section Two is devoted to descriptions of Microwave Terms, Ideas and Theorems. Index.

A-C CALCULATION CHARTS
Student engineers will find this book invaluable. Simplifies and speeds work. Covers all AC calculations from 10 cycles to 1000 megacycles.

160 PAGES  PRICE  $7.50

JOHN F. RIDER, Publisher, Inc.
404 FOURTH AVENUE, NEW YORK 16, N. Y.

ELECTRONICS — November, 1946
The Original
SPINTITE WRENCH
SPINS With Ease and Speed
Encourages nimble hands along the assembly line. Made in eleven sizes from 3/16" to 5/8" square, hex or knurled .

2,000 to 3,500 kilocycles and is fully described in a 4-page bulletin PC101.

Thermal Relay. Thomas A. Edison, Inc., West Orange, N. J. The model 501 thermal relay is in effect a thermal time-delay device, preset and sealed. Publication No. 3007X tells all about it.

Contract Manufacturer. Lewyt Corp., 60 Broadway, Brooklyn 11, N. Y. Some of the manufacturing facilities and contracting arrangements of the company are described in newspaper clipping pasteup form bound into a 16-page brochure.

Connectors. Cannon Electric Development Co., 3209 Humboldt St., Los Angeles 31, Calif. Descriptive of applications is a 78-page loose-leaf book picturing Cannon plugs. There is no specific engineering or ordering information in this interesting publication.

TELEVISION OVER BIKINI

Practicing for the atom bomb tests at Bikini, Captains Davis and Seldomridge direct the takeoff of a pilotless B-17. The television receiver in the foregound shows the instrument panel of the bomber while the small control box is used to direct the takeoff and landing. The mother plane controls the B-17 in the air.

The Original
SPINTITE WRENCH
SPINS With Ease and Speed
Encourages nimble hands along the assembly line. Made in eleven sizes from 3/16" to 5/8" square, hex or knurled .

2,000 to 3,500 kilocycles and is fully described in a 4-page bulletin PC101.

Thermal Relay. Thomas A. Edison, Inc., West Orange, N. J. The model 501 thermal relay is in effect a thermal time-delay device, preset and sealed. Publication No. 3007X tells all about it.

Contract Manufacturer. Lewyt Corp., 60 Broadway, Brooklyn 11, N. Y. Some of the manufacturing facilities and contracting arrangements of the company are described in newspaper clipping pasteup form bound into a 16-page brochure.

Connectors. Cannon Electric Development Co., 3209 Humboldt St., Los Angeles 31, Calif. Descriptive of applications is a 78-page loose-leaf book picturing Cannon plugs. There is no specific engineering or ordering information in this interesting publication.

TELEVISION OVER BIKINI

Practicing for the atom bomb tests at Bikini, Captains Davis and Seldomridge direct the takeoff of a pilotless B-17. The television receiver in the foregound shows the instrument panel of the bomber while the small control box is used to direct the takeoff and landing. The mother plane controls the B-17 in the air.
For thirty-five years we have been leaders, specializing in the creation and production of distinctive etched and lithographed products. We serve the leaders of many industries, meeting their high standards of quality and precision workmanship. Send for new pamphlet.

**NEW 15" TUBE for Television**

High Vacuum, High Brilliance, Magnetic Focus & Deflection, Black & White Screen. Length 20¼", Face Plate approximately Flat. Operates anywhere from 8,000-15,000 Volts, best at 12,500 Volts. Write for full data. Also in production 12-inch magnetic tubes.

**NO ION SPOTS — NO ION TRAP**

**ZETKA LABORATORIES, INC.**
131 GETTY AVE., CLIFTON, NEW JERSEY

Affiliated with
UNITED STATES TELEVISION MFG. CORP.

**The STOUT HEART of World Famous Hathaway Oscillographs is the Type OA-2 Galvanometer**

Bifilar moving element, low mass, ultra-simple, takes less driving energy. Complete in one unit, with magnet and universal mounting. Natural frequency, 10,000 cycles per sec. Sensitivity to 50 millimeters per milliamperes at one meter.

There's a HATHAWAY Oscillograph to meet every requirement — Hathaway specialized service to help apply it to your problems. Write for information on Hathaway Oscillographs and Galvanometers. Hathaway Instrument Company, 1315 S. Clarkson St., Denver 10, Colorado.

ELECTRONICS — November, 1946
NEWS OF THE INDUSTRY

Edited by JOHN MARKUS

Rochester Fall Meeting announcement; radio production for August; color television demonstration; meetings to come

New RMA Tube Designations and Wiring Standards

Two new RMA standards, a chassis wiring color code and a new type designation system for tubes other than receiving and cathode-ray types, have been approved by the Engineering Department of Radio Manufacturers Association and are now in effect among its members.

Where color coding is used, it shall be standard to employ the following schedule of solid colors for chassis hookup and component-lead wire insulation:

- **Black**—Grounds, grounded elements, & returns
- **Brown**—Heaters or filaments, off ground
- **Red**—Power supply & plus
- **Orange**—Screen grids
- **Yellow**—Cathodes
- **Green**—Control grids
- **Blue**—Plates
- **Violet**—Not used

For tubes and devices exclusive of receiving and cathode-ray tubes, the type designation shall consist of a pure numeric starting with 5500 and shall be assigned consecutively and chronologically in the order of type number request. A new type designation shall be assigned to a new version of a prototype whenever the new version is not completely interchangeable with the prototype. Whenever a new designation is assigned to a type which is unilaterally interchangeable with a former type, such interchangeability may be indicated by marking the new type with its assigned designation followed, at the option of the manufacturer, by the designation of the former type. The new system is not retroactive. Typical type designations are 5501, 5512, 5923, 6234, and 6545, as contrasted to designations like 1C23, 1N35, and 6D25 under the system previously in effect.

Moscow Radio Meeting

A fourteenth-man delegation from various government agencies represented the United States at a five-power preliminary telecommunications meeting held in Moscow recently for informal preliminary discussions aimed at convening of a world telecommunications conference sometime in 1947. This conference would revise the Madrid telecommunication convention of 1932, now in effect.

Navy Expands Training of Electronic Technicians

The basic course for electronic technician's mates in the Navy has been broadened from 20 weeks to 42 weeks, with classroom and

"... PRODUCED MORE THAN FIFTY PERCENT OF ALL RADAR ..."
Almost every radio set made in recent years has a Magnavox speaker or other Magnavox components.

MAGNAVOX...first and foremost in the production of quality speakers

FOR 35 years Magnavox has specialized in speakers and speaker satisfaction. The oldest and largest manufacturer of loud speakers, Magnavox is established as the standard of quality.

Magnavox designers and engineers have achieved a breadth of experience and knowledge that enables them to meet your specifications exactly. Over 160 different speakers are produced expressly for the manufacturing trade.

Hard-to-satisfy research engineers constantly seek better speaker designs and production methods. They stand ready to apply their developments to your speaker problems. When you need speakers, specify Magnavox. There is no substitute for experience. The Magnavox Company, Components Division, Fort Wayne 4, Indiana.

MAGNAVOX has served the radio industry for over 30 years

SPEAKERS • CAPACITORS • ELECTRONIC EQUIPMENT

ELECTRONICS — November, 1946

www.americanradiohistory.com
Electricity

FOR RADIO AND ELECTRONIC APPLICATIONS

ONAN ELECTRIC GENERATING PLANTS
supply reliable, economical electrical service
for electronics and television applications as well as for scores of general uses.
Driven by Onan 4-cylinder gasoline engines, these
power units are of single-unit, compact design
and sturdy construction. Suitable
for mobile, stationary or emergency service.
Capacity range: 250 to 10,000
watts; 115 to 660 volts A.C.,
50 to 100 cycles; 6 to 500
volts D.C.; combination A.C.
and D.C. types.

D. W. ONAN & SONS
3557 Royalton Ave.,
Minneapolis 5, Minn.

SAFE • SURE • SIMPLE

PROTECTION FOR COSTLY TUBES

Cramer PRECISION MODEL C TIME DELAY RELAY
Here is a simple, dependably accurate and rugged control which has been specified by many radio engineers because it has been especially designed for tube protection. Providing a fixed time delay (with adjustable feature), its flexibility of design permits special combinations and circuit arrangements which our Engineering Department can adapt to your requirements. Get the long run economy of accurate, highly dependable and ruggedly designed Cramer Time Controls at comparable initial cost. Write us today for engineering bulletins.

THE R. W. CRAMER COMPANY, Inc.
Box No. 3, Centerbrook, Conn.

SPECIALISTS IN TIME
AS A FACTOR OF CONTROL

August Radio Output

A total output of 1,442,757 radio sets was reported for August by RMA member-companies, and the corresponding Bureau of Census figure is 1,700,000 sets by the entire industry. RMA figures break down into 101,744 console and radiophonograph combinations, 13,892 f-m sets, 1,050,183 table models of the electric type, and the rest battery and auto sets.

The latest OPA list of radio manufacturers includes names of 211 producers and 20 nonproducers of radio sets, along with 176 manufacturers and 10 nonmanufacturers.

Revisions in Program of Rochester Fall Meeting

The technical program of the Rochester Fall Meeting, scheduled for Nov. 11, 12, 13 at the Sheraton Hotel, Rochester, N. Y., has been modified from the setup given on page 262 of the Oct. 1946 issue as follows:

Monday Nov. 11, 2:00 p.m. session, add Measurement Methods for Ferromagnetic Materials, by H. W. Lamson of General Radio Co., and remove this paper from the last Wednesday session.

Tuesday Nov. 12, 9:30 a.m. session, Some New Tube Developments will be presented by F. E. Gehrke of Sylvania Laboratories instead of M. A. Acheson. An additional paper in this session is Wide Band 1-f Amplifiers Above 150 MC, by M. T. Leibebaum of Airborne Instruments Laboratory, Inc.

Wednesday Nov. 13, 9:30 a.m. session, add Application of Selenium Rectifiers to Receiver Designs, by H. Heus and T. M. Limatina of Sylvania Electric Products Inc. 2:00 p.m. session, add High Frequency A-M Broadcasting Designed for Small Community Use, by Sarkes Tarzian, A. Valtetino, and M. Weijdel, consulting engineers. 9:00 p.m. photographic session—Recent Developments in Color Photography, by A. L. Torgers of Eastman Kodak Co.

Laboratory instruction increased from 800 hours to 1,680 hours. Upon completion, the students receive practical experience at sea or shore stations before becoming eligible for the 28-week advanced course. These two courses cover radio, radar, sonar, loran, and other recently developed applications of a secret or confidential nature. In addition, advanced and specialized courses in specific equipments such as blind-landing and television are given.
MICROPHONE NEWS
The NEW St. Louis OUTDOOR RUGGED MICROPHONE

One of the "Finest Line of Modern Dynamic Microphones." Each engineered to fit your specific applications. Modern design—Rugged construction. Ranges: 40 to 9000 Cycles. Built to take the toughest treatment under the worst operating and climatic conditions. Alnico V Magnet. Variable impedance output adjustable to low, 200, 500 or high, Gummetal Gray, Black Lacquer or Olive Drab Finishes.

Write today for further information on the Complete St. Louis Line. Licensed under patents of the American Tel. & Tel. Co. and Western Electric Company, Inc.

ST. LOUIS MICROPHONE CO.
2726-28 Brentwood Blvd.
St. Louis 17, Missouri

HEYCO SOLDERING LUGS
Available in various sizes and shapes. Their copper lugs are easy to apply. Samples free.

HEYCO STRAIN RELIEFS
Three low-cost types. Prolong appliance life... Improve product performance... Act as grommet. Samples and literature.

HEYMAN MANUFACTURING CO.
510 Michigan Ave. Kenilworth, N. J.

Complete plastic fabrication "ALL UNDER ONE ROOF"

Measuring 1¾" x 2½" x 1¾", this acrylic stand-off insulator holds vertical whip antennas erect in marine radio installations. A brass strip with wing nut swings open to permit easy removal for low-bridge underpassing. This is another typical example of Printloid's ingenuity with plastics.

Write for our new 1946 catalog of special plastic fabrications.

"The House That Plastic Built"

VOLT METERS FOR EVERY RF NEED...

PERMANENT ACCURACY, HIGH STABILITY AND IMPEDANCE INPUT! You get all three with each of these three voltmeters. Suitable for laboratory, test bench or production line. Each has a frequency and voltage range adaptable to your particular needs... sturdy construction; easy-to-read meter scales.

HIGH FREQUENCY ELECTRONIC VOLTMETER MODEL VM-27A
RANGE: 0.1 to 100 volts in five ranges: 0.1, 1, 10 and 100 volts full scale.
ACCURACY: 2 per cent of full scale on all ranges in equivalent voltage.
CALIBRATION: Calibrated to read 0.167 of full scale in 10 volt range; 0.1 volt in 1 volt range; 0.1 microvolt in 0.1 volt range.
FREQUENCY RANGE: 500 kilocycles to 500 megacycles.
INPUT IMPEDANCE: 10 micro-ohms to 1000 megohms.
POWER SUPPLY: 115 volts 50 cycles at 30 watts.
TUBES: One 6AL5 in probe, two matched 6J5GT and one 6X5GT rectifier.
DIMENSIONS: 3½ x 2½ x 2²/₃"
WEIGHT: 3 lbs.
PRICE: $99.50 F.O.B. Flushing, N. Y.

