COMMERCIAL GRADE COMPONENTS
A wide range of units for every application

U.T.C. Commercial Grade components employ rugged, drawn steel cases for units from 1" diameter to 300 VA rating...vertical mounting, permanent mold, aluminum castings for power components up to 15 KVA.
Units are conservatively designed...vacuum impregnated...sealed with special sealing compound to insure dependability under continuous commercial service.

A few of the large number of standard CG units are described below. In addition to catalogued units, special CG units are supplied to customer's specifications.

INPUT, INTERSTAGE, MIXING AND LOW LEVEL OUTPUT TRANSFORMERS

(200 ohm windings are balanced and can be used for 250 ohms)

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Application</th>
<th>Primary Impedance Ohms</th>
<th>Secondary Impedance Ohms</th>
<th>Lt. Wt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>121</td>
<td>1 plate to 3 grids</td>
<td>15,000</td>
<td>3:1 ratio</td>
<td>5</td>
</tr>
<tr>
<td>122</td>
<td>2 plates to 3 grids</td>
<td>15,000</td>
<td>3:1 ratio overall</td>
<td>10</td>
</tr>
<tr>
<td>123</td>
<td>1 grid to 1 grid hum-bucking</td>
<td>50, 200, 500</td>
<td>3:1 ratio overall</td>
<td>15</td>
</tr>
</tbody>
</table>

CG VARIMATCH MODULATION UNITS
Will match any modulator tubes to any RF load. Primary impedances from 300 to 20,000 ohms, Secondary impedances from 30,000 to 300 ohms.

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Max. Audio Watts</th>
<th>Class C Input</th>
<th>Typical Modulator Tubes</th>
<th>List Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>CVN-1</td>
<td>30</td>
<td>30, 10, 20, 40, 45, 46, 64, 84, 104</td>
<td>3A3, 4A12</td>
<td>8.50</td>
</tr>
<tr>
<td>CVN-2</td>
<td>60</td>
<td>46, 60, 65, 66, 85, 150, 200, 250</td>
<td>6A6, 6L6, 6H6, 6K6</td>
<td>12.00</td>
</tr>
<tr>
<td>CVN-3</td>
<td>100</td>
<td>100, 125, 150, 175, 200, 250, 300, 375</td>
<td>6B4, 6B6, 6H6, 6K6, 6L6</td>
<td>18.00</td>
</tr>
</tbody>
</table>

For full details on this line, write for Catalog

UTC Commercial Grade Components

U.T.C. Commercial Grade Components employ rugged, drawn steel cases for units from 1" diameter to 300 VA rating...vertical mounting, permanent mold, aluminum castings for power components up to 15 KVA.
Units are conservatively designed...vacuum impregnated...sealed with special sealing compound to insure dependability under continuous commercial service.

A few of the large number of standard CG units are described below. In addition to catalogued units, special CG units are supplied to customer's specifications.

INPUT, INTERSTAGE, MIXING AND LOW LEVEL OUTPUT TRANSFORMERS

(200 ohm windings are balanced and can be used for 250 ohms)

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<td>100</td>
<td>100, 125, 150, 175, 200, 250, 300, 375</td>
<td>6B4, 6B6, 6H6, 6K6, 6L6</td>
<td>18.00</td>
</tr>
</tbody>
</table>

For full details on this line, write for Catalog

United Transformer Co.
150 Varick Street
New York 13, N.Y.

Export Division: 13 East 40th Street, New York 16, N.Y.
Cables: "ARLAB"

www.americanradiohistory.com
MEASURING MOISTURE
Installation of Fielden Drimeter on drying machine at Forstmann Woolen Co. plant in Passaic, N. J., to indicate moisture content of wool fabrics directly and continuously on a meter with accuracy of 1 percent while machine is in operation. For details see p 126. Photo by Syd Karon

AIRLINE TEST TECHNIQUES, by Joseph Albin
Facilities at main overhaul base of American Airlines at LaGuardia Field, New York

VHF TELEPHONE LINK FOR ISOLATED COMMUNITIES, by E. H. B. Bartelink and E. A. Slusser
Modified standard radio equipment is combined with a telephone-line terminating network

STABLE TIME AND FREQUENCY STANDARD
Microwave absorption in ammonia gas is basis of the National Bureau of Standards clock

HIGH-SPEED TRIGGER CIRCUITS, by Wm. B. Lurie
Pulses are provided for projectile research and other critical timing operations

AUTOMATIC BRIDGE FOR COMPONENT TESTING
Production device combines high speed with laboratory accuracy

TELEVISION FRONT-END DESIGN, Part 1, by H. M. Watt
Factors involved and methods of evaluating them for different types of circuits

STABILIZED DECADE-GAIN ISOLATION AMPLIFIER, by Joseph F. Keithley
Permits measurement of voltages on high-impedance circuits with low circuit loading

DIRECTIONAL ANTENNAS FOR A-M BROADCASTING, by John H. Battison
Simple method of plotting radiation patterns for two and three-tower arrays

CARRIER COMMUNICATION LEVEL REGULATOR, by W. S. Chaskin
All-electronic unit corrects twist and maintains constant level for open-wire lines

A COMPACT DIRECT-READING AUDIO-FREQUENCY METER
Simple audio measurement device for industrial, communications, or a-f use

ATMOSPHERIC NOISE MEASUREMENT, by H. Reiche
Canadian noise recordings use special preamplifying and signal-calibration equipment

RADAR RANGE CALIBRATION, by Robert L. Rod
Instrument for calibrating the concentric rings of a ppi indicator

LOW-DISTORTION A-M SIGNAL GENERATOR, by Ernest S. Sampson
Unique circuits permit accurate adjustment for full 100-percent modulation

RECEIVER GAIN NOMOGRAPH, by Peter G. Sulzer
Gives required voltage gain in terms of bandwidth, noise figure, antenna resistance and detector voltage

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The "Spectra" is an amazing new instrument developed by the Photo Research Corporation of San Fernando, Calif. For the first time in the history of colorimetry this instrument makes it possible to determine the color of illumination as easily as you can tell time with a watch or temperature with a thermometer. The "Spectra" is vitally important to photographers, motion picture technicians, theatrical specialists, printers, engravers, artists, divers, manufacturers of inks, dyes and pigments, dealers in fabrics, clothing and cosmetics. In fact, it should be absolutely essential to all to whom the accuracy of color is imperative.

In order to obtain direct reading of color temperature, it was necessary for the "Spectra" to incorporate an extremely sensitive microammeter that would read directly in degrees Kelvin. Because of Marion's recognized reputation for manufacturing extremely sensitive, trouble-free meters and instruments of this nature, Photo Research naturally turned to Marion for this key component.

Working with Karl Freund, Director of Photo Research Corporation and pioneer in photographic instrumentation, Marion designed, engineered and manufactured the kind of an indicating instrument required. Now, Marion meters are enabling technicians to secure direct readings in degrees Kelvin with the "Spectra" Color Temperature Meter in many aspects of science and industry.