HIGH VOLTAGE ELECTRONIC VOLTMETER MODEL VM-27E
RANGE: 10 to 10,000 volts ± 1 per cent in five ranges: 100, 300, 1000, 3000 and 10,000 volts full scale.
ACCURACY: 5 per cent of full scale on all ranges in equivalent voltage.
REQUENCY RANGE: 40 kilocycles to 100 megacycles.
INPUT IMPEDANCE: Approximately 1 micro-microfarad at a 0.1 microfarad capacity.
POWER SUPPLY: 115 volts 50 cycles at 30 watts.
TUBES: One 6AL5 in probe, two matched 6J5GT and one 6X5GT rectifier.
DIMENSIONS: 5½ x 2½ x 2²/₃"
WEIGHT: 8 lbs.
PRICE: $205.00 F.O.B. Flushing, N. Y.

ALFRED W. BARBER LABORATORIES * FLUSHING * NEW YORK
34-06 FRANCIS LEWIS BLVD.
Live Pickup Demonstrated with UHF Color Television

SUCCESSFUL DEMONSTRATION of color television for live pickups has been announced, using a studio-type orthicon. Images were viewed in a fully lighted room. Color breakup in fast sports scenes such as boxing was not discernible, according to the CBS press release. Remote live pickup color equipment for both outdoor and indoor events is scheduled for operation by the end of the year. A new aluminum-backed cathode-ray receiving tube that concentrates the light on the viewing screen was used in the receivers.

Radio for Private Fliers

TWO NEW FREQUENCIES to be used by private aircraft will be guarded by the Civil Aeronautics Administration beginning Jan. 1, 1947. These are 121.1 mc for air to ground communication, and 122.5 mc for air to ground communication at airport control towers. The present frequencies 131.7 and 131.9 mc for these purposes will continue to be guarded. It is expected that some time may elapse before all municipal and private airports acquire the necessary vhf equipment to match this CAA service for private fliers.

MEETINGS TO COME

Nov. 11-13; Rochester FALL MEETING; Sheraton Hotel, Rochester, N. Y.; technical papers and exhibits.

Nov. 11-14; INTERNATIONAL MUNICIPAL SIGNAL ASSOCIATION; Annual Meeting; Miami, Florida; technical program and exhibits.

of phonographs. OPA officials believe that many newcomers dropped out upon receiving unsatisfactory price ceilings or have stopped producing as well-known brands became plentiful.

So little...

Plug-In Sensitive Relays—More Compact Than Ever Before

SIGMA Type 41 RO (DC); 41 ROZ (AC)

NEW FEATURES OF THIS DESIGN:

- Fits octal socket.
- Outline dimensions: 1\(\frac{3}{4}\)" x 1\(\frac{3}{4}\)" x 2" above socket.
- Permits lining up contiguous relays as close together as the smallest octal sockets will permit.

Features of All SIGMA Series 41 Relays:

- DC sensitivity: 0.020 watts (min. input.)
- AC sensitivity: 0.1 volt-ampere (min. input.)
- One standard 110 volt AC model draws about 1.5 milliampere.
- Contact ratings up to 15 amperes on low voltage.
- High quality construction—mechanically rugged.
- Very low cost.
T2 lampholder, molded of bakelite, holding lip, dia. 13/16". Tip of lamp bulb protrudes sufficiently to be removed from front of panel without use of special tool.

Very low current consumption bulb (0.038 max. amp. on 24 volts). Series resistor of small size on 120-220-440 volts, etc.

T2PC Lens-cap, molded in plastic, T2MC Lens-cap, metal with glass lens.

WRITE TODAY FOR CATALOGUE

THE H. R. KIRKLAND COMPANY
8 King Street Morristown, N. J.

---

New! PRESSUREGRAPH
LINEAR PRESSURE — TIME — CURVE INDICATOR

Indicates in linear response, on screen of cathode ray oscillograph, the pressure-time curve of any internal combustion engine, pump, airline, or other pressure system where pressure measurements are desired. Covers wide range of engine speeds and pressures up to 10,000 p.s.i. Screws into cylinder and can be calibrated using static pressures. Vibration-proof. Accurate, dependable for frequent engine tuning. Simple operation—only one control.

Also Pioneer Manufacturers of

THE FAMOUS Electo BATTERY ELIMINATORS

A complete line—Models for use anywhere beyond high line connections (operate from 6 volt battery)—Others for operation from 110 volt AC. Improve radio reception. Greatly reduce battery drain.

For complete information write

ELECTRO PRODUCTS LABORATORIES
549 W. Randolph St., Chicago 6, Ill. Phone State 7444

An entirely new vista in circuit conception and development now possible with Victoreen sub-miniature electrometer vacuum tubes.

**Actual Size**

Consider these factors for research...laboratory...production:

1. Low filament drain 10 milliamperes.
2. High input resistance 1016 ohms.
3. Versatility in instrumentation for chemical, oil, nuclear physics research, etc.
4. Ideal for electrometer applications.
5. Extreme portability—low battery drain.

Available As

Diodes
Triodes
Tetrodes
Pentodes

Actual size

Victoreen hi-megohm resistors are specially designed for the hard applications where stability with long life is required. Designed for laboratory use and fine instrumentation. Vacuum sealed in glass to cover a range of 100 to 10,000,000 megohms.

Write for technical data booklet on tubes and resistors.

**NEWS OF THE INDUSTRY** (continued)

cover fire and police radio, signaling, etc.

**Nov. 19-21; Communications Section, Association of American Railroads; Annual Session; Hotel Statler, Detroit, Mich.; four papers on communications subjects.**

**Nov. 18-22; The National Metal Exposition; Municipal Auditorium, Atlantic City, N. J.; held in conjunction with annual meetings of The American Industrial Radium and X-ray Society, The American Welding Society, The American Society for Metals, and two sections of the American Institute of Mining and Metallurgical Engineers. Of more than 70 technical papers to be delivered at ASM meetings, one each day in the afternoon will be devoted to Electronic Methods of Inspection of Metals.**

**Dec. 2-7; National Power Show; Grand Central Palace, New York City.**

**Dec. 5-7; Joint EMSA and ASXRED Winter Meeting; Mellon Institute of Industrial Research and Univ. of Pittsburgh, Pittsburgh, Pa.; sponsored by Electron Microscope Society of America and American Society for X-ray and Electron Diffraction; make dinner reservations with Dr. Max Lauffer, Univ. of Pittsburgh.**

**Jan. 23-26; Society of the Plastics Industry; technical papers and exhibit; Edgewater Beach Hotel, Chicago.**

**Jan. 27-31; Electrical Engineering Exposition; held concurrently with AIEE winter convention; 71st Regiment Armory, New York City.**

**Jan. 27-31; International Heating and Ventilating Exposition; Lakeside Hall, Cleveland, Ohio.**

**BUSINESS NEWS**

Bendix Aviation Corp. has been for many months engaged in research on controls and engine accessories for guided missiles and pilotless aircraft, with Dr. Harner Selvidge, formerly of Johns Hopkins University, as director. Two laboratories are devoted exclusively to help you with your sheet metal fabrication requirements.

**S. Walter Co.**

**PRECISION SHEET METAL PRODUCTS**

144 - 146 CENTRE STREET

BROOKLYN 31, NEW YORK

Tel. MAIN 4-7395

November, 1946 — ELECTRONICS
Optical Glass Specialties

Television Reflectors

Precision-polished optical face plates for cathode ray tubes

Optical lenses, prisms and flats

FS Precision-Bore Glass Tubes with bore exact within .0002"

Contact us for such requirements

FISH-SCHURMAN CORPORATION
230 East 45th St., New York 17, N. Y.

Free Radionic Catalog

GRACOIL

"One Good Turn – or a Million"

* Here, in expanded plant facilities, GRACOIL Coils and Transformers are expertly designed and built to exact specifications. Plan your next product with GRACOILS.

THE GRAMER COMPANY
Established in 1935
Electrical Coils and Transformers

2736 N. PULASKI RD., CHICAGO 39, ILL. U. S. A.
NEWS OF THE INDUSTRY (continued)

to this work, one at the Eclipse-Pioneer division in Teterboro, N. J., with R. Beardsley Graham as chief engineer, and the other at the Pacific division in North Hollywood, California with Rollin M. Russell as executive engineer.

North American Philips Co., Inc. has moved its Wire Division from Dobbs Ferry, N. Y., to Lewiston, Maine. A new addition has been erected to house the added production operations there.

A. W. Franklin Mfg. Corp. has relocated in a modern new building at 43-20 34th St., Long Island City, N. Y.

The Indiana Steel Products Co. has acquired approximately 14 acres of land along the Saw Mill River Parkway in Greenburgh, New York as a site for their proposed new and ultramodern plant to be used largely for production of special products in the permanent magnet field.

Sentinel Laboratories, Philadelphia, Pa., has opened an electronics engineering service for research, design, and development.

Sterling Electronic Co., Pasadena, Calif., has been formed recently with J. S. Jackson, Jr., as president, and production of electronic volt-ohmmeters is under way.


McGraw-Hill Book Co., Inc., New York, N. Y., announces a change of policy whereby catalog descriptions of their books will contain the year of publication or last revision. Prices on approximately 90 percent

November, 1946 — ELECTRONICS
EISLER EQUIPMENT*

...COMPLETE AND DIVERSIFIED FOR EVERY PHASE OF ELECTRONIC MANUFACTURE!

TRANSFORMERS of all types—furnace, distribution, power, phase changing, air, oil, induction, water cooled, plate, filament and auto-transformers. Filter chokes and inter-phase reactors.

Transformers supplied from 1/4 to 300 KVA.

24 Head Radio Tube Exhausting Machine.

EISLER Compound Vacuum Pump.

"EISLER" machines are in use and in production by 99% of all American radio tube and incandescent lamp manufacturers and throughout the world.

CHAS. EISLER
EISLER ENGINEERING CO.
751 SO. 13TH ST. [Near Avon Ave.]
NEWARK 3, NEW JERSEY

Preferred as a source of precision-made WASHERS and STAMPINGS manufactured to your specifications

CUP WASHERS for Binding Screws

WHITEHEAD STAMPING CO.
1691 W. Lafayette Blvd.
Detroit 16, Michigan

For Originality
LOOK TO

XCELITE screwdrivers give you a lifetime of efficient use. Their SAE 6150 Chrome Vanadium steel shafts are firmly anchored in tough, genuine XCELITE handles that fit your grip perfectly. XCELITE handles, ground lengthwise with the flat belt, won't slip off the screw slot easily. Keep asking your dealer for XCELITE...you'll soon see them in quantity!

PARK METALWARE CO., INC.
Dept. C.
Orchard Park, New York

Preferred by Experts

ELECTRONICS — November, 1946

You Want
Radio Technicians
with a
"High Hooper"

TO some men "radio" is a magic word: It piques their curiosity—and spurs them to action! Their every thought is devoted to mastering the complex mechanisms by which radio is controlled.

Experience has proved that such men, with radio in their blood, make the finest technicians. As they say, in measuring top talent radio programs, these men have a high "Hooper"—they're tops!

It has been our good fortune to attract as students and to develop thousands of such men from "hams" into well qualified technicians in broadcasting, communications, sound, manufacturing, sales and service.

Yes, since the inception of radio we have helped direct the destinies of thousands of aspiring men seeking an outlet for their talents. During the past four decades we have acquired an interesting insight into the motives which inspire mechanically minded men to apply their skill and training to assure maximum efficiency on the job.

For this reason we believe we can be of service to you in your personnel problem—as it applies to your technical staff.

We think you'll be interested in our observations, as we apply to YOUR personnel problems. We feel certain you'll want to clip the coupon below and send for our free booklet "Report to Industry." Whether you employ one man or hundreds, you will enjoy this factal, informative presentation. Send for it today! No obligation.

NATIONAL SCHOOLS
Pioneers of Technical Trade Training Since 1903
Figueras at Santa Barbara
Los Angeles 37, California

Fill out and mail to
PUBLIC RELATIONS DIRECTOR
National Schools—Figueras at Santa Barbara
Los Angeles 37, California

Please send me "Report to Industry" No. E-11

Name:
Title:
Address:
City Zone State

275
of their books were raised as of July 1, 1946 to meet increased costs.

**Federal Telecommunication Laboratories**, Nutley, N. J., demonstrated to the press Sept. 9 an adaption of I.T.&T.'s pulse time modulation system whereby eight separate radio broadcast programs can be placed on one carrier frequency and radiated over one antenna.

**Barker & Williamson**, Upper Darby, Pa., have leased a new factory building in Bristol, Pa. for special and developmental work.

**Bendix Radio Division**, Baltimore, Md. has been granted an experimental license by the FCC for a full-color television broadcasting station, to be located in their Towson, Md. plant.

**Worner Electronic Devices**, Chicago, is moving into its own new plant in Rankin, Illinois.

**Philco Corporation**, Philadelphia, has started production of radiophonograph combinations in its new $2,250,000 plant in Philadelphia, adjoining the main Philco plants. When in full operation, the...
CAPACITORS - OIL, PAPER and ELECTROLYTIC

Illinois Condenser Company
1616 N. Throop St.
Chicago 22, Ill.

Find Out Now About ★ STAR ★ CERAMICS

There are many kinds for special uses, such as applications calling for resistance to electricity, heat, moisture, chemicals or weathering agents. There are more than a score of formulas in actual production at one time in our factory.

Send for "A Brief Survey of Technical Characteristics of Molded Ceramic Products." It is right to the point.

★

The STAR PORCELAIN CO.
Electronics Dept.
Trenton 9, N. J.

COUNT AND CONTROL FAST!

Potter Dual-Predetermined Electronic Counter

A time and money-saving instrument

- For processes requiring a rapidly repeated operation to occur after a predetermined number of counts!
- For counting and stacking sheet metal.
- For accurate control of length and spacing of slide fasteners.
- For use in automatic packaging of objects such as buttons and pills.
- And for many other operations throughout industry.

This instrument uses three to four standard Potter 4-tube counter decade circuits arranged to give two independent predetermining channels in which any number, from 0 to 10,000, may be initially set up. Each channel is alternately preset to the desired predetermined number by automatic, self-contained circuits at a speed not obtainable with predetermined mechanical counters. The input is arranged for operation with either make-contacts or sharp negative pulses. Input frequencies may be in excess of 1000 cycles per second. The output includes an ultra-high speed relay with single pole double throw contacts. The standard unit may be ordered for a total count capacity of 1000 to 10,000 with either the single or dual predetermining channels. Other count capacities on special order. Write for additional details.

ELECTRONIC COUNTER PRODUCTS
136-36 Roosevelt Avenue
Flushing, New York

POTENTIOMETERS
JACKS
RHEOSTATS
RESISTORS
PHONE PLUGS
SWITCHES
SWITCH STACK ASSEMBLIES
"T" AND "L" PAD ATTENUATORS

CARTER RADIO DIVISION
"Twenty-five years of service to industry"

CARTER RADIO DIVISION
PRECISION PARTS CO.
213 Institute Place
Chicago 10, Illinois

Write for full details and catalogue today

ELECTRONICS — November, 1946

www.americanradiohistory.com
S U R E . . .

We don't guarantee that the NEW BUD METAL WALL TYPE SPEAKER CASE will stand up against a sledge hammer ... but we do say that it is not subject to the cracking, splitting and warping that characterize ordinary wooden speaker cases.

This new metal wall type speaker case is not only superior in appearance and construction ... but it has reproduction capabilities equal to the finest wood housings. Keyway holes are provided for wall mounting and there are four embossed feet on the bottom in case you require its use on a table or other surface. It is finished in a rich brown wrinkle. Your local distributor will be glad to show this BUD Speaker Cabinet to you!

B U D
Can Supply All Your Needs!

... with the latest types of equipment including: condensers—choke jacks — insulators plugs — leads — jewel lights and a complete line of ultra-modern cabinets and chassis.

B U D
BUD RADIO, INC.
CLEVELAND 3, OHIO

NEWS OF THE INDUSTRY

(continued)

new plant will have continuous radio production lines claimed to be the longest in the world.

ELECTRO-VOICE has combined all facilities of its three South Bend plants in one big modern plant 14 miles north in Buchanan, Michigan.

RADIO ENGINEERING LABORATORIES, INC., Long Island City, N. Y. has tentatively scheduled for Dec. 2, 3, and 4 an f-m engineering clinic to be headed by Frank A. Gunther, devoted to review of f-m theory and solution of problems facing f-m broadcast station engineers. REL engineers and outstanding engineers in the f-m field will participate.

RCA VICTOR DIVISION, Camden, N. J. has made initial deliveries of land and mobile f-m transmitters and receivers to the three Bell System companies that will provide two-way highway radiotelephone service on or in the vicinity of the Boston Post Road running between New York and Boston. Six 250-watt land transmitters will be used, operating in the 30-44 mc band.

COLLINS RADIO Co., Cedar Rapids, Iowa, maintains a technical staff at its private hangar on Cedar Rapids Municipal airport, for the purpose
MODEL 2406
Volt • Ohm Milliammeter
25,000 OHMS PER VOLT D.C.

NEW ENGINEERING
NEW DESIGN • NEW RANGES

50 RANGES
Voltage: 5 D.C. 0-10-50-250-500-1000 at 25000 ohms per volt.
5 A.C. 0-10-50-250-500-1000 at 1000 ohms per volt.
Current: 4 A.C. 0-5-1-5-10 amp.
6 D.C. 0-50 microamperes - 0-1-10-50-250 milliamperes - 0-10 amperes.
4 Resistance 0-4000-40,000 ohms - 4-40 megohms
6 Decibel -10 to +15, +29, +43, +49, +55
Output Condenser in series with A.C. volt ranges

QUADRIGA WASHERS
Meet requirements of the electronic field — QUADRIGA WASHERS, to your specifications. Prompt delivery of any quantity. Special flat, tension and spring, formed and drawn, cupped and finishing. Write for valuable catalog.

THE QUADRIGA MFG. CO.
221-A W. Grand Ave., Chicago 10, Ill.

WIRE & RIBBON for
VACUUM TUBE FILAMENTS & GRIDS

- Many sizes and alloys for a range of applications such as miniature tubes, hearing aid tubes, low-current-drain battery tubes, receiving tubes...
- Melted and worked to assure maximum uniformity and strength. WIRES drawn to .0004” diameter; RIBBON rolled to .0001” thickness...
- Wollaston Process Wire drawn as small as .00001”; made to your specifications for diameter and resistance.

SPECIAL ALLOYS made to meet individual requirements. Write for list of stock alloys.

SIGMUND COHN & CO.
44 GOLD ST. NEW YORK
SINCE 1901

ELECTRONICS - November, 1946
of installing Collins radio equipment in aircraft.

DORMITZER ELECTRIC & Mfg. Corp., Boston, Mass. has been formed by combining facilities and personnel of Wholesale Radio Laboratories and American Coil Co., and will manufacture industrial x-ray units, transformers, amplifying systems, and electromechanical devices as well as custom equipment.

PERSONNEL

ARTHUR H. JONES, now with Gray Mfg. Co., Hartford, Conn., was awarded the Legion of Merit for his wartime services as Lieutenant Colonel in the Coast Artillery Corps, where he devised new and improved methods for radar spotting of mortars.

HENRY LAVIN, recently discharged from the Navy as chief radio technician, received an appointment as field engineer for Kahn and Co., Hartford, Conn.

L. MORGAN CRAFT has been elected vice-president in charge of engineering and manufacturing for The Collins Radio Co., Cedar Rapids, Iowa. Within a few years after joining the Collins organization in 1938 he was made chief engineer, and since then has assumed increasingly greater administrative responsibilities.

L. M. Craft

W. N. Tuttle

W. N. TUTTLE of General Radio Co. received the Medal of Freedom for distinguished work in adapting blind bombing equipment and technique for introduction into the Eighth Air Force.

EDWARD F. SCHULTZ, chief engineer of Press Wireless during the war,
**Man, Here's Comfort for EARS!**

That's right, misers. The Telex MONOSET replaces hot, headache-y, old-style headphones wherever comfortable hearing is needed. Worn under the chin, the MONOSET eliminates head and ear fatigue. So far comfort for ears (your own or your customers) specify Telex MONOSET. Immediate delivery.

Weights only 1.3 oz. Fully adjustable to all head sizes. Rugged Tensite construction. Removable plastic ear tips. Frequency response: 50 to 3,000 c.p.s. Maximum sound pressure output: 200 to 400 db's per sq. cent. Available in two impedances: 120 and 2,000 ohms.

Write to Department H for information and quotations.

"Hearing At Its Best"

**Smaller Parts**

Filaments, anodes, supports, springs, etc. for electronic tubes. Small wire and flat metal formed parts to your prints for your assemblies. Double pointed pins. Wire straightened and cut diameter up to 1/3 inch. Any length up to 12 feet.

LUXON fishing tackle accessories.

Inquiries will receive prompt attention.

**Art Wire And Stamping Co.**

227 High St.
Newark 2, N.J.

**Lateral Feedback Cutter**

Driver Amplifier Combination

<table>
<thead>
<tr>
<th>Description</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>New Circuit</strong></td>
<td>16 db OVERALL FEEDBACK</td>
</tr>
<tr>
<td><strong>Thoroughly Life-Tested</strong></td>
<td>20 db STABILIZING FEEDBACK</td>
</tr>
<tr>
<td><strong>First on the Market</strong></td>
<td>35-40 db TOTAL FEEDBACK</td>
</tr>
<tr>
<td><strong>Stable—Dependable</strong></td>
<td>Thru the useful range</td>
</tr>
</tbody>
</table>

**Characteristics:** 10-12 db reserve power UNDISTORTED ±± 2 vu 30-12,000 with 30 cm/sec capability at 12 kc. Sharp cut-off at 12 kc to avoid widening groove. Overall flux feedback for stable and damping. Internal current feedback for stability. Input equalizer—instant selection of recording characteristic. Intermodulation unbelievably low. interchangeable cutters. Regular size cutter standard mounting holes. 50 watt amplifier push-pull throughout.

**Negligible Maintenance—Install It and Forget It**

"No comparison with previous systems for technical performance or listening satisfaction."

Engineering staff available for special requirements.

**Cook Laboratories**

139 Gordon Blvd. • Floral Park • New York
has joined Cook Electric Co., Chicago, and will assist in directing research on transient motion measuring instruments and electronic controls for aircraft.

ROY DALLY is now chief engineer in charge of phonograph needle and pickup design for Electrovox Co., Inc., Newark, N. J.

WILLIAM F. FRANKART has been appointed senior radio project engineer at Lear, Inc., Grand Rapids, Michigan. He was formerly chief radio engineer for Precision Specialties, Inc. of Los Angeles. Before that he was employed by Air Associates, Inc. of California as a design engineer, and previous to that was in turn assistant chief engineer at Aireon Mfg. Corp. of Kansas City and project engineer for Farnsworth Radio & Television Corp. of Fort Wayne, Indiana.

L. E. BESSEMER, formerly chief production engineer for Collins Radio Co., Cedar Rapids, Iowa, has been promoted to become general manager of the Manufacturing Division.

SAMUEL HEYMAN, formerly production manager of Aerovox Corp., becomes factory manager for the To Deutsdammann Corp., Canton, Mass.

ROBERT W. MCKIRDY, who served during the war as Electronics Liaison Officer between the Bureau of Ships and the British Admiralty Delegation, has joined Centro Research Laboratories, Inc., Briarcliff Manor, N. Y., as technical service director.

FIRST COMMERCIAL radio program was sponsored in 1922 by a Jackson Heights, N. Y., real estate company, Queensborough Corp. It paid $100 for ten minutes.

In addition to the pigtail contact model shown here, Bradley also offers cells with plug-in and nut-and-bolt mountings.

The shapes of Luxtron photocells vary from circles to squares, with every in-between shape desired. Their sizes range from very small to the largest required.

For direct conversion of light into electric energy, specify Bradley’s photocells. They are rugged, lightweight and true-to-rating.

Illustrated literature, available on request, shows more models of Bradley photocells, plus a line of copper oxide and selenium rectifiers. Write for “The Bradley Line.”
PLEASE:

Are you on the mailing list for our bulletins and catalogs? If not, you ought to be. We've probably got just what you want in parts, or complete rigs, and our prices are shaved paper-thin. So send us a note or post card. Keep smart company.

LAFAYETTE
Radio
Radio Wire Television
DEPT. EX-6 100 SIXTH AVE., NEW YORK 13, N. Y.
110 FEDERAL STREET, BOSTON 10, MASS.
24 CENTRAL AVENUE, NEWARK 2, N. J.

THE NEWEST CONTRIBUTION TO FASTER, LOWER COST METAL JOINING
EASY-FLO 45 and EASY-FLO 35

These new silver brazing alloys offer new low brazing temperatures and new low silver contents, features that make possible the faster production of strong, tight, leak-tight joints and lower costs on a wide variety of metal joining operations. They have been created by Handy & Harman, originators of the well-known silver brazing alloys, SIL-FLO and EASY-FLO. They are offered to industry now as a timely contribution to help lick two big problems - to increase production and to decrease costs.

What will these New Alloys do for you?

THAT'S THE QUESTION - You want to know if the lower flow point, lower silver content, faster spreading action and small amount of alloy required will save time and cut your costs - and how much. For a quick answer - ask your regular supplier for a free demonstration - or better still, place a trial order with him and put these alloys to your own tests on your own work.

H ANDY & H ARMAN
82 FULTON ST., NEW YORK 7, N. Y.
Bridgewater, Conn. • Chicago, I1. • Los Angeles, Cal. • Providence, R. I. • Toronto, Canada
Agents in Principal Cities

PERMANENT MAGNETS

Alloys: COBALT • CHROME • ALNICO

The making of permanent magnets is an alloy, too ... of experience, engineering, facilities. We'll be glad to tell you more. Write for bulletin.

Thomas & Skinner
THOMAS & SKINNER STEEL PRODUCTS CO.
1116 E. 23rd St., Indianapolis 5, Ind.