When you need general or special-purpose meters for electrical indicating or measuring functions, you are invited to call on us here at Marion. We have had long and practical experience in helping others with these problems. We want to help you too.
*Centralab’s “Printed Electronic Circuit” — Industry’s newest method for improving design and manufacturing efficiency!

More and more manufacturers are turning to CRL’s space-saving Printed Electronic Circuits to help them produce finer products, faster. That’s how it is with Wells Gardner & Company, Chicago. Two Centralab P. E. C. units — Couplate and Filpec — are helping this firm cut assembling time of table-model radios by reducing the number of components needed and by eliminating many soldering operations. What’s more, these same units are improving performance of Wells Gardner radios by resisting temperature and humidity... by practically eliminating loose or broken connections.

INTEGRAL CERAMIC CONSTRUCTION: Each Printed Electronic Circuit is an integral assembly of Hi-Kap capacitors and resistors closely bonded to a steatite ceramic plate and mutually connected by means of metallic silver paths “printed” on the base plate.

For complete information about Filpec and Couplate as well as other CRL Printed Electronic Circuits, see your nearest Centralab Representative, or write direct.

LOOK TO Centralab® IN 1949!

Division of GLOBE-UNION INC.
THE RIGHT START
is a DUMONT oscillograph!

Specifically designed to utilize the outstanding capabilities of the Du Mont Type 281-A Cathode-ray Tube, the Type 281-A Cathode-ray Indicator has proved particularly well suited for high-tension studies such as surge testing of power-distribution transformers, lightning arresters and cables, or the study of discharges such as lightning. This instrument also has many applications in the diversified field of nuclear physics.

The capabilities of the Du Mont Type 281-A are further increased by the addition of the Du Mont Type 286-A High-voltage Power Supply. Thus with an extra 25,000 volts accelerating potential, the Type 281-A becomes probably the fastest writing and brightest oscillograph in the world. At a total accelerating potential of 29,000 volts, this combination permits writing rates in excess of 400 inches per micro-second.

A still further combination may be had by means of other elements of Du Mont Oscillography, whereby to achieve all the advantages of permanent oscillograph recording. The Types 314-A and/or 271-A Oscillograph-record Cameras assure lasting records of all traces displayed on the screen of the cathode-ray tube. The very fast writing-rates of the Type 5RP-A Cathode-ray Tube in the above combination may be easily and simply photographed for repeated reference. The Type 314-A affords either continuous-motion or single-image photography. The Type 271-A provides single-image photography only. Both cameras are readily mounted.

Tube Type 5RP-A and all Du Mont cathode-ray tubes, may be purchased separately.

Consult us about your oscillographic needs. Equipment demonstration arranged—no obligation.
February 10, 1949

Thomas R. Moore, Jr.
Antara Products Division
General Aniline & Film Corp.
444 Madison Avenue
New York, New York

Dear Tom:

We feel it will be of interest to you that we have been able to use Carbonyl E powdered iron cores at frequencies up to 25 mc. without sacrifice in performance. This has been accomplished by modifications of coil structures and close cooperation with quality core manufacturers at initial stages of design. The largest production quantities have been in HF I.F. Transformers and in I.F. Coils in Television Receivers.

Very truly yours,

F. W. Edwards
Chief Engineer

G.A. & F. Carbonyl Iron Powder

Yes! we said it was possible, and now Standard Coil Products has proved it. This outstanding manufacturer has been able to use low-cost Carbonyl Iron Powder, "E" Grade, in high frequency applications. "E" powder, lowest in cost of all grades, has heretofore been used at 455 KC. Now it has proved effective in HF transformers operating up to 25 mc.

For high Q at low cost use "E" powder in your cores and coils. Remember its stability and performance, its savings in space, weight, wire. Read Standard Coil Product's experience. Ask your core maker; ask your coil winder. You, too, can save with low-cost "E" powder!

Proper balance can be mighty difficult . . . but not for IRC resistors.

Basically engineered for balanced performance in every important characteristic, each IRC resistor type offers outstanding features for specific applications—without sacrifice of any significant factor.

New, ADVANCED Type BT Resistors, for example, are uniformly superior in every important JAN-R-11 requirement. At \( \frac{3}{2}, \frac{1}{2}, 1 \) and 2 watts they meet JAN-R-11 specifications for fixed composition resistors. Balanced in every characteristic, small IRC ADVANCED BT's are particularly suited to high ambient temperatures and rigorous television circuits. 12-page Bulletin B-1 gives all the performance facts. Use the convenient coupon.
For close tolerance requirements, IRC Precisions offer a fine balance of accuracy and dependability. Extensively used by leading instrument makers, they excel in every important characteristic. 1% accuracy is standard. Noise level is inherently low, and windings are fully protected against high humidity. Available in a wide selection of ranges and types, as described in Bulletin D-1.

Miniature MPM resistors are IRC engineered for high frequency applications. Their frequency characteristics are outstanding, but absolute balance has been maintained with all other significant electrical characteristics. Thin resistance film is permanently bonded to ceramic rods. Cupped ends of wire lead terminals are cemented to resistor bodies to form axial pigtailed. Rated at 1/4 watt, Type MPM's are available in resistance values from 10 ohms to 1.0 megohms. Write for Technical Data Bulletin F-1.

IRC Type W Wire Wound Controls are so carefully balanced, your customers can actually feel the difference. With center tap they are widely used as vertical and horizontal centering controls in television receivers. Design provides maximum adaptability to most rheostat and potentiometer applications within 2-watt power rating. Type W Controls have a 1 1/4" diameter, and 1/2" depth behind panel. Spiral Spring Connector provides positive electrical connection. Bulletin 1-2 gives details. Write for your copy.

Wherever the Circuit Says — Power Resistors • Precisions • Insulated Composition Resistors • Low Wattage Wire Wounds • Rheostats • Controls • Voltmeter Multipliers • Deposited Carbon Precisors • Voltage Dividers • HF and High Voltage Resistors

INTERNATIONAL RESISTANCE COMPANY
401 N. Broad St., Philadelphia 8, Pa.

INTERNATIONAL RESISTANCE COMPANY
403 N. Broad St., Philadelphia 8, Pa.

All standard IRC resistors are readily available in nominal quantities from your local distributor's well-stocked shelves. This is IRC's Industrial-Service Plan at work, assuring you 'round-the-corner service on your small order requirements. We'll be glad to send you the name of your nearest IRC Distributor.

INTERNATIONAL RESISTANCE COMPANY
401 N. Broad Street, Philadelphia 8, Pa.
In Canada: International Resistance Co., Ltd., Toronto, Licensee

Name
Title
Company

Also send name and address of our IRC Distributor

www.americanradiohistory.com
Centralab reports to

APRIL, 1949

More and more Hearing Aid makers are turning to Centralab's P.E.C.* to simplify production ... to build smaller, finer units!

JOHNSTON — finds special Ampec audio-amplifier cuts weight.
PARAVOX — uses custom CRL Ampec for quick assembly.
ALLEN-HOWE — was first to use P. E. C. in hearing aids.

The illustrated units are now on the market — Watch for at least 5 more by June First!

BELTONE — replaces 45 parts with one P. E. C. unit.
MICROTONE — uses 12 P. E. C. units to save space.

*Two Centralab Printed Electronic Circuits are used in hearing aids. (1) Ampec consists of all components of an audio-amplifier — tube sockets, capacitors, resistors, wiring — printed on one, compact ceramic chassis. (2) Filpec combines two capacitors and one resistor into a balanced diode load filter that is lighter and smaller than one ordinary capacitor.

Simplified wiring and assembly ... fewer individual components ... fewer leads to be soldered — these are some of important production-boosting advantages you get with CRL's Electronic Circuits. In addition, P. E. C. — by combin-

ing up to 45 individual parts into one light, tiny unit — makes it possible to reduce the weight and size of the electronic products you manufacture. For complete P. E. C. information, see your Centralab Representative, or write direct.

April, 1949 — ELECTRONICS
Great step forward in switching is CRL's New Rotary Coil and Cam Index Switch. Its coil spring gives you smoother action, longer life.

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

CRL Hi-Vo-Kaps combine high voltage, small size for TV use. Also used as filter and by-pass capacitors in video amplifiers 42-10.

Important: the recognized dependability and high quality of ceramic by-pass and coupling capacitors is now available at Centralab Distributors!

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

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

That's the way a friend recently spoke about the size of The Richardson Company.

His reasons are factors you may want to consider in selecting a supplier of plastics materials and services.

Here's how he put it:

BIG ENOUGH to have ALL of the facilities for big runs of (1) Laminated INSUROK sheets, tubes and rods, (2) punched parts, (3) fabricated parts and (4) Molded INSUROK products (molded of Durez, Plaskon, Melamine, Bakelite, etc.)

LITTLE ENOUGH to give personal and individual attention to EVERY customer and his problem.

Our size is just one of many factors that work in your favor when you turn to Richardson for plastics. Other important benefits are ready to go to work for you... such as experience, seasoned laboratory and production talent, competent production skills and a genuine interest in helping you improve your product and control production costs.

Why not discover for yourself what Richardson offers in the way of plastics materials and services?
A MAJOR ADVANCE IN TELEVISION TECHNIQUE
Developed by FEDERAL
Offered Only by FEDERAL
Patent Pending
AVAILABLE IMMEDIATELY

Minimizes Noise, “Snow” and “Ghosts”
Due to Transmission Line Pick-Up!

Here is the development for which the industry has been waiting.

It is a shielded, balanced 300-ohm line—Intelin K-111—developed and produced by Federal—and only by Federal.

Tests have given positive proof that Intelin K-111 goes far toward solving the lead-in problem that has been a major obstacle to television progress. K-111 protects against transmission line pick-up of ignition, streetcar, fluorescent light, diathermy and practically every other type of noise, “snow” and “ghosts” which interfere with picture clarity. This new lead-in won’t pick up re-radiation from nearby lead-ins in urban areas. In rural areas, where signal strength is weak, Intelin K-111 provides greatly improved reception by reducing the noise level.

Now manufacturers can obtain a lead-in that protects the quality performance they build into receivers of 300-ohm input impedance. Antenna kit makers can greatly improve their products. And, by changing to Intelin K-111, servicemen can call a halt to many of the customer complaints that take the profit out of service policies.

Intelin K-111 is also recommended for a pick-up-free connection between antenna post and input stage of FM and TV receivers—and for test equipment and other HF applications. For information, write to Department D-113.

Federal Telephone and Radio Corporation
Blaw-Knox makes specifications and budget meet!

THE consulting radio engineer prescribed uniform cross section towers of maximum strength and efficiency for this directional array, but the budget demanded a minimum of expenditure. So there was only one place to take the prescription—BLAW-KNOX.

The three type LT towers illustrated, although low in cost, have the strength and high factor of safety characteristic of Blaw-Knox design and engineering. The type SGN tower completing the array has the additional strength to support the heavy-duty FM pylon and any future TV requirements.

Your tower prescription will be promptly filled at BLAW-KNOX.

BLAW-KNOX DIVISION OF BLAW-KNOX COMPANY
2077 FARMERS BANK BUILDING, PITTSBURGH 22, PA.

BLAW-KNOX ANTENNA TOWERS

April, 1949 — ELECTRONICS
Facts for Manufacturers of High Frequency Equipment

**Power Loss**

\[ \text{Power Loss} = 55.5 \varepsilon^1 \tan \delta \times f \times V^2 \times 10^{-6} \text{ Watts} \]

Because they influence efficient and effective operation, low loss characteristics of Zircon Porcelain are most desirable in the manufacture of high frequency equipment.

Meeting the requirements of the power loss formula, Zircon Porcelain retains its low loss characteristics over a wide range of temperatures and frequencies. This factor is clearly demonstrated in the charts shown.

For applications in the field of radio, radar and other equipment of this nature, it will pay to get more detailed information. Write direct or discuss the use of Zircon Porcelain with one of our qualified field staff.

**CHART 1**

- Zircon Porcelain
- High Voltage Porcelain
- Special Zircon Porcelain

**CHART 2**

- High Voltage Porcelain
- Zircon Porcelain
- Special Zircon Porcelain

TAM

TITANIUM ALLOY MFG. DIVISION
NATIONAL LEAD COMPANY

Executive and Sales Offices: 111 BROADWAY, NEW YORK, N.Y. • General Offices and Works: NIAGARA FALLS, N.Y.

TAM is a registered trademark.

ELECTRONICS—April, 1949
PERFORMANCE FAR EXCEEDS PROMISE with PERFORMANCE-INSURED DURANITE CAPACITORS

The new AEROLENE impregnant eliminates the necessity of stockpiling and using both wax and oil capacitors. One impregnant does the work of both. Results in lower inventories with corresponding reduction in manufacturing costs.

DURANITE capacitors show no deterioration in stock. May be stored in advance of actual use, with corresponding economy and convenience.

DURANITE does not dry out. Does not develop cracks or fissures. It stays tight throughout.

Sample DURANITES right off the production lines cheerfully sent for your own tests and conclusions. Meanwhile, let us quote on your TV and other severe-service capacitor needs.

Based on our lab and life tests, Aerovox has made several superlative claims for the exclusive DURANITE technique. And because DURANITE means a new impregnant, Aerolene, new processing methods, new casing material—Aerovox has sought not to confuse DURANITE capacitors with conventional molded tubulars.

For example: Note actual clipping from DURANITE introductory literature issued almost two years ago and based on units produced by our pilot plant. Then note the performance of a batch of initial-production DURANITES that were in a brief case and carried in planes, trains and autos many thousands of miles along the Eastern Seaboard from March through November (during the humid summer months), and just recently measured for insulation resistance by lab men of a leading radio manufacturer* Could usual paper tubulars approach this performance?