PRECIOUS METALS IN ALL FORMS FOR THE ELECTRONIC INDUSTRIES

PLATINUM WIRE • RIBBON FOIL
SEAMLESS TUBING

FOR A COMPLETE LIST OF OUR PRODUCTS
SEND FOR OUR NEW FOLDER, E-20
"PLATINUM, GOLD & SILVER FOR SCIENCE, INDUSTRY & THE ARTS"

THE AMERICAN PLATINUM WORKS
231 NEW JERSEY R. R. AVE.
NEWARK 5, N. J.
Western Electric
728B LOUDSPEAKER

No fooling, the first time you hear music and speech delivered by the new 728B you'll find it hard to believe you're listening to reproduced sound! New design features, developed by Bell Laboratories, make the 728B ideal for studios where high quality reproduction from a single unit speaker is a "must." For full details—Graybar Electric Co., 429 Lexington Ave., New York 17, N. Y., or...

NEW BOOKS

Scientific Instruments

Any single volume that attempts to describe scientific instruments ranging from water meters and calculating machines through cathode-ray tubes and optical devices, must be arbitrary of choice. The editor has doubtless planned his volume for a given purpose, packing it with useful information, but the final result gives the feeling of perusing a mail-order catalog. Furthermore, though not labeled as such by the publisher, this is apparently a reprint of a British book, and illustrates British instruments.—A. A. MCK.

Radioman's Handbook
Compiled by technical staff of Coyne Electrical School. Published by Coyne Electrical School, Chicago, Ill., 365 pages, $3.25.

A CONGLOMERATION of elementary radio theory, examples of arithmetical calculations used in radio, and some of the simpler tables, charts, and nomographs used by technicians rather than engineers. The level of writing is for home radio students and radio shop technicians.—J. M.

Electron and Nuclear Counters
By SERGE A. KORFF, Associate Professor of Physics, New York University. D. Van Nostrand Co., Inc., New York, N. Y., 212 pages, $3.00.

A HIGHLY COMMENDABLE survey and summary of the present state of the art of using Geiger counters and related special-purpose counters, written at an intermediate level for graduate students, workers in industrial laboratories and medical research institutions, and the many others who are finding counters to be useful tools for measurements and research. Some knowledge of atomic physics and some familiarity with vacuum-tube circuits is presupposed.

Chapter 1 analyzes progressive
CHECK AUDIO SYSTEMS
THIS NEW QUICK WAY

MAKE FREQUENCY RESPONSE
CHECKS INSTANTANEOUSLY

Invaluable for Broadcast and F. M. Stations. Laboratories production testing, and Motion Picture Sound Equipment.

SEE A COMPLETE PICTURE of the response characteristics for all types of transcription pickups, amplifiers, and audio systems with the new Sweep Frequency Transcription on 12" and 16" Vinylite. Make adjustments in your components quickly. Reveals all types of distortion and transient phenomena—frequency range 60 to 10,000 CPS. Write for free technical data sheet #104.E.

CLARKSTAN CORP.
11927 W. Pico, Los Angeles 34, Calif.

ALLIED DISCS
and
RECORDING EQUIPMENT

ALLIED Discs are favored by noted broadcasters and other users, for their high fidelity. Test them on your work. One of the first companies to make instantaneous recording equipment, ALLIED offers you the benefit of its seasoned skill.

Write for our New Descriptive Bulletin.

ALLIED RECORDING PRODUCTS CO.
21-09 43rd Ave., LONG ISLAND CITY, NEW YORK

ALLIED for everything in Electronics and Sound
Equipment for Research Development • Maintenance

1946 Catalog FREE

Largest Stocks • Complete Service
From one Central Supply Service

Leading industrial and engineering firms depend on the ALLIED Catalog as their Buying Guide for everything in radio, electronics and sound. Lists more than 10,000 quality items... radio and electronic parts, vacuum tubes, tools, test instruments, audio amplifiers, accessories... complete lines stocked by a single reliable source. Try ALLIED'S expert, specialized industrial service. Send for FREE Catalog now!

Everything in Radio and Electronics
ALLIED RADIO CORP.
833 W. Jackson Blvd., Dept. 24-L-6 Chicago 7, Illinois

SPECIAL
PARTS
DIVISION
105 LAFAYETTE ST., NEW YORK 13, N. Y.
TELEPHONE WORTH 4-6654

ALLIED'S
CATALOG

PRINTING-FINISHING SERVICE
DIALS • NAME PLATES • CALIBRATIONS
INSTRUMENT PANELS AND HOUSINGS

ALUMINUM
ACETATES
ACRYLATES
PHENOLICS
NITRATES

Printing so durable that it replaces etching, so sharp on wrinkle that it appears engraved; also perfect writing and erasing finish on both metals and plastics.

PROMPT QUOTATIONS - PROMPT DELIVERIES - SAMPLES ON REQUEST
The ANSONIA CLOCK COMPANY Inc.
SPECIAL PARTS DIVISION, 105 LAFAYETTE ST., NEW YORK 13, N. Y.

LAMINATED PLASTICS

Phenol Fibre... Water-, oil-, and chemical-resistant sheets of high dielectric strength. Supplied in black and natural color. Standard sheets approximately 49 x 49 inches. Thicknesses from .010 to 9 inches. Rods and tubes.

Vulcanized Fibre Remarkably uniform, high-grade, hard fibre in sheets 56 x 90 inches to save waste in cutting. Smaller sheets if desired. Also in standard-size rods.

FABRICATED PARTS • TAYLOR INSULATION • SILENT GEAR STOCK
We’re ready whenever you are. Send blueprints.

TAYLOR FIBRE COMPANY Norristown, Pennsylvania
Pacific Coast Plant: La Verne, California • Offices in Principal Cities

ELECTRONICS — November, 1946
PHENOL AND VULCANIZED FIBRE FABRICATIONS
by

BAER

Available now to your exact specifications!

PUNCHED, STAMPED, SHAVED, SAWED, DRILLED, MILLED, TAPPED, THREADED

If you have stiff production schedules investigate BAER facilities for volume production and accuracy. Orders for any quantities, shapes and sizes to your specifications. For details, write today for descriptive Bulletin 120.

N. S. BAER COMPANY
Craftsmen in Fibre Fabrication
7-11 MONTGOMERY ST. • HILLSIDE N. J.

IN-RES-CO RESISTORS

For dependable service in communications...

IN-RES-CO resistors are conservatively rated, compact, convenient to mount. They are available for quick delivery on short notice. Standard tolerances are 1 or 2%: closer tolerances are supplied on order. Most units are wire wound for permanent, exact resistance value. Inductive and non-inductive types included. Every component engineered for maximum stability, long life and noise-free operation. Write today for the informative IN-RES-CO catalogue — no obligation.

TYPES SB AND RB compact, accurate resistors, Sb: 1 1/16" long, max. res. 1 Meg., RB: 9/16" long, max. res. 0.5 Meg. Bath 9/16" diam. Standard tolerance 0.5%.

NEW BOOKS (continued)

changes in counter behavior as voltage is raised, and presents the terminology of counter circuits. Following chapters cover counting chambers, integrating types of ionization chambers, proportional counters, neutron counters, counters for heavy ionizing particles, nonselfquenching counters, and selfquenching counters. Chapter V gives highly practical suggestions for preparation and construction of counters, chapter VI covers errors and corrections in counting, and the final chapter covers auxiliary circuits such as quenching, coincidence, scaling, recording, voltage supply, regulating, integrating, and pulse amplifying circuits. Values of components for many of the circuits are given. A unique and valuable appendix contains a list of manufacturers of counters and associated equipment along with conventional reference and bibliography sections. All in all, this book constitutes a significant contribution to the literature of electronics.

—J. M.

Wave Propagation in Periodic Structures


Mathematical treatments of wave propagation in electric lines and filters, crystal lattices, and in an idealized elastic medium, being essentially identical, provide the theme of this short addition to the International Series in Pure and Applied Physics. For those who can make the mental jump from familiar electrical symbols to generalized notation and are not confused by the various particular physical phenomena to which the mathematics is applied, the work demonstrates how to use complex algebra and calculus in solving the problems under discussion. Wave propagation and boundary conditions of uniform systems are thoroughly analyzed. As the text was prepared from notes made by Mary H. Payne while attending the author’s lectures, explanations that
PROFESSIONAL SERVICES
Consulting — Patents — Design — Development — Measurements
in Radio, Audio, Industrial Electronic Applications

H. RUSSELL BROWNELL
Consulting Engineer
Specializing in Measurements & Testing Instruments & Techniques — Electrical — Electronic — Magnetic.
188 West 4th St. New York 14, N. Y. Chelsea 2-4208

EDWARD J. CONTENT
Acoustical Consultant
and Audio Systems Engineering, FM Standard Broadcast and Television Studio Design.
Ronbury Ratt Stamford 3-1409

DONALDSON ELECTRONICS LABORATORY
Research and Development
Shoran Radio Survey Consultant
Custom Built 'Nories', Quiet Circuits
Microclosed Sweeps - Microwave Systems
Industrial Applications
P.O. Box 440 San Antonio, Texas

STANLEY D. EILENBERGER
Consulting Engineer
INDUSTRIAL ELECTRONICS
Design — Development — Models
Complete Laboratory and Shop Facilities
6209-13—27th Ave.
Kraczak, Wis.
Telephone 2-4218

ELECTRO ENGINEERING WORKS
Specializing in High Voltage Filament and Plant Transformers for Electronic Projects
Quick Deliveries
2021 College Ave. Oakland 11, Calif.

ELECTRONIC RESEARCH ASSOCIATES
ERA will apply progressive, war-proven developments in electronic research...counting... timing... measuring... industrial controls...to your manufacturing advantage.
Room 311, 305 Linden Ave., South San Francisco, Cal.

ELECTRONEERS
Electronic Consultants
Industrial — Communications — Medical
Write or phone for preliminary survey without charge.
400 Fifth Ave. Murray Hill 2-1402
New York 17, N. Y.

ELM LABORATORIES
ELECTRONIC MECHANICAL RESEARCH & DESIGN
Patented ELM Developments include
PILKRAM Automatic Audio Program Tuner, Funeo Tape Recorder, Graphic Equalizer, Folded Loop, Scanned Xirai Holder, Hense Receiver Design.
20 South Broadway, New York Phone Hobbs Ferry 4958

PAUL E. GERST & CO.
CONSULTING ENGINEERS
Specialists in
Electrical Products Design
B. Machinery, Apparatus & Application
E. Engles and Frequency Apparatus
Electronic Radio Communications
250 W. Wacker Dr. Chicago 6, Ill.

C. M. HATHAWAY
Consulting Engineer
Research and Development
Tool & Methods Engineering
Pilot Manufacturing
1315 S. Clarkson St., Denver 10, Colorado

INDUSTRIAL DEVELOPMENT ENGINEERING ASSOCIATES
Engineering Consultants
Electronic Components, Motion Picture & Sound Equipment Development — Design — Models
5874 College Ave. Indianapolis 5, Ind.

RICHARD C. KLEINBERGER
Licensed Professional Engineer
Electronic Heating Applications
20 Cashman Road, White Plains, N. Y.

MIDLAND ASSOCIATES
Consulting Engineers
Engineering Design & Development
Television Receivers — Technical Manual
FM. Receivers — Test Instruments A.M. Receivers — Special Problems
in all phases of Electronics
1309 Lunt Ave. Chicago 26, Ill.

ALBERT PREISMAN
Consulting Engineer
Television, Radio Techniques, Video Amplifiers, Radio Networks, Industrial Applications
Affiliated with MANAGEMENT-TRAINING ASSOCIATES
2308-14th St., N. W. Washington, D. C.

JOSEPH RAZEK, Ph.D.
Consulting Physicist
Electric and Mechanical Engineering Problems
Instrumentation and Control Devices
Electronics Specialists in Ultrasonic, Spectrometers and Industrial Color Control
Laboratory and Shop Facilities
202 Darby Road, Larken, Pa.
Phone hilltop 6309

ARTHUR J. SANIAL
Consulting Engineer
Loudspeakers and Allied Devices
164-14 32 Ave.
Flushing, N. Y.

TECHLIT CONSULTANTS, INC.
Technical literature and art. Specialists in electronics. Instruction manuals, instruction text books, diagrams, catalogues, brochures, photo-illustration, schematics, wiring diagrams. Expert work at low cost. We have never missed a deadline.
140 Nassau Street
New York 7, N. Y.

PAUL D. ZOTTU
Consulting Engineer
INDUSTRIAL ELECTRONICS
272 Centre St.
Newton, Mass.

"By reason of special training, wide experience and tested ability, coupled with professional integrity the consulting engineer brings to his client the extreme of his professional expertise and economic advice that rises above the local limitations and encompasses the availability of all modern developments in the fields where he practices as an expert. His services, which do not replace but supplement and broaden those of regularly employed personnel, are justified on the ground that he saves his client more than he costs him.

THE CONSULTING ENGINEER

ELECTRONICS — November, 1946

287
Tables of Fractional Powers


The book contains two parts. Part I presents values of \( A^x \) for \( A = 0.01 \) to 0.99 in steps of 0.01, and \( A = 2 \) to 9 in steps of 1 for values of \( x = 0.001 \) to 0.01 in steps of 0.001, and 0.01 to 0.99 in steps of 0.01; also for \( A = \pi \) and \( A = 10 \) for values of \( x \) from 0.001 to 1.000 in steps of 0.001. Part II presents values of \( x^A \) for \( a = \pm 1/2, \pm 1/3, \pm 2/3, \) and \( \pm 1/4 \) for values of \( x \) from 0 to 9.99 in steps of 0.01. A bibliography of seventy-six tabulations containing related tables is included.—F. R.