Definitely—but very definitely—DURANITES are setting brand new standards of stability, dependability and durability.

AEROVox TYPE P-88 DURANITE TUBULARS

Insulation Resistance after Nine Months

<table>
<thead>
<tr>
<th>Cap. Mfd.</th>
<th>Volts</th>
<th>IR in Megohms</th>
<th>Case Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01</td>
<td>400</td>
<td>30,000</td>
<td>11/32 x 1 1/8&quot;</td>
</tr>
<tr>
<td>0.022</td>
<td>400</td>
<td>35,000</td>
<td>13/32 x 1 3/8&quot;</td>
</tr>
<tr>
<td>0.022</td>
<td>600</td>
<td>100,000</td>
<td>15/32 x 1 3/8&quot;</td>
</tr>
<tr>
<td>0.10</td>
<td>400</td>
<td>24,000</td>
<td>17/32 x 1 5/8&quot;</td>
</tr>
<tr>
<td>0.22</td>
<td>400</td>
<td>40,000</td>
<td>21/32 x 2&quot;</td>
</tr>
</tbody>
</table>

See accompanying text for conditions.

FOR RADIO-ELECTRONIC AND INDUSTRIAL APPLICATIONS

AEROVox CORPORATION, NEW BEDFORD, MASS., U.S.A.

Sales Offices In All Principal Cities • Export: 13 E. 40th St., New York 16, N.Y.

Cable: ‘ARLAB’ • In Canada: AEROVox CANADA LTD., HAMILTON, ONT.

April, 1949 — ELECTRONICS

www.americanradiohistory.com
Truarc saves 5 minutes, 9 cents in materials per unit without re-design of electric sanders

Every sander through the production lines costs 9 cents less for materials, requires 5 minutes less labor—with just the simple change from cap screw and nut to Waldes Truarc rings by Porter-Cable Machine Company, Syracuse, New York. The change to Truarc required no new design, no alterations in castings, but just the reappraisal of old methods.

Truarc can help you cut costs and increase production, too. Wherever you use machined shoulders, nuts, bolts, snap rings, cotter pins—there's a Truarc ring that does a better job of holding parts together. All Waldes Truarc Retaining Rings are precision engineered, remain always circular to give a never-failing grip.

Waldes Kohinoor, Inc., 47-10 Austel Place Long Island City 1, N. Y.

Please send 28-page Data Book on Waldes Truarc Retaining Rings.

Name: __________________________
Title: __________________________
Company: _______________________
Business Address: ________________

City: ___________ Zone: _______ State: _______
IF YOU MACHINE COPPER—

THIS REVERE METAL WILL SAVE YOU MONEY

REVERE makes Free-Cutting Copper Rod, and if you are making electronic devices requiring machined copper parts of high conductivity, it will pay you to investigate the savings made possible by this metal. We would suggest that you make trial runs to prove what it will do under your own shop conditions. That was the procedure followed by The Trumbull Electric Mfg. Co., Plainville, Conn., with these results:

Part #18107 and 18108, contacts for the Type D switch illustrated, were designed around this alloy. Trumbull states: "On both these parts we found we could make them in one operation instead of two. That is, due to the smooth free cutting of the metal, it was unnecessary to perform a facing operation. . . . Our Screw machine foreman advises that, in his opinion, both these parts could be made four times as fast as out of ordinary electrolytic copper rod."

#3731, 60 amp. post stud—5,760 pieces run in 19.6 hours with no machine down-time; 10,425 pieces of ordinary copper rod run in 66.6 hours with 11.8 hours machine down-time. In addition to the extra time required, three sets of dies were used for the regular rod. "The savings of the free-cutting material over ordinary copper were figured at $1.81 per thousand, including in these costs both material and direct labor."

#16552, space washer. "Savings per thousand over electrolytic copper were 77¢. This figure included the material difference and direct labor. In addition, there was an 18% saving in machine down-time."

#K-60-1A, 70-200 amp. stud. "The use of Free-Cutting Copper Rod on this part very definitely increased production and practically voided machine down-time."

In a letter to Revere, Trumbull added: "In general, at least for most of the parts we have used, we find that there is at least a 25% saving in machine time of free-cutting over regular copper. In addition, the workers are enthusiastic about this material, particularly when running studs, because of the fact that it is no longer necessary for them to keep a constant close watch on the machine to see that the turnings do not become tangled up with the moving parts of the machine."

The Trumbull experience is being duplicated in other machine shops. If you have not tried this Revere Metal, we suggest you get in touch with your nearest Revere Sales Office.

REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York


April, 1949 — ELECTRONICS
Glass bushings
Now Available

to manufacturers of
electronic equipment

Can be welded, brazed, or soldered to case, forming a strong, permanent, hermetic seal that eliminates moisture problems and often permits more compact, light-weight design.

General Electric now offers to other manufacturers the glass bushings that it has used so successfully on capacitors, rectifiers, modulator and instrument transformers, and other electrical equipment. These bushings are cast of an exceptionally stable, low-expansion glass. Metal hardware is a special nickel-alloy steel, fused to the glass in casting. Bushings are attached directly to the apparatus without gaskets by soldering, welding or brazing the metal bushing flange to the metal case.

The resulting joint between bushing and equipment is permanent, vacuum-tight, and of high mechanical strength. It is especially desirable for equipment subject to vibration, shock, fungus growth or severe changes in temperature. These glass bushings are available to meet dry, 60-cycle, flashover values of from 10 to 50 kv, and in current ratings of 25 and 50 amperes (large sizes up to 800 amperes). They may be single or multi-conductor and can be provided with a top flange to permit mounting tube sockets directly on the bushings. Diameters range from 1\(\frac{1}{8}\) to 3\(\frac{1}{8}\) inches and weights from 2\(\frac{1}{4}\) oz. to 4 lb.

WRITE TODAY FOR BULLETIN GEA-5093

GENERAL ELECTRIC

www.americanradiohistory.com
These publications will be of value to you. GEA-640B—an interesting picture story on capacitors. GEA-2621 and -4357 on d-c capacitors. GEA-2027 on general a-c capacitors. GEA-2526 and -4655 on ballast capacitors. Write Apparatus Department, General Electric Company, Schenectady 5, N. Y.
THESE are your capacitors. By and large, they are the result of challenges made on the drawing boards of your equipment design engineers—challenges that have led us to new concepts in capacitor development and design.

We have made contributions—the introduction of the liquid dielectrics Pyranol and Lectronol, the development of thin kraft paper and Lectrofilm, and the use of silicone rubber bushings and gaskets—all evidences of our efforts toward smaller size, lower weight, higher quality, and lower-cost capacitors.

But basically these capacitors have been built to meet your needs. We hope sincerely that you will call upon us whenever we can be of assistance.
HERE'S THE ALL-PURPOSE SWITCH

DESIGN engineers already have utilized the SB-1 for over 10,000 control combinations on circuits up to 20 amperes at 600 volts a-c or d-c.