Circuit Analysis by Laboratory Methods


Laboratory manuals, like all texts, are judged by teachers on their suitability to the particular objectives of courses for which they may be used. There are several laboratory manuals for introductory applied electrical engineering courses, flanked on one side by basic texts on electrical measurements per se, and on the other side by manuals on advanced electrical machine testing.

All such books include both reference material on theory and instructions for experiments. This book includes in addition standard laboratory practices and report writing. The level of the material makes it suitable for trade school and first year college electrical and nonelectrical courses in d-c and a-c circuits, depending on the nature of the class instruction which this work is intended to supplement.—F. R.
Electronic Tube Machinery
of every type,—standard, and special design
Specialists in Equipment for the manufacture
of Radio Tubes, Cathode Ray Tubes, Fluorescent Lamps, Incandescent Lamps, Neon Tubes, Photo Cells, X-ray Tubes and other glass or electronic products, on production or laboratory basis.

Electron Tube Machinery
of every type,—standard, and special design
Specialists in Equipment for the manufacture
of Radio Tubes, Cathode Ray Tubes, Fluorescent Lamps, Incandescent Lamps, Neon Tubes, Photo Cells, X-ray Tubes and other glass or electronic products, on production or laboratory basis.

MINIATURE PRECISION BALL BEARINGS

BULDHAN, Brooklyn, New York

MINIATURE PRECISION BEARINGS

For precision instruments, laboratory equipment, electronic devices, to minimize friction, space, weight; overcome starting torque.

1228-1240 DUANE ST.

NEW YORK 7, N. Y.

Bursen-Ampere Co., 1012 McGee, Kansas City, Mo.

Send me FREE catalog advertised in Electronics.

1 AM.

STATE CONNECTION IN INDUSTRY

NAME

ADDRESS

TOWN

STATE
TWO NEW SMALL EASTERN HIGH PRESSURE PUMPS

These two new gear pumps, GR-1 and GR-2, were specifically designed by Eastern to provide pumps to handle small volumes of liquids at high pressures. They are designed for pumping light or heavy oils, fuel oil, glycerine, glycol, and other organic lubricating liquids. Because of their hardened steel gears they are not suitable for use with water. In addition, there is the GW series which is particularly suited to pumping water or beverages. These pumps require no lubrication and therefore the possibility of any contamination of the liquid being pumped is eliminated.

CONSTRUCTION—Pump is close coupled to the motor and the drive is through a splined shaft. Available with mechanical rotary seal only.

MOTORS—Available in different motor characteristics.

BELT DRIVE—An adoption of this unit is available for either belt drive or drive through a flexible coupling. Outlet and inlet tapped for 1/4" IPS pipe thread.

ALLOYS—Stock construction is of aluminum alloy with hardened steel gears.

PRIMING AND CONTROL—These pumps are self-priming with 6 foot lift. A built-in bypass can be furnished for pressure regulation.

SPECIFICATIONS
  - Type: Gear. Size: 11/4" x 51/4" x 51/4".

PERFORMANCE—See Chart.

Eastern builds many other types of small industrial pumps, centrifugals both single and multistage, positive pressure pumps, laboratory pumps, air driven pumps, belt driven pumps and special purpose pumps. Whatever pumping need you have, especially where small size and light weight combined with high performance and economy of operation are factors, can be quickly filled by either one of Eastern's wide range of standard models or a specially designed pump. These pumps are described in the NEW CATALOG. Write for your copy now.

EASTERN ENGINEERING COMPANY
84 FOX STREET
NEW HAVEN, CONN.

Backtalk

This department is operated as an open forum where our readers may discuss problems of the electronics industry or comment upon articles which ELECTRONICS has published.

Birth of Radar Idea?

Dear Editor:

In SEPTEMBER ELECTRONICS, page 184, you intimate that the idea of radar was given by Baird in the year 1926. But this idea is much older.

In: Geschichtszahlen der drahtlosen Telegraphie und Telefonie by Dr. Ing. Franz Maria Feldhaus and Ing. Walther H. Fitz, Verlag Rothgiesser & Diesing, Berlin 1925, page 103 you may read:

(Translation) 1904: Eng. Christian Hülsmeyer in Dusseldorf invented the Telemobiloscope, a device for automatically signaling on the sea. The electric waves of a transmitter of wireless telegraphy are only able to reach a receiver on the same ship if they are reflected by the metal of another ship which is looked for.

And in: Lexikon der Elektrizität und Elektrotechnik by Fritz Hoppe, A. Hartlebens Verlag, Wien and Leipzig, 1906, page 999:

(Translation) Telemobiloscope is a device invented by Hülsmeyer, Dusseldorf, which is based on the fundamentals of wireless telegraphy with the purpose to find ships and metallic things on the sea. The receiver and the transmitter are placed on the same ship. The electric waves sent out by the transmitter cannot reach the receiver directly but have to be reflected by a metallic body (for instance a ship) on the sea and in this reflected way to the receiver.

DR. KURT BORCHARDT
Toronto, Ontario, Canada

Carbon Pickup

Dear Sir:

I read with interest the article

November, 1946 — ELECTRONICS
JONES 2400 SERIES PLUGS AND SOCKETS

A new series of Plugs and Sockets designed for highest electrical and mechanical efficiency. Improved Socket Contacts provide 4 individual flexing surfaces which make positive contact over practically their entire length.

The Contacts on both Plugs and Sockets are mounted in recessed pockets greatly increasing leakage distance, increasing voltage rating, Molded E.M 120 Bakelite insulation. Plug and Socket contacts are silver plated. The finished appearance of this series will add considerably to your equipment.

The 2400 Series are interchangeable with all units of the corresponding No. 400 Series.

Send today for general catalog No. 14 listing and illustrating our complete line of Plugs, Sockets and Terminal Strips.

HOWARD B. JONES DIVISION
CINCINNATI TRANSFER CO.
2400 W. GEORGE ST. CHICAGO 18

SPECIAL VALUES
ELECTRONIC AND COMMUNICATION SUPPLIES

Immediate delivery
PLATE TRANSFORMER
600 Volt CT—700 Mils, 110 Volts, 60 cycles tapped. $19.60
Limited Quantity $20.00

A GOOD BUY

Full Wave Rectifier tube model 770, with line operated power supply, in tube. Use 15 R. M. C. for rating. $20.00

ADDITIONAL BARGAINS

Larson Silver Plated Antenna 8 ft. 300 watts, B.W. 1000. $5.00

Additional Bargains for the Select few: $30.00 per set.

Send for a complete line of B & W Cables and Westline Xtras for stock. Send us your request or ask for catalog.

Searchlight Section

UNDISPLAYED RATES

15 CENT A WORD, MINIMUM CHARGE $3.00

WANTED

Prominent Aircraft Company, Eastern United States needs men with following qualifications:

Experienced engineers with Bachelor's, Master's, Doctor's degrees in Electrical Engineering, Physics, Mathematics. At least two years experience in design of radar and television systems, automatic computers, servomechanisms, target seekers, etc. required. Positions open for preliminary and detail research and development of guided missiles under Army and Navy contracts.

Starting salary commensurate with experience. Address

4555, Philadelphia 7, Pa.

Additional Employment Ads on pages 292 and 293

www.americanradiohistory.com
OPPORTUNITIES AT ZENITH

Zenith has some interesting openings for experienced Senior and Junior radio engineers in all branches of home radio receiver design and development. Apply to J. E. Brown, Chief Engineer, Zenith Radio Corporation, 6001 West Dickens, Chicago. All applications treated in confidence.

FOR SALE

Here's an opportunity to purchase a complete TRANSFORMER FACTORY all operating—fully staffed—located in the east—requires approx. $150,000. cash.

PW-256, Electronics 330 West 42nd St., New York 18, N. Y.

NATIONAL DISTRIBUTION AVAILABLE

For Manufacturers who make products suitable for sale to Radio, Electrical, Electronic Jobbers and Industries. We have a complete sales staff for national and export distribution. Reply with samples or description of product.

RA-228, Electronics 330 West 42nd St., New York 18, N. Y.

SALES ENGINEERS Wanted

by large radio parts manufacturer

Will be trained for territorial office management. Good appearance, pleasant personality and desire to learn overall sales and business management are essential, but none need apply who lack the prime requisite of practical broadcast receiver design engineering experience. In reply give historical background, nationality and salary requirement.

SW-355, Electronics 330 West 42nd St., New York 18, N. Y.

Electronic Engineering Service
Research Design Development in ELECTRONICS and APPLIED PHYSICS for industry and laboratory
SUBMIT YOUR PROBLEMS

WANTED...

1—RADIATION PHYSICIST
With background in measurement and detection of radiations and designing of associated instruments. Weight of background and interests should be in physical chemistry.

2—X-RAY TUBE ENGINEER
3—TRANSMITTING TUBE ENGINEER
Must have experience in actual tube design and production.

THESE THREE MEN will have stimulating work, laboratory freedom, full security and good salaries. Write in complete confidence. Or arrange for an immediate interview.

AMPEREX ELECTRONIC CORPORATION
25 Washington Street Brooklyn 1, New York
Telephone: MAin 5-2050

WANTED

ELECTRONIC ENGINEER
Electronic Engineer, preferably under 30 years of age wanted for Research Department of Caterpillar Tractor Co., manufacturers of Diesel Engines, Tractors and earthmoving equipment. Applicant should be an Electrical Engineering graduate and have practical knowledge of laboratory electronic instrumentation, design and application.

Please state qualifications, education, training and experience so that an interview can be arranged.

All applications will be carefully considered and acknowledged. Please address:

CATERPILLAR TRACTOR CO.
PEORIA, ILLINOIS

WANTED

ELECTRICAL OR ELECTRO-CHEMICAL ENGINEER
with experience in manufacture of electrolytic capacitors, capable of designing and installation of equipment. Give full details—confidential.

P-244, Electronics
520 North Michigan Ave., Chicago 11, Ill.

WANTED

SUPERVISING INSTRUMENT ENGINEER
Electrical engineering background and thoroughly familiar with design, development and production of industrial instruments. Energetic and willing to obtain results for his own advancement. A good position for the right man.

P-241, Electronics
360 West 42nd St., New York 18, N. Y.

PHYSICISTS AND ELECTRICAL ENGINEERS
Wanted for Vacuum Tube Research
Apply by letter stating qualifications to:
Director of Research
NATIONAL UNION RADIO CORPORATION
57 State Street, Newark, New Jersey

Don't forget the BOX NUMBER
When answering the classified advertisements in this magazine, don't forget to put the box number on your envelope. It's our only means of identifying the advertisement you are answering.
MAGNETRONS!
MAGNETRONS!
MAGNETRONS!

MAGNETRONS!
Westinghouse Type 2J32 (JAN.) just released. This is the first large lot of MAGNETRONS to flow into the civilian market! The 2J32 is designed for 10 cm. operation. Rated at 3/0 kw feet pulse power. Complete information supplied. Brand new, packed in individual protective cartons. The 2J32 is listed at $200.

AMERICAN PLAT; TRANSFORMER! 115v-ol cycle primary; 3220 volt-ohm unit secondary. M36, 11" x 14" x 10. This transformer goes for $39.95.

NEW CATHODE RAY TUBES!! Made by North American Philips

Type Lnt Cost HI POWER XMTR TUBES

<table>
<thead>
<tr>
<th>Type</th>
<th>Lnt</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>5CP1</td>
<td>390</td>
<td>5.50</td>
</tr>
<tr>
<td>5FP7</td>
<td>350</td>
<td>4.95</td>
</tr>
<tr>
<td>5JP2</td>
<td>310</td>
<td>2.95</td>
</tr>
</tbody>
</table>

AMERICAN PLAT; TRANSFORMER! 115v-ol cycle primary; 3220 volt-ohm unit secondary. M36, 11" x 14" x 10. This transformer goes for $39.95.

Each unit consists of the following:
1—4" Jensen PM45 Speaker
1—Power Transformer, 115 volt 60 cycle input, output 315-O-315 volts at 70 MA, 6.3 volts center tapped at 3.5 amperes, 5 volt at 3 amperes
1—Single variable condenser, 312 MMF with clock wise increase characteristics
1—Input Transformer
1—Output Transformer
1—Crowe 4" Dial
1—National Verney Drive
1—IRC Attenuator, 100,000 impedance 3 DB per step to 57 DB, Type B-31P
9—Octal Sockets
2—2" Skirted knobs
1—DPST Toggle Switch
1—3 deck, 2 pole, 5 position each wafer switch.
1—Fuse post

The unit was designed to use 1.65SJ; 1.65N76T; 1, 6 U 66T; 1-5Y6T; 1-UR-150/30

NO TUBES SUPPLIED WITH UNIT

Has a large quantity of assorted resistors, mica condensers, bathtub condensers, potentiometer, connectors, etc.

Priced at ONLY $7.50 F.O.B., N. Y. C.

New Incomplete Navy Oax Sonar Units

Remler Appointed Agent for
WAR ASSETS ADMINISTRATION
(under contract No. 59-A-48)

... to handle and sell a wide variety of
ELECTRONIC EQUIPMENT
released for civilian use
Write for Bulletin Z-1A

REMLER COMPANY LTD.
2117 Bryant St., San Francisco 10, Calif.