Standard parts and a simple basic design mean longer life and low initial cost. There's a standard SB-1 for most jobs. If a standard can't satisfy, we'll build what you want from standard cams, contacts, and fingers of the basic design.

A variety of attractive switch handles, and water-tight, dust-tight, oil-immersed, fabricated-metal, or explosion-proof housings are available to fit your particular installation problems.

Your nearest G-E sales representative will be glad to assist you in the selection of an SB-1. Also, ask him for a copy of GEA-4746 which gives additional information about the SB-1, or write to Apparatus Department, Section 856-6, General Electric Company, Schenectady 5, New York.
DEFLECTION YOKE SHELLS
with black exterior finish, as illustrated above, have 3" inside diameter and 3.093 outside diameter.

Q-3 is 2 31/32" long. The others, Q-4, Q-5, Q-6, Q-11, Q-12, Q-13 are 2 11/32" long.

COSMALITE* SHELLS
for Television deflection yokes are made to meet your individual needs.

Keep in mind that we have tools available without charge for all Shells shown above. And...we can quickly make tools for other punching and notching as may be required. COSMALITE is known as a quality product. It meets the most exacting requirements.

Inquiries given specialized attention


The CLEVELAND CONTAINER Co.
6201 BARBERTON AVE. - CLEVELAND 2, OHIO
PLANTS AND SALES OFFICES at Plymouth, Wis., Chicago, Detroit, Ogdensburg, N.Y., Jamesburg, N.J.
ABRASIVE DIVISION at Cleveland, Ohio
CANADIAN PLANT: The Cleveland Container, Canada, Ltd., Prescott, Ontario

ELECTRONICS - April, 1949
MITCHELL-RAND

WEDGES

all sizes ... all styles

HARD WOOD MAPLE * FIBRE AND FISH PAPER

MITCHELL-RAND HARD WOOD MAPLE WEDGES are fine grain, hard, accurately sized and shaped and wax processed to resist humidity and moisture. They are available in lengths of 30 inches and in any of 20 styles and sizes.

MITCHELL-RAND MOLDED and FORMED WEDGES are of FIBRE and FISH PAPER. They are flexible, easy to handle, have great bending strength with high dielectric and tensile resistance ... available in lengths of 40 inches and in almost any shape and form.

For WEDGES as for all other ELECTRICAL INSULATIONS you can depend upon —

MITCHELL-RAND

THE ELECTRICAL INSULATION HEADQUARTERS SINCE 1889.
TWO new Hypex Projectors—designed for 360-degree sound dispersal—are now available. With sound distributed horizontally in all directions, these new models are intended for installations where coverage of relatively large areas and suspension from the ceiling are desired. Like all Hypex Projectors, these radial units incorporate the famous Hypex formula which results in improved acoustic performance.

By the addition of the two radials to the four previously announced Hypex units illustrated below, the Hypex line now includes a model for every “sound” need, indoors or outdoors.

JENSEN MANUFACTURING COMPANY
Division of the Muller Company
6607 SOUTH LARAMIE AVENUE, CHICAGO 38, ILLINOIS

In Canada: COPPER WIRE PRODUCTS, LTD., 351 CARLAW AVENUE, TORONTO
A NEW SOLUTION TO OLD PROBLEMS

Aerocom's New Artificial Antenna,
Simulating Actual Operating Conditions,
Saves Time On Transmitter And Receiver Tuning

It is no longer necessary to final tune transmitters or receivers aboard aircraft. With the new Artificial Antenna (Model DA200) you can precisely simulate, electrically, any normal aircraft antenna. All this without leaving the test bench. This equipment will accept any transmitter power up to 200 watts -- coaxial fitting provides direct 52 ohm metered load. Sturdily constructed for hard usage, can be mounted in standard rack cabinet or used on bench top.

The problem of transmitter failure in radio beacons is very serious. The safety of crew and passengers depends on the continuous operation of this navigational aid.

Aerocom's Automatic Transfer provides the means of placing your standby transmitter "On the Air" should the main transmitter fail for any reason except loss of powerline voltage. It can be set to function either on abnormally low carrier power or abnormally low level of keyed tone identification signals.

A letter or wire from you will bring descriptive literature

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

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


April, 1949 — ELECTRONICS
MYCALEX 410 MAKES HISTORY

Sets astonishing high operational record for telemetering commutator used on aeronautical research projects... MYCALEX 410 only insulation to fill exacting requirements.

To February 7, 1949, more than 200 hours of maintenance free, high speed, clean signal telemetering commutator performance has been logged on MYCALEX 410 Units. Experience indicated four hours was optimistic... specifications hoped for ten hours... and the challenging problem was solved by MYCALEX 410 molded insulation.

SPECIFICATIONS TO BE MET IN PRODUCING MYCALEX 410 MOLDED INSULATION COMMUTATORS FOR TELEMETERING

O.D. 2.995" ± .000 - .002 • Location of 3 slip rings and the 3 contact arrays from the center has a total tolerance of ± .001. • Contact spacing 6° apart ± 1 minute. • Parting line thicknesses on insulation body are + .002 - .000. • Concentricity between ball bearing bushing and O.D. .0015. • Assembly height from face of slip rings and contacts to Mycalex 410 has tolerance of + .002 - .000. • Every contact must be tested from its neighbor contact for infinity on a 500 volt megger meter. • Plate ambient -20° C. to + 100° C. • Plate to operate at 95% humidity must not warp, crack, change in dielectric constant or resistivity. • Contacts to resist high temperatures and must not loosen when repeatedly heated by soldering.

SPECIFY MYCALEX 410 for Low Dielectric loss... High Dielectric strength... High Arc Resistance... Stability over wide Humidity and Temperature Changes... Resistance to High Temperatures... Mechanical Precision... Mechanical Strength... Metal Inserts Molded in Place... Minimum Service Expense... Cooperation of MYCALEX Engineering Staff.

MYCALEX 410 molded insulation is designed to meet the most exacting requirements of all types of high frequency circuits. Difficult, involved and less complicated insulation problems are being solved by MYCALEX 410 molded insulation... the exclusive formulation of MYCALEX CORP. OF AMERICA... our engineering staff is at your service.

MYCALEX CORP. OF AMERICA

"Owners of 'MYCALEX' Patents"

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

ELECTRONICS — April, 1949
The Name that Makes NEWS in TRANSFORMERS

POWER TRANSFORMERS
A Complete Line in 2 alternate "Sealed in Steel" Mountings

Exclusive features like these make this the "Engineer's Line": Plate and filament voltages to fit today's most-used tubes; in two mountings—with solder lugs or 10" leads; one series for condenser input, another for reactor input use; exactly matching reactor for each power transformer. Get complete catalog now.

HIGH Q CHOKES for Dynamic Noise Suppression Circuits

Two efficient filter reactors, inductance values .8 and 2.4 henrys respectively, are designed for noise suppression circuits, but can be used in any tuned circuit requiring the given inductances. Inductance values are accurate within ±5% with up to 15 ma. d-c. Minimum Q of 20. Mounted in identical drawn steel cases 11/16" x 23/4" x 1 3/4". Write for descriptive sheet including diagram of simplified dynamic circuit.

FULL FREQUENCY RANGE AUDIO TRANSFORMERS

within ± 1/2 db.
typical response
30 to 15,000 cycles

For uniformly low distortion, for response curves that are truly flat over the full frequency range, use these CHICAGO input and output units. Get the facts on the BO-6 (P-6L6's to 6/8 or 18/20-ohm speaker), the BO-7 (600/150-ohm line to 6/8 or 16/20-ohm speaker), and other CHICAGO full frequency units—they're tops in transformers.

ISOLATION TRANSFORMERS
for safer, more efficient servicing

For isolating chassis ground from line ground and eliminating the shock hazard (important on "hot" TV sets). Dual purpose: where line is under/over voltage, sec. supplies 115 v.; with 115-volt line, sec. supplies 125/115/105 volts (high/low voltage helps find doubtful tube, etc.). Three sizes: 50, 150, or 250-VA, to cover full range of servicing needs.

MODULATION TRANSFORMER for Ham and Commercial Transmitters

A Modulation Transformer ideally suited for use in ham and commercial speech transmitters. Will deliver 250 watts of Class B audio power from P-P 203A's, 211A's, 805A's, 78TL6's, etc. to a Class C load with response variations not exceeding ±1 db. over the speech range, 200-3,500 cycles. Primary impedances, 9000/6700 ohms; secondary impedances, 8000/6000/4000 ohms. A matching driver transformer is available.

REPLACEMENT TRANSFORMERS
Premium Quality Yet They Cost No More

The new CHICAGO Replacement Line provides servicemen with a wide range of standard ratings that fit the most frequent power and audio transformer requirements. These units, backed by CHICAGO's 20 years of manufacturing experience represent the finest quality attainable through engineering ingenuity and precision manufacture—yet they cost no more.

Write for complete CHICAGO Transformer Catalogs

April, 1949 — ELECTRONICS
Look for the orange package . . . the universally popular solder for use in electrical applications where bonding must be secure and free from corrosion.

The flux is in the solder . . . all you need is heat! Federated Rosin Core Solder is available in 1, 5, and 20-pound sizes.

Federated makes every commercial solder . . .

Asarco Body Filler Metal, acid-core, solid wire, spray-gun, and bar . . . purity and composition guaranteed by the world’s leading supplier of solder.
INDIANA PERMANENT MAGNETS may be your answer, too...

"Packaged Energy" Saves Size, Weight, and Cost

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

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

THE INDIANA STEEL PRODUCTS COMPANY
PRODUCERS OF "PACKAGED ENERGY"
6 NORTH MICHIGAN AVENUE • CHICAGO 2, ILL.
electrolytics
for really dependable
performance for
television and other
exacting uses

SPRAGUE
PIONEERS OF
ELECTRIC AND ELECTRONIC PROGRESS

BUILT FOR LONG, TROUBLE-FREE PERFORMANCE
UP TO 450 VOLTS AT 85°C.

These sturdy little dry electrolytics have what
it takes to match the toughest capacitor
assignments in television and other exacting
equipment where the use of ordinary
components may only be inviting trouble.
They're compact, easy to mount. They'll
withstand plenty of heat. Thanks to a recently
developed processing technique, they are
outstandingly stable, even after extended
shelf life. In every respect, they are designed
for better-than-average service on tougher-
than-average jobs.

SPRAGUE ELECTRIC COMPANY, NORTH ADAMS, MASSACHUSETTS

ELECTRONICS — April, 1949
A new low-inertia, high-torque motor by KOLLSMAN

This newest addition to the Kollsman line of special-purpose motors is a two-phase, low-inertia induction unit. It is designed for use in 400-cycle servo (null follow-up) systems which require a small motor with an unusually high torque/inertia ratio.

The Model 1318-0460 delivers maximum torque at stall, has a low moment of inertia and will not run single phase. Its frame is fully enclosed. Units with either plain or pinion shaft are available.

The Model 1318-0460 is but one of a complete line of special-purpose motors developed by Kollsman for remote indication and control applications. Complete information concerning any or all of these units is available by addressing: Kollsman Instrument Division, Square D Company, 80-08 45th Avenue, Elmhurst, N. Y.
The Disc Cathode, product of the Electronics Division of Superior Tube Company, is designed primarily for television and other cathode ray gun structures. The Disc Cathode is manufactured to Superior Print ED1-1, a copy of which is available upon request.

For television, other tubular products of the Electronics Division include:
- Stainless Steel Anode and Grid Cylinders, available with rolled ends, straight and angle cut, etc.
- Seamless and Lockseam Nickel Cathodes.
- Aluminum Wave Guide Tubing in cut or random lengths for the "X" and "K" bands.
- Tubing for glass to metal seals.

You are invited to contact Superior's Electronics Division for complete information.


The Disc Cathode manufactured by the Superior Tube Company has been proved in service. It consists of a tubular nickel shank, a ceramic insulator, and an emitting cap welded to the shank. Its use relieves you of a delicate assembly operation. Through the use of integral beads (embosses) on the tubing, the ceramic is firmly held in place, so that it does not move during processing.

Close control of tolerances, material and cleanliness is maintained, with the result that the cut-off characteristics of your television tube are more uniform. In addition to the plain ceramic insulators (Print ED2-3) illustrated above, a grooved type (Print ED2-3A), is also available in regular production.
BUILT ON ALUMINUM

The "EXTRA SOMETHING" that spells TOP PERFORMANCE

NO "primrose path" guides the fancy skater to the championship spotlight. The amazing feats that thrill her audiences were made possible only through tireless practice and tenacity of purpose—the "Extra Something" that spells Top Performance.

In the manufacture of Seletron Selenium Rectifiers we have labored with similar tenacity of purpose to impart to our product the "Extra Something" that spells Top Performance—extra quality in materials, extra care in maintaining the highest precision standards, extra testing and inspection from start to finish of the production line.

Where such an exacting formula is followed the result must be a product of dependable performance and long life.

Write today for catalog. Address Dept. ES-16

SELETRON DIVISION
RADIO RECEPTOR COMPANY, INC.
Since 1922 in Radio and Electronics
251 WEST 19TH STREET. NEW YORK 11, N. Y.

April, 1949 — ELECTRONICS

CODE NUMBER 5L1 5M1 5P1 5R1 5Q1
Current Rating 75 ma. 100 ma. 150 ma. 200 ma. 250 ma.
Plate Height 1" 1" 1½" 1½" 1"
Plate Width ¾" 1" 1½" 1½" 1"
KAY ELECTRIC COMPANY

FOUR NEW KAY INSTRUMENTS
INTRODUCED AT I.R.E. SHOW...
For High Frequency Laboratory Work and TV Receiver Development and Service.

THE MEGA-NODE (NOisE dioDE) HELPS OVERCOME RF FRONT END PROBLEMS
- A Calibrated Random Noise Source
- Read the Noise Figure of Your Receiver Directly from a Panel Meter in db-
- Selection of Various Output Impedances by Panel Switch.