REMLER
Since 1918
Pioneers in Electronics and Plastics

SURPLUS PARTS and EQUIPMENT
55,000 Sq. Ft. of Government-owned electronic parts and equipment. All material inspected and tested: backed by usual 90-day manufacturer's guarantee.

SPECIAL ELECTRONIC BUY
IMMEDIATE ORDER
A REAL HOT ITEM
HEWLETT-PACKARD MODEL 400A VACUUM TUBE VOLT METER
Slightly used but thoroughly reconditioned and guaranteed by us.

Special $99.00
Write or Wire order to
D-D SUPPLY COMPANY
254 E. 54th Street Brooklyn 3, New York Phone—Dickens 2-4385

PRECISION WAVEMETERS
500 to 10,000 Megacycles
CO-AXIAL PROBE TYPE
KAY ELECTRIC CO.
47 N. Grove St. E. Orange, N. J.

Each unit consists of the following:
1—4" Jensen PM45 Speaker
1—Power Transformer, 115 volt 60 cycle input, output 315-O-315 volts at 70 MA, 6.3 volts center tapped at 3.5 amperes, 5 volt at 3 amperes
1—Single variable condenser, 312 MMF with clock wise increase characteristics
1—Input Transformer
1—Output Transformer
1—Crowe 4" Dial
1—National Verney Drive
1—IRC Attenuator, 100,000 impedance 3 DB per step to 57 DB, Type B-31P
9—Octal Sockets
2—2" Skirted knobs
1—DPST Toggle Switch
1—3 deck, 2 pole, 5 position each wafer switch.
1—Fuse post

The unit was designed to use 1.65SJ; 1.65N76T; 1, 6 U 66T; 1-5Y6T; 1-UR-150/30

NO TUBES SUPPLIED WITH UNIT

Has a large quantity of assorted resistors, mica condensers, bathtub condensers, potentiometer, connectors, etc.

Priced at ONLY $7.50 F.O.B., N. Y. C.

MARITIME SWITCHBOARD
336 Canal Street New York 12, N. Y.
**SURPLUS NEW METERS**

**D.C. METERS**

**MICROAMMETERS GALVANOMETERS**

McClintock, 3¾" square, 0-50 ua mvt., spec. scale $6.50

Gruni, 2½", 0-100 ua mvt., Black scale with markings, ⅔ to 1 & ¾ to 2 DBM and 0-100, 2000 ohms resist $3.50

Weston 311, 3¼", 0-200 ua $7.50

Marion, 2½", 200 microamp undamped mvt., spec. sc. $3.50

Marion, 3¼", 0-200 ua 68 ohms resistance, undamped mvt. $4.95

**G. E. DO-41, 3¾" 200 MICROAMP MVT, SPEC. SC. KNIFE EDGE POINTER, COMP. WITH PAPER V-O-M-A.**

SCALE $6.00

W.E. 3½", concentric style, 0-200 microamp scale $4.00


**D. C. MILLIAMMETERS**

G.E., DO-51, 3¼" square, 0-1 M.A. $4.95

G.E., DO-53, 3¾" square, 1 M.A. mvt., 5000 ohm resist, 0-50 sc $1.95

G.E., DW-41, 2½", 1 M.A. $3.95

G.E., DO-53, 3¼", square, 20 M.A. $4.95

Weston 306, 251", 3 M.A. $3.00

W.H., RX-33, 3½" square, 0-30 & 0-300 M.A. dual range $4.95

Simpson 25, 3¾", 5 M.A. movement Zero Right Scale—6 to 100 caption “DB” above 1 Microvolt. $3.00

Simpson 26, 3½", 0-15 M.A. $4.50

Simpson 3½", 0-200 M.A. $4.50

Weston 35½", 0-1000 M.A. $4.50

**D.C. VOLTMETERS & KILOVOLT METERS**

**G.E., DW-41. 2½", 15 VOLT BLACK SCALE, 15 MARKINGS, NO CAPTION $2.50**

W.H., NX-33, 2½", Surf. Mtd. 3-0-3 V, 200 r/v. $1.25

W.H., NX-35, 3½", 15 K.V. comp. with 1000 r/v ext prec resist L.P. $16.00

Your cost $16.00

W.H., NX-35, 3½", 20 K.V. comp with 100 r/v ext prec resist L.P. $21.00

Your cost $21.00

W.H., NX-35, 3½", 0-200 V, 1000 r/v $5.50

W.H., NX-35, 3½", 0-200 V, 1000 r/v mtd on 45 degree metal angle panel $6.00

Western Electric, 3½", Concentric Style, 0-75 volt D.C. 1000 r/v $3.00

W.E., 3½", 500 volt, 1000 r/v Concentric Style $5.00

Weston 301, 3½", 0-4 K.V with ext prec resist $7.95

Guren, 2½", 150 volt. $3.50

**D.C. AMMETERS**

Triplett, 3½", 0-15 amp. $4.00

Weston 316, 2½", 200 amp. with ext shunt $9.50

G.E., DO-41, 3½", 200 amp. with ext shunt $12.50

**RADIO FREQUENCY AMMETERS**

G.E., DW-44, 2½", 0-1 A.R.F. Black scale $3.50

G.E., DO-44, 3½", 1.5 Amp. $6.50

Weston 425, 3½", 1 Amp Surf Mtd. $6.50

Weston 507, 2½", 0-1.5 A.R.F. Black scale, Metal case $2.95

Weston 507, 2½", 3 Amp bk sc $3.50

Weston 640, 4½", Surf Mtd, 0-3 A.R.F. $9.50

Weston 425, 3½", 0-500 M.A. R.F. $7.50

Simpson, 2", 3 Amp, expanded at lower part of scale $3.50

**A.C. VOLTMETERS**

G.E., AW-42, 2½", 0-10 V.A.C. $3.95

G.E., AO-22, 3½", 1000 cycle, 50 volts, mid on metal angle bracket with 6" Tyrex leads & clips $2.50

G.E., AO-22, 3½", 150 volt $5.95

G.E., AO-22, 3½", 0-150 V.A.C. Black scale $3.00

G.E., AO-22, 3½", 300 volt. $8.00

Weston 476, 3½", 130 volt. $4.50

W.H., NA-33, 3½", 150 volt. $5.50

Triplett 332, JP, 3½", 0-150 V.A.C. metal case $4.50

Triplett 232, 2½", 250 volt. $4.95

**A.C. AMMETERS**

G.E., AO-22, 3½", 80 Amp S.C. $3.50

Simpson, 3½" square case 60 Amp S.C. $4.50

Simpson 3½" square, 0-60 sc $4.50

**AIRCRAFT METERS**

G.E., 2½", Aircraft type, 300 Amps D.C. black scale, luminous mkgs with internal shunt. $1.50

G.E., 2½", Aircraft type, 0-60 Amps D.C. black scale, luminous mkgs with external shunt. $2.25

G.E., 2½", Aircraft type, 0-60 Amps & 0-30 Volts D.C. black scale, luminous mkgs with external shunt. $3.00

G.E., 2½", Aircraft type, 0-120 Amp D.C. black scale, luminous mkgs with external shunt. $2.75

W.H., 2½", Aircraft type, 0-30 volt D.C. bk sc luc mkgs, 5 M.A. movement motor 200 ohm resist. $1.25

W.H., 2½", Aircraft type, 0-120 Amp & 30 Volts D.C. black scale, luminous mkgs with external shunt. $3.50

W.H., 2½", Aircraft type, 0-150 volt A.C. bk sc lum mkgs, suitable for use from 25 to 125 cycles. $1.50

**PORTABLE A.C. AMMETER SURPLUS NEW WESTON MODEL 528**

**DUAL RANGE 0-3 Amp. and 0-15 Amp. full scale for use on any frequency from 25 to 500 cycles. Ideal instrument for all commercial, industrial, experimental, home, radio, motor and general repair shop testing. Comes complete with a genuine leather, plish-lined carrying case and a pair of test leads. A very convenient pocket sized test meter priced at less than 50% of manufacturers list. Your cost only $12.50**

**SPECIAL METERS**

Weston 301, Power Level Indicator, 625 Microamp 1.2 volt A.C. mvt, self cont rect, blank sc. $6.00

Weston 301, 3½", 0-150 V.A.C. Rectifier Type, 1000 r/v A.C. $6.50

Weston 301, 3½", Type 61 Diesel, 1½" 6 M.W. 600 ohms high speed type 29-35 sec. to final reading L.P. $24.50

Your cost $9.50

Weston 705, Sensistol relay 100 microamp, Solenoid reset, S.P. norm closed $7.50

G.E., miniature, 1½" square, 1 M.A. 100 ohm mvt, 10 divsc bk sc $2.75

G.E., DW-46, 2½", DB-10-5, 6 M.W. 600 ohms zero DC-190 volts. $4.50

G.E., DO-46, 3½", 400 Microamp 1 volt A.C. mvt, self cont. rect. Spec. sc. $5.50

G.E., Totalizing hour meter, 3½" 5 Digit, 99,999 hrs. 115 volt 60 cycle. $4.95

J.B.T., 3½", Frequency Meter, 58-62 cycle 5 read. $4.00

Marion, 2½", ring mid “m” meter made for National Co. 1 M.A. mvt scale -1-9-8 units 0-40 D.B. above $9.3.50

Roller Smith, mainiature, 1½" sq 1.57 M.A. mvt, spec bk sc $2.50

Roller Smith, miniature, 1½" sq 2 M.A. mvt, with 2 lead & plug jack 0-10 div sc $2.50

**PRECISION RESISTORS**

±½% Accuracy—Wire Wound—1 M.A. Weston, G.E., 1 R C on Sprague 1.0 Meg 1 KV $1.50

1.5 Meg 1.5 KV $2.00

2.5 Meg 2.5 KV $2.50

5.0 Meg 5.0 KV $5.00

20.0 Meg 20.0 KV $16.50

---

**MARITIME SWITCHBOARD**

Worth, 4-R2147, 330 Canal St., N. Y. 13, N. Y.

ELECTRONICS — November, 1946

295
WANTED RADIO & Electronic PARTS

Have you any surplus, discontinued or unnecessary RADIO, ELECTRONIC or ELECTRICAL EQUIPMENT or PARTS. We will buy them—any quantity—large or small.

Write or phone us, giving complete information. We will give you quick action.

CLARK-REISS DISTRIBUTORS
22 Broadway
Diligby 4-6891
New York City 4

RADIO, ELECTRONIC PLANTS, INVENTORIES, & SURPLUS STOCKS
BOUGHT FOR CASH
W. 246, Electronics
220 West 42nd St., New York 18, N. Y.

INSTRUMENTS

Complete repair, rebuilding services on panel, switchboard, portable indicating meters.

Take advantage of these services by a company equipped to turn out high quality work.

A competent staff and modern laboratory assure dependable and continuous performance.

Backed by 20 years' experience in the instrument field.

PRECISION ELECTRICAL INSTRUMENT CO.
146 Grand Street New York 13, N. Y.

HAZELTON INSTRUMENT CO.,
Electric Meter Laboratory
Electrical instruments, Tube Checkers and Analyzers repaired
War surplus meters converted for civilian use.
140 Liberty St., New York, N. Y.
Tel. Barclay 7-4239

BEST QUALITY, USED ELECTRON TUBE MACHINERY

Equipment for the manufacture of all kinds of electron tubes, radio tubes, neon tubes, photoelectric bulbs, gas filled electronic devices, x-ray tubes, etc.

AMERICAN ELECTRICAL SALES CO., Inc.
44-67 East 9th St., New York, N. Y.

Volume Controls
FOR IMMEDIATE DELIVERY

We have in stock hundreds of thousands of volume controls available for immediate shipment. These controls were built to the very highest standards of precision by Allen-Bradley, Chicago Telephone Supply, Clarostat and I.R.C. All are new and fully guaranteed. All types and sizes from 100 ohms to 5 megohms are represented. Send us your requirements or write for special Volume Control Catalog.

Our huge inventory of Government Contract termination components also includes a million RELAYS of all types. Relays for every purpose, JAN inspected and packed in original cartons, have been priced at a fraction of their original cost. Special Relay Catalog will be mailed upon request.

A complete selection of MICRO-SWITCHES is also available immediately. These are listed in our special Micro-Switch Catalog.

In addition, Wells is a quick source for resistors, mica condensers, field wire, selenium rectifiers, time switches and transmitting tubes. Quotations upon request.

WELLS SALES, INC.
4717-R WEST MADISON ST., CHICAGO 44, ILL.

Four Federal F124 Transmitter Tubes and sockets, from 1753 to 4721 hours, in good condition.

MAKE US AN OFFER
RADIO STATION KSL
Salt Lake City, Utah

PAN-OSCILLO RECEIVER

Latest design, 2nd Oscilloscope, panoramic adapter, synchronoscope, receiver (when used with converter). Push-pull vertical and horizontal amplifiers. Ideal for laboratory, television, and general use. 110 V, 60 cycle AC. New in orig. carton. Originally $2,000, now sold for $97.50 F.O.B. Write for picture flyer or send 60c for eighty-page technical manual.