SPECIFICATIONS
Frequency Range: 1 to 220 mc
Output impedances: 50, 75, 100, 150, 300 ohms and infinity controlled by panel switch. Balanced or Unbalanced.
Noise Figure Ranges: 0 to 17 db at 50 ohms
0 to 23 db at 300 ohms
Filament Voltage: Regulated
Power Supply: 117 Volts plus or minus 8 volts 60 cps
Dimensions: 8" x 16" x 8"

Price $295.00 F. O. B. Factory

THE MEGALYZER JR. A SENSITIVE VISUAL VOLTMETER AND SPECTRUM ANALYZER ATTACHMENT
- Used in Combination with Mega-Sweep and Standard Oscilloscope as a High Frequency Spectrum Analyzer.
- With Same Combination plus Calibrated Signal Generator, Voltage Measurements over Wide Frequency Range can be Made.

SPECIFICATIONS
Frequency Range: 30 to 500 mc Usefull to 1000 mc.
Frequency Sweep on Display: Up to 30 mc
Frequency Resolution: 100 KC
Sensitivity: 100 to 10,000 microvolts. Range can be extended upward by external pads.

Price $250.00 F. O. B. Factory

THE MEGALIGNER PROVides TUNABLE C W TYPE "BIRDIE" MARKER OR TUNABLE PIP MARKER
- A Television Marker Generator
- Covers All Present and Proposed Television IF Frequency Bands
- PIP Type Marker Does Not Go Through Receiver. Does Not Overload Receiver in Pass Band Nor Disappear in Traps.
- Accuracy .5% of Full Scale

SPECIFICATIONS
Frequency Range: Two Bands 19 to 30 mc; 30 to 49 mc
Marker Outputs: CW "Birdie" or "PIP" Type
Power Supply: Self Contained
Amplitude Control: Both Outputs Adjustable by Panel Controls
Accuracy: .5% Full Scale
Mixing System: Self Contained Mixer System for Use with Sweeping Oscillator to Obtain "PIP"

Price $150.00 F. O. B. Factory

THE MICROWAVE-MEGA-MATCH DISPLAYS REFLECTED ENERGY IN X-BAND
- Displays Amount of Reflected Energy Over a Wide Frequency Range
- Sweep Frequency Width on Display up to 30 mc
- Rapid Adjustment of Microwave Antennas and Matching Sections is possible.
- Indications of Reflection Coefficient Change Done to .02.
- Approximately 75 feet 1" x 1/2" Waveguide Occupying Space 8 feet by 1 foot Supplied as Delay Waveguide.

SPECIFICATIONS
Frequency Range: 8500 to 9700 mc (X-Band)
Frequency Sweep on Display: Up to 30 mc
Frequency Measurement: Calibrated Microwave Wave meter Sensitivity: Reflection Coefficient Changes Indicated down to .02.
Equipment Includes Power Supply and Control Box. Approximately 75 Ft. 1" x 1/2" Delay Waveguide in 8" by 1" space

Price $895.00 F. O. B. Factory

FOR FURTHER DETAILS WRITE

KAY ELECTRIC CO., 25 MAPLE AVE., PINE BROOK, N. J.
Tel Caldwell 6-4000

Manufacturers of: Mega-Sweep, Mega-Marker, Mega-Pipper, Mega-Marker Jr., Mega-Match, Mega-Pulser, Megalyzer, Micro-Pulser, Kay Sound Spectrograph.

ELECTRONICS — April, 1949
Reduced studio operating budgets...expanded program facilities...
with the DU MONT MONOCHROME SCANNER Model TA-150-A...

Precisely, this latest Du Mont development, the Monochrome Scanner Model TA-150-A, is virtually "The Magic Lantern of Telecasting." It handles test patterns, commercials, station identification, still photographs, cartoons, graphs—any and all non-animated subjects in the only logical and really economical manner.

When driven from a sync generator such as the Du Mont Model TA-107-B, this unit develops an RMA standard composite signal from standard 2 x 2" glass slides. Still-image pickups become a simple, economical, one-man job. The need for costly film trailers and the operation of movie projectors for short bits, are minimized. The Monochrome Scanner soon pays for itself. Definitely, here's a "must" in the money-making telecast setup.

Early delivery predicated on previous orders

DU MONT MONOCHROME SCANNER Model TA-150-A

A short-persistence Du Mont 10" C.R. tube produces a light beam focused by a projection lens to the glass slide. A condenser lens focuses that light beam after passing through the slide, onto a multiplier-type photo-electric cell. The signal voltage developed is amplified and mixed with blanking and sync pulses, resulting in the RMA standard composite picture signal.

An automatic slide changer handles up to 25 positive or negative 2 x 2" glass slides, operated from local or remote position. The equipment houses the C.R. tube and necessary circuits for producing a bright, sharply focused raster on the tube screen. The raster is kept in constant focus by the focus-stabilizer circuit. Sweep-failure protection is provided by automatically cutting off the high voltage to the tube. The raster is developed by sweep circuits driven by horizontal and vertical pulses.

A switch inserts sync if a composite signal is required, or leaves out the sync if only a video and blanking signal is required for video mixing purposes. Controls to set sync and blanking levels are provided. The control panel carries all necessary switches, fuses and fuse indicators. A fadeout switch sets the fading of the signal to black level when slides are changed for slow, medium or fast rate of change.

The unit is complete with its own high and low voltage power supplies. Operates on 115 V, 60 cycles. Approx. 80 amps.

Mounted in standard rack measuring 831/2" h. x 22" w. x 18" deep.

DU MONT First with the Finest in Television

ALLEN B. DU MONT LABORATORIES, INC. • TELEVISION EQUIPMENT DIVISION, 42 HARDING AVE., CLIFTON, N. J. • DU MONT NETWORK AND STATION WABD, 515 MADISON AVE., NEW YORK 22, N. Y. • DU MONT'S JOHN WANAMAKER TELEVISION STUDIOS, WANAMAKER PLACE, NEW YORK 3, N. Y. • STATION WTTG, WASHINGTON, D. C. • HOME OFFICES AND PLANTS, PASSAIC, N. J.

April, 1949 — ELECTRONICS
Specify **HI-Q** COMPONENTS

For Every HI-QUALITY Installation

Above is a reproduction of the large mural which adorns the wall of our new offices in Franklinville, N. Y. It provides a comprehensive picture of the many applications into which HI-Q Components find their way.

**HI-Q COMPONENTS**

**BETTER 4 WAYS**

- **PRECISION** Tested step by step from raw material to finished product. Accuracy guaranteed to your specified tolerance.
- **UNIFORMITY** Constancy of quality is maintained over entire production through continuous manufacturing controls.
- **DEPENDABILITY** Interpret this factor in terms of your customers' satisfaction. Year after year of trouble-free performance. Our Hi-Q makes your product better.
- **MINIATURIZATION** The smallest BIG VALUE components in the business make possible space saving factors which reduce your production cost... increase your profits.

- In the air, on land and sea, in myriads of industrial and domestic applications, you'll find Hi-Q Components set the standard for Precision, Quality, Uniformity and Miniaturization. The services of our engineering staff are always available for consultations. Why not write us today?

**Hi-Q**

**Electrical Reactance Corp.**

FRANKLINVILLE, N. Y.

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

ELECTRONICS — April, 1949

www.americanradiohistory.com
The best features of Presto’s dual motor gear drive with the overhead mechanism and turntable of the famous Presto 6-N.

Yes, engineers have often asked us for a compact, economical yet high-quality recorder. Now you may have it in the Presto 66-G for standard and microgroove recording.

Here is a unit ideally suited and priced for the typical broadcast station or large transcription manufacturer. List price, Standard Model, $996! ($70 additional for microgroove.)

Here’s perfection in total speed regulation and very low mechanical disturbance, thanks to the standard Presto dual motor gear drive. Here’s high-quality recording, too, for the 66-G, of course, includes the Presto 1-D cutting head.

You’ll find 66-G equal to the most exacting recording tasks when used with suitable amplifiers such as Presto 92-A recording amplifier and 41-A limiter amplifier.

FOR HIGHEST FIDELITY . . . IT’S PRESTO DISCS
Microgroove, even more than standard recording, demands a perfect disc. The answer is Presto. For, sixteen years ago, Presto made the first lacquer-coated discs . . . and today Presto discs are first in quality.

READY NOW: Magnetic Tape Recorder
You probably saw Presto’s new superquality magnetic tape recorder at the I.R.E. Show. If not, be sure to see it in Presto’s room at the N.A.B. Convention in Chicago.

Mailing Address: P. O. Box 500, Hackensack, N. J.
In Canada: WALTER P. DOWNS, LTD., Dominion Sq. Bldg., Montreal
OHMITE RHEOSTATS are available in ten sizes from 25 to 1000 watts.

Models H (enclosed) and J (enclosed)
Also AN 3153 (AN-R-14a)

**Models H (enclosed) and J (enclosed)**

OHMITE RHEOSTATS MEET THESE RIGID TESTS:

- ★ 5-Hour Vibration Test
- ★ 100-Hour Salt-Spray Corrosion Test
- ★ 150-Hour 95% Humidity Electrolysis Test

and other tests as prescribed in Specification JAN-R-22.

By meeting these severe Joint Army-Navy requirements, Ohmite Rheostats have proved what industry has long accepted as true—that they can be depended upon for unfailing performance under the toughest operating conditions. All-ceramic construction...a smoothly gliding metal-graphite brush...uniform windings locked in place by vitreous enamel...insure close control throughout years of trouble-free service. It will pay you to standardize on Ohmite Rheostats for your product.

Be Right with OHMITE

RHEOSTATS - RESISTORS - TAP SWITCHES

See Nex...
Resistors Illustrated Are Grade 1, Class I, Characteristic "F"

**MEET REQUIREMENTS OF**
**JOINT ARMY-NAVY SPECIFICATION JAN-R-26**

**STYLES AND SIZES**

**TAB-TERMINAL TYPE**

<table>
<thead>
<tr>
<th>Style</th>
<th>Overall Length</th>
<th>Diameter</th>
<th>Watts</th>
</tr>
</thead>
<tbody>
<tr>
<td>EW-30</td>
<td>1&quot;</td>
<td>19/32&quot;</td>
<td>8</td>
</tr>
<tr>
<td>EW-31</td>
<td>1-1/2&quot;</td>
<td>19/32&quot;</td>
<td>10</td>
</tr>
<tr>
<td>EW-32</td>
<td>2&quot;</td>
<td>19/32&quot;</td>
<td>12</td>
</tr>
<tr>
<td>EW-33</td>
<td>3&quot;</td>
<td>19/32&quot;</td>
<td>18</td>
</tr>
<tr>
<td>EW-34</td>
<td>3-1/2&quot;</td>
<td>19/32&quot;</td>
<td>30</td>
</tr>
</tbody>
</table>

**FERRULE-TERMINAL TYPE**

<table>
<thead>
<tr>
<th>Style</th>
<th>Overall Length</th>
<th>Diameter</th>
<th>Watts</th>
</tr>
</thead>
<tbody>
<tr>
<td>RW-35</td>
<td>4&quot;</td>
<td>29/32&quot;</td>
<td>38</td>
</tr>
<tr>
<td>RW-36</td>
<td>4-1/4&quot;</td>
<td>1-5/16&quot;</td>
<td>60</td>
</tr>
<tr>
<td>RW-37</td>
<td>5-1/8&quot;</td>
<td>1-5/16&quot;</td>
<td>70</td>
</tr>
<tr>
<td>RW-38</td>
<td>6-1/8&quot;</td>
<td>1-5/16&quot;</td>
<td>110</td>
</tr>
<tr>
<td>RW-39</td>
<td>8-1/8&quot;</td>
<td>1-5/16&quot;</td>
<td>166</td>
</tr>
</tbody>
</table>

To qualify for approval under Joint Army-Navy characteristics, resistors are required to withstand in excess of nine cycles of immersion in saltwater baths of 100°C and 0°C; to withstand a severe vibration test for five hours; and, in addition, are subjected to all other tests as specified in JAN-R-26. Ohmite Resistors designed for JAN-R-26 are specially vitreous enameled and have a textured gray finish. Available in the types and sizes listed.

Write on Letterhead for Bulletin No. 139

**OHMITE MFG. COMPANY**

4917 Flournoy St., Chicago 44, Ill.

Be Right with...

**OHMITE**

RHEOSTATS • RESISTORS • TAP SWITCHES

www.americanradiohistory.com
SEE HOW MUCH THIS .002" ELECTRICAL STEEL CAN IMPROVE YOUR PRODUCTS

Is the wide swing in induction indicated below of value to your products when the corresponding change in magnetizing force is small?

These and other characteristics of Armco Thin-Gage Electrical Steels offer you many advantages in the design and operation of various high-frequency equipment.

For example, if excessive heating is a limiting feature of your design, or it is important that the eddy currents produce only the slightest delay in building up of the flux, then Armco Thin-Gage Electrical Steels can assure top performance for your products.

Charts on this page show results of tests on .002" (.05 mm.) Armco Thin-Gage. Note that its operating characteristics are given for frequencies up to 100,000 cycles a second.

Magnetic properties of this thin steel are fully developed by annealing at the mill, and the strip is supplied with CARLITE insulation on both sides. This insulation will remain effective even if you reanneal the laminations on your cores.

Whether you are now manufacturing high-frequency devices, or your equipment is in the "idea stage," be sure to look into the extra advantages of special Armco Thin-Gage Electrical Steels. Write for complete information. Armco Steel Corporation, 152 Curtis Street, Middletown, Ohio. Export: The Armco International Corporation.

ARMCO THIN-GAGE ELECTRICAL STEELS