METERS—NEW ORIGINAL BOXES
2 MILLLIAMMETERS WESTON 0-100 $2.95.
3 WESTINGHOUSE 0-500 $3.65.
5 WESTINGHOUSE TRIPLET 0-150 Two for $6.40
5 MILLIAMMETERS WESTON 0-50 $4.45.
5 VOLTMETERS MARION 0-1000 DC $3.65.
5 FREQUENCY METER 45-55 cycles $2.95.
2 OUTPUT METER 0-111110 $3.95.
3 MEGOHMETERS TRIPLET 0-500 $6.40.
4 TRANSMITTING TUBES—new original boxes
6 E. LE Phase $11.45.
4 RCA 1095 $11.45.

METAL RADIO-ELECTRONIC CASES

METERS AND INSTRUMENTS

40c Each
LOTS OF 100
F.O.B. Chicago
BRAND NEW!

119 Lafayette St., New York 13, N. Y.

APPROXIMATELY 23 GAUGE SHEET STEEL

WARSAWSKY & LAZAR
DEPT. E
2126 S. Michigan Ave. Chicago 16 Ill.

Delivery vs. Delay...

When knowing where to find what you need is the deciding factor between DELIVERY and DELAY... consult the advertising pages. If you do not find what you need...

WRITE ELECTRONICS

November, 1946—ELECTRONICS
Eldico
MICROWAVE EQUIPMENT

SYNCHROSCOPES
Browning Labs type P4E sweep ranges 1.7 - 12 microseconds wide band amplifiers, 5" scope a laboratory instrument suitable for radar, television, etc. 250.00

WAVE METER
WE-140-A resonance indicator. Range 2.65 KMC to 3.00 KMC. Micrometer pot tuning 55.50

HALF WAVE DIPOLE
10 cm ½ wave with co-ax input. Plexiglass hemispherical shield and reflector. Lots of 6 - 1.85 ea.

MAGNETRONS
Type 725A or 2J21A designed for 3 cm region. JAN-1 inspected.
Lots of 10 - 18.50 ea.
Lots of 100 - 15.00 ea.
Magnets for above Magnetrons (CFF 2000 Gausses).
Lots of 10 - 13.50 ea.
Lots of 100 - 10.00 ea.

FREQ. STANDARD
covering frequencies from 100 to 45,000 kc. Check points at 1000-100-10 KC. Features multi-vibrator and tuned output amplifier. For 100-250 volt, 25-60 cycle operation. Furnished with dual crystals and spare tubes. 29.50

ABSORPTION TYPE WAVE METER
Type BC206D ultra high frequencies (160 to 220 Megacycles) coaxial pot wave meter utilizing diode rectifier and amplification with visual or aural detection. Less tubes 37.50

TUBES AND CRYSTALS
UHF OSCILLATORS TUBE
Shapard Pierce - 725A/B-3CM region - JAN-1 boxed - manufactured by Western Electric and Raytheon.
5.28
715 B MAGNETRON DRIVER 10.00 ea.

UHF CRYSTALS
JAN 1 - 1N21 - 1N21A - 1N21B - 1N23A or 1N23B. Each crystal individually boxed and stamped - JAN-1. Inspected - 100 lots -any type.
70c ea.
1N23 - Lots of 100 - 1.00 ea.

TEST EQUIPMENT
'X' BAND SIGNAL GENERATOR
consists of 'x' band oscillator, freq. meter, power level meter and attenuator. Output of 'X' band oscillator is constant or pulsed. Designed to operate on 115V 50 to 1200 cps. 139.50

FREQUENCY METER
Frequency range 375 to 725 mc. with guaranteed accuracy of better than 1 mc. under all conditions. Visual or aural indication, modulated or unmodulated complete with spares. 59.50

SEND FOR OUR COMPLETE CATALOG

Just a Few New Units Left—
INDEX TO ADVERTISERS

TELEVISION
R.F.
POWER SUPPLY

This high voltage R.F. power supply coil is designed to be used in a power supply circuit to supply anode voltage for television Kinescopes.

2 circuits available
10,000 VOLTS
30,000 VOLTS

Engineering data or consultation service on use of coils are available.

IMMEDIATE DELIVERY
ON SAMPLE QUANTITIES

ESSEX
ELECTRONICS
BERKELEY HEIGHTS, NEW JERSEY

du Pont de Nemours & Co., Inc., E. R.
Plastics Dept.

298

Durez Plastics & Chemicals, Inc.

Page

173

November, 1946 — ELECTRONICS

INDEX TO ADVERTISERS

Accurate Spring Mfg. Co.
Adhesion Colloid Corporation
Acme Electric Corp.
Acmeous Mfg. Co., Ltd.
Aco Electric Co.
Advance Electric & Relay Co.
Aircraft-Marine Products, Inc.
Aircraft Radio Corporation
Allen Mfg. Co.
Allen-Bradley Co.
Alliance Manufacturing Co.
Allied Radio Corporation
Allied Recording Products Co.
Allis-Chalmers Mfg. Co.
Allied Corporation
Allied Lancing Corporation
American Brass Co.
American Metal Hose Co.
American Phosphate Corp.
American Petroleum Works
American Screw Company
American Television & Radio Co.
Amperex Corporation
Amperex Company
Andrews Co.
Ansonia Clock Co.
Ansonia Electric Co.
Aluminum Electric Co.
Art Wire & Stamping Co.
Astatore Corporation
Atlas Sound Corp.
Audak Company
Audio Devices, Inc.
Automatic Mfg. Corporation

Bair Co., N. S.
Ballantine Laboratories, Inc.
Babcock Labs, Alfred W.
Beaver Gear Works, Inc.
Bell Telephone Laboratories
Bentley, Harris Mfg. Co.
Bendix Radio, Inc.
Blaw-Knox Company
Boonton Radio Corporation
Brach Mfg. Corp., L.
Bradley Laboratories, Inc.
Brush Development Co.
Bud Radio, Inc.
Burham Instrument Co.
Burnett & Company
Burstein, A.

Page

19

19

31

104

108

246

371

202

221

173

104

175

175

175

189

174

19

285

175

284

281

208

250

282

210

278

262

198

263

199

285

284

199

283

284

269

284

284

284

284

251

279

299

282

283

283

283

283

283

283

283

283

283

283

283

283

283

283

283

283

283

283

283

283

283
<table>
<thead>
<tr>
<th>Company Name</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lakeview Laboratories</td>
<td>209</td>
</tr>
<tr>
<td>Lapp Insulator Co., Inc.</td>
<td>25</td>
</tr>
<tr>
<td>Leavitt Co.</td>
<td>27</td>
</tr>
<tr>
<td>Leith &amp; Bond</td>
<td>271, 277</td>
</tr>
<tr>
<td>Lifetone, Inc.</td>
<td>27</td>
</tr>
<tr>
<td>Lord Manufacturing Company</td>
<td>15</td>
</tr>
<tr>
<td>Magazines Co.</td>
<td>247</td>
</tr>
<tr>
<td>Maguire Industries, Inc.</td>
<td>58</td>
</tr>
<tr>
<td>Makepeace Company, D. E.</td>
<td>12</td>
</tr>
<tr>
<td>Makepeace Mfg. Co.</td>
<td>18</td>
</tr>
<tr>
<td>Marion Electron Instrument Co.</td>
<td>182</td>
</tr>
<tr>
<td>Match-Master Co.</td>
<td>277</td>
</tr>
<tr>
<td>McGraw-Hill Book Co.</td>
<td>259</td>
</tr>
<tr>
<td>Measurements Corporation</td>
<td>265, 266</td>
</tr>
<tr>
<td>Mepham Corp., G. S.</td>
<td>248</td>
</tr>
<tr>
<td>Mica Insulator Co.</td>
<td>50, 51</td>
</tr>
<tr>
<td>Midwest Molding &amp; Mfg. Co.</td>
<td>283</td>
</tr>
<tr>
<td>Miles Reproducer Co., Inc.</td>
<td>289</td>
</tr>
<tr>
<td>Milford River &amp; Machine Co.</td>
<td>255</td>
</tr>
<tr>
<td>Millen Mfg. Co., Inc.</td>
<td>168, 244</td>
</tr>
<tr>
<td>Miniature Precision Bearings</td>
<td>289</td>
</tr>
<tr>
<td>Minnesota Mining &amp; Mfg. Co.</td>
<td>53</td>
</tr>
<tr>
<td>Mitchell-Rand Insulation Co., Inc.</td>
<td>28</td>
</tr>
<tr>
<td>Muestra, Inc., Plastic Div.</td>
<td>61</td>
</tr>
<tr>
<td>Multi-Products Tool Company</td>
<td>61</td>
</tr>
<tr>
<td>Murphy Co., Wm. J.</td>
<td>156</td>
</tr>
<tr>
<td>Mylecex Corporation of America</td>
<td>24</td>
</tr>
<tr>
<td>National Company, Inc.</td>
<td>66</td>
</tr>
<tr>
<td>National Carbon Co.</td>
<td>149</td>
</tr>
<tr>
<td>National Mfg. Co.</td>
<td>236</td>
</tr>
<tr>
<td>National Radio Service Co.</td>
<td>242</td>
</tr>
<tr>
<td>National Supply Co.</td>
<td>251</td>
</tr>
<tr>
<td>National Vulcanized Fibre Co.</td>
<td>67</td>
</tr>
<tr>
<td>Newark Electric Inc.</td>
<td>263</td>
</tr>
<tr>
<td>Niagara Radio &amp; Supply Co.</td>
<td>291</td>
</tr>
<tr>
<td>North American Philips Co., Inc.</td>
<td>253</td>
</tr>
<tr>
<td>Northern Communications Mfg. Co., Inc.</td>
<td>218</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Osm &amp; Sons, D. W.</td>
<td>268</td>
</tr>
<tr>
<td>O'Neil-Inw Mfg. Co.</td>
<td>280</td>
</tr>
<tr>
<td>Owen-Corning Fiberglas Corp.</td>
<td>38</td>
</tr>
<tr>
<td>Palmet Co.</td>
<td>258</td>
</tr>
<tr>
<td>Pax-Metal Products Corporation</td>
<td>258</td>
</tr>
<tr>
<td>Paramount Paper Tube Corp.</td>
<td>259</td>
</tr>
<tr>
<td>Park Metalware Co.</td>
<td>259</td>
</tr>
<tr>
<td>Parker-Bowes Co.</td>
<td>28</td>
</tr>
<tr>
<td>Paton-MacGuery Co.</td>
<td>263</td>
</tr>
<tr>
<td>Peerless Electrical Products Co.</td>
<td>216</td>
</tr>
<tr>
<td>Penn Engineering and Manufacturing Co.</td>
<td>65</td>
</tr>
<tr>
<td>Pennsylvania Electric Co.</td>
<td>193</td>
</tr>
<tr>
<td>Petersen Radio Co.</td>
<td>152</td>
</tr>
<tr>
<td>Phillips Screw Manufacturer</td>
<td>233</td>
</tr>
<tr>
<td>Proctor Electron Corp.</td>
<td>195</td>
</tr>
<tr>
<td>Plaskon Div., Ebyhows, Ford Glass</td>
<td>81</td>
</tr>
<tr>
<td>Plax Corporation</td>
<td>167</td>
</tr>
<tr>
<td>Precision Instrument Co.</td>
<td>277</td>
</tr>
<tr>
<td>Precision Electronics Co.</td>
<td>280</td>
</tr>
<tr>
<td>Precision Metal Etching Co.</td>
<td>265</td>
</tr>
<tr>
<td>Press Wireless Manufacturing Corp.</td>
<td>75</td>
</tr>
<tr>
<td>Presto Recording Corporation</td>
<td>79</td>
</tr>
<tr>
<td>Printland, Inc.</td>
<td>269</td>
</tr>
<tr>
<td>Progressive Mfg. Co.</td>
<td>256</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quadra Manufacturing Co.</td>
<td>279</td>
</tr>
<tr>
<td>Quaker City Gear Works, Inc.</td>
<td>252</td>
</tr>
<tr>
<td>Radio Corp. of America, Victor Div.</td>
<td>Back Cover</td>
</tr>
<tr>
<td>Radio Receptor Co., Inc.</td>
<td>160</td>
</tr>
<tr>
<td>Radio Supply &amp; Engineering Co., Inc.</td>
<td>260</td>
</tr>
<tr>
<td>Radio Wire Television</td>
<td>283</td>
</tr>
<tr>
<td>Radioline Equipment Co.</td>
<td>271</td>
</tr>
<tr>
<td>Railway Express Agency, Air Express Div.</td>
<td>281</td>
</tr>
<tr>
<td>Raytheon Products Co.</td>
<td>277</td>
</tr>
<tr>
<td>Reverb Soundcraft Co.</td>
<td>277</td>
</tr>
<tr>
<td>Revere Copper &amp; Brass, Inc.</td>
<td>327</td>
</tr>
<tr>
<td>Richards Company</td>
<td>83</td>
</tr>
<tr>
<td>Rider, Publisher, Inc., John F.</td>
<td>83</td>
</tr>
<tr>
<td>Robinson Recording Labs.</td>
<td>148</td>
</tr>
<tr>
<td>Rockwell Manufacturing Co.</td>
<td>235</td>
</tr>
<tr>
<td>Rollin Company</td>
<td>198</td>
</tr>
<tr>
<td>St. Louis Microphone Co.</td>
<td>269</td>
</tr>
<tr>
<td>Sangamo Electric Company</td>
<td>16</td>
</tr>
<tr>
<td>Schweitzer Paper Co.</td>
<td>46</td>
</tr>
<tr>
<td>Scientific Electric Div. of &quot;S&quot; Corrugated</td>
<td>44</td>
</tr>
<tr>
<td>Scovill Mfg. Co., Waterville Screw Products</td>
<td>167</td>
</tr>
<tr>
<td>Shellcross Mfg. Co.</td>
<td>146</td>
</tr>
<tr>
<td>Sherron Electronics Co.</td>
<td>57</td>
</tr>
<tr>
<td>Shure Brothers, Inc.</td>
<td>158</td>
</tr>
<tr>
<td>Sigma Insulation Co.</td>
<td>291</td>
</tr>
<tr>
<td>Sillers-Johnson Co.</td>
<td>250</td>
</tr>
<tr>
<td>Simplicity Electric Co.</td>
<td>253</td>
</tr>
<tr>
<td>Solar Electric Company</td>
<td>187</td>
</tr>
<tr>
<td>Solar Mfg. Co., Corp.</td>
<td>80</td>
</tr>
<tr>
<td>Sorensen &amp; Company, Inc.</td>
<td>258</td>
</tr>
<tr>
<td>Sound Apparatus Co.</td>
<td>274</td>
</tr>
<tr>
<td>Sprague Electric Co.</td>
<td>161</td>
</tr>
<tr>
<td>Stackpole Carbon Company</td>
<td>207</td>
</tr>
<tr>
<td>Stamford Mfg. Co., Inc.</td>
<td>289</td>
</tr>
<tr>
<td>Standard Pressed Steel Co.</td>
<td>213</td>
</tr>
<tr>
<td>Star Expansion Products Co.</td>
<td>261</td>
</tr>
<tr>
<td>Star Porcelain Company</td>
<td>277</td>
</tr>
<tr>
<td>Stevens-Walsh Co.</td>
<td>264</td>
</tr>
<tr>
<td>Steward Mfg. Co., M. D.</td>
<td>289</td>
</tr>
<tr>
<td>Stewart Mfg. Corp., F. W.</td>
<td>261</td>
</tr>
<tr>
<td>Stokes Machine Co., F. J.</td>
<td>278</td>
</tr>
<tr>
<td>Struthers-Dunn Co.</td>
<td>148</td>
</tr>
<tr>
<td>Sun Radio &amp; Electronics Co., Inc.</td>
<td>289</td>
</tr>
<tr>
<td>Superior Electric Co.</td>
<td>62</td>
</tr>
<tr>
<td>Superior Tube Company</td>
<td>249</td>
</tr>
<tr>
<td>Supergain Electrical Instrumentation Co.</td>
<td>276</td>
</tr>
<tr>
<td>Sylvana Electric Products, Inc.</td>
<td>163</td>
</tr>
<tr>
<td>singers, each capable of reaching high C, one may have a pleasing voice—the other, not at all. It is the same with pickups. To achieve EAR-ACCEPTABILITY, all other factors must be satisfied. Of these, VIBRATORY-MOMENTUM is most important. The only way to test EAR-ACCEPTABILITY of a pickup is to put it to the EAR-TEST. The sharp, clean-cut facsimile performance of MICRODYNE—regardless of climatic conditions—is a marvel to all who know that EAR-ACCEPTABILITY is the final criterion.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taylor Fibre Co.</td>
<td>285</td>
</tr>
<tr>
<td>Tech Laboratories</td>
<td>287</td>
</tr>
<tr>
<td>Television Products Co.</td>
<td>289</td>
</tr>
<tr>
<td>Telex, Inc.</td>
<td>144</td>
</tr>
<tr>
<td>Thermaflex Electrical Mfg. Co.</td>
<td>281</td>
</tr>
<tr>
<td>Thomas &amp; Skinner Steel Products Co.</td>
<td>283</td>
</tr>
<tr>
<td>Tennessee Products, Inc.</td>
<td>185</td>
</tr>
<tr>
<td>Tofflight Tool Co.</td>
<td>289</td>
</tr>
<tr>
<td>Transco, Inc. &amp; Co.</td>
<td>276</td>
</tr>
<tr>
<td>Tripletter Electrical Instrument Co.</td>
<td>279</td>
</tr>
<tr>
<td>Tunet-Solt Lamp Works, Inc.</td>
<td>229</td>
</tr>
<tr>
<td>Turner Co.</td>
<td>169</td>
</tr>
<tr>
<td>United Carbide &amp; Carbon Corp., 149, 277, 285</td>
<td></td>
</tr>
<tr>
<td>United Electronics Co.</td>
<td>285</td>
</tr>
<tr>
<td>United Transformer Corp., Inside Front Cover</td>
<td></td>
</tr>
<tr>
<td>Vickers Instrument Co.</td>
<td>275</td>
</tr>
<tr>
<td>Wadsworth Mfg. Co.</td>
<td>285</td>
</tr>
<tr>
<td>Walter Co., S.</td>
<td>278</td>
</tr>
<tr>
<td>War Assets Administration</td>
<td>284</td>
</tr>
<tr>
<td>Ward Leonard Electric Co.</td>
<td>22</td>
</tr>
<tr>
<td>Weller Mfg. Co.</td>
<td>252</td>
</tr>
<tr>
<td>Western Electric Co.</td>
<td>52, 254</td>
</tr>
<tr>
<td>Westfield Metal Products Co., Inc.</td>
<td>251</td>
</tr>
<tr>
<td>Weston Electric Instrument Corp.</td>
<td>251</td>
</tr>
<tr>
<td>Wheeler &amp; Sons, Inc., S. B.</td>
<td>276</td>
</tr>
<tr>
<td>Whoso Electric Mfg. Co., S. S., H.</td>
<td>249, 258</td>
</tr>
<tr>
<td>Whistler Stamping Co.</td>
<td>275</td>
</tr>
<tr>
<td>Wilson, W. H.</td>
<td>21</td>
</tr>
<tr>
<td>Zoeken Labs., Inc.</td>
<td>265</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zenith Labs</td>
<td>267</td>
</tr>
<tr>
<td>PROFESSIONAL SERVICES</td>
<td>287</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEARCHLIGHT SECTION</td>
<td>(Classified Advertising)</td>
</tr>
<tr>
<td>BUSINESS OPPORTUNITIES</td>
<td>292</td>
</tr>
<tr>
<td>EMPLOYMENT</td>
<td>291, 292, 293</td>
</tr>
<tr>
<td>EMPLOYING</td>
<td>287</td>
</tr>
<tr>
<td>PERMANING</td>
<td>289</td>
</tr>
<tr>
<td>SPECIAL SERVICES</td>
<td>286</td>
</tr>
<tr>
<td>WANTED TO PURCHASE</td>
<td>276</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>USED EQUIPMENT</td>
<td>292, 297</td>
</tr>
<tr>
<td>American Electric Sales Co., Inc.</td>
<td>296</td>
</tr>
<tr>
<td>Clark-Reels Distributors</td>
<td>296</td>
</tr>
<tr>
<td>Communication Measurements Laboratory</td>
<td>294</td>
</tr>
<tr>
<td>Communication Measurements Co.</td>
<td>294</td>
</tr>
<tr>
<td>D.D. Supply Co.</td>
<td>276</td>
</tr>
<tr>
<td>Edco of N. Y., Inc.</td>
<td>294</td>
</tr>
<tr>
<td>Electra-Tech, Equipment Co.</td>
<td>276</td>
</tr>
<tr>
<td>Hathaway Instrument Co.</td>
<td>296</td>
</tr>
<tr>
<td>Kay Electric Co.</td>
<td>294</td>
</tr>
<tr>
<td>Maritime Switchboard</td>
<td>294</td>
</tr>
<tr>
<td>Material Handling Equipment Co.</td>
<td>294</td>
</tr>
<tr>
<td>Radio Station KSL</td>
<td>276</td>
</tr>
<tr>
<td>Remington</td>
<td>296</td>
</tr>
<tr>
<td>Warshawsky &amp; Laster</td>
<td>276</td>
</tr>
<tr>
<td>Sauls, Inc.</td>
<td>276</td>
</tr>
<tr>
<td>Westchester Electric Products</td>
<td>276</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUDA COMPANY</td>
<td>500 Fifth Avenue, New York 18</td>
</tr>
<tr>
<td>&quot;Creators of Fine Electronic-Acoustical Apparatus since 1915&quot;</td>
<td>297</td>
</tr>
</tbody>
</table>
Excellent electrical properties
Thin coating of insulation
More conductors in a given space
Ease of handling
Easy stripping
Light weight
Resistance to ozone, wear, sunlight, water, chemicals, and most other normally destructive factors
14 colors including NEMA standards

Wire insulation made with GEON has ALL these advantages

Be sure to specify wire or cable insulated with GEON in order to get all these advantages. Or, for information regarding special applications please write Department F-11, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio.
ATTENUATORS
DAVEN offers the most extensive line of standard and special attenuators for radio broadcast, television, sound recording, sound cinema, public address systems, laboratory test equipment and industrial electronic uses. Among the many features of DAVEN attenuators are detent gear for accurate index, improved shielding, captive terminal board, special silver contacts, certain stop, separable coupling, on dual and multiple unit models.

VOLUME LEVEL INDICATORS
Daven volume level indicators are designed to indicate audio levels in broadcasting, sound recording, and allied fields. They are sturdily constructed and correctly damped for precise monitoring. Specialized experience, for almost a quarter-century, in the design and development of test equipment has established Daven-Engineered products as "preferred" by leaders in the industry.

TOTALIZING & CALCULATING INSTRUMENTS*
Automatically totalize various dial settings at one point on the face of the unit, where the total can be seen quickly and easily. On units where the decimal point is not fixed, the calculating indicator sets the decimal point in the correct place. Eliminates the possibility of error in calculations... Saves time and effort. Available on bridges, resistance decades, voltage dividers, attenuation networks, etc.

*Patent applied for

DAVEN ENGINEERED SWITCHES
Featuring extremely low end uniform contact resistance and low noise level, Daven switches are supplied in varied combinations of decks, poles per deck and contacts per deck. Heavy duty, laminated, self-wiping arms need no lubrication; switch contacts and arms are of a special silver alloy (other metals to your specifications); bakelite or ceramic panels; break-before-make or make-before-break wiring.

POWER OUTPUT METERS
Designed to measure the power output of audio systems. Forty different values of load impedance available between 2.5 and 20,000 ohms providing a convenient method of impedance matching. They may also be used to determine internal impedance or optimum load, to measure insertion loss of a network, to measure noise pick-up level, and to test band width, selectivity and fidelity.

RESISTORS
Non-inductively precision wire wound SUPER DAVOHM resistors assure optimum permanency of calibration, close accuracy and extremely low temperature coefficients. Supplied in any resistance value from 0.1 ohm to 10 megohms. Built to tolerances within ±0.1%. To meet the most exacting requirements, Seal-Ohm resistors are offered. These hermetically sealed resistors may be obtained with the same characteristics as DAVOHM.

The RCA-1P42 high-vacuum phototube opens up entirely new fields of application to the design engineer—particularly for control purposes where space limitation is a prime consideration. Its extremely small size, combined with the unique "head-on" construction, permits exceedingly close spacing of the tubes in banks for controlling a large number of circuits, or the use of a single tube in closely confined quarters.

The semi-transparent cathode surface on the glass window in the large end of the 1P42 is sensitive to light sources predominating in blue radiation, and has negligible sensitivity to infrared radiation. The tube has an S-4 spectral response and maximum response at a wavelength of 4200 Angstroms.

The RCA-1P42 is especially designed for compact services such as the control of complex business-machine operations. It is also applicable to small equipment for sound-film reproduction.

A technical bulletin on the RCA-1P42 is available on request. RCA tube application engineers will be glad to work with you in adapting this or any other RCA tube types to your equipment designs. Address RCA, Commercial Engineering, Section D-6K, Harrison, N. J.

**RATINGS AND CHARACTERISTICS**

**MAXIMUM RATINGS, ABSOLUTE VALUES:**
- Anode-Supply Voltage (DC or Peak AC)...
  - ...150 max. Volts
- Cathode-Current Density...
  - ...14 max. Microamp/sq. in.
- Average Cathode Current*...
  - ...0.4 max. Microampere
- Ambient Temperature...
  - ...75 max. °C

**CHARACTERISTICS:**
- Maximum Dark Current at 150 volts...
  - ...0.005 Microampere
- Sensitivity:
  - At 4200 Angstroms...
  - ...0.020 Microamp/uvatt
  - Luminous**...
  - ...25 Microamp/lumen

**MINIMUM CIRCUIT VALUES:**
- DC Load Resistance...
  - ...1 Megohm

*On basis of the use of a sensitive cathode area 0.19" in diameter.
**Given for conditions where a Mazda projection lamp operated at a filament color temperature of 2870°K is used as a light source. With daylight, the value is several times higher; with light from a high-pressure arc, many times higher.

RCA Laboratories, Princeton, N. J.

THE FOUNTAINHEAD OF MODERN TUBE DEVELOPMENT IS RCA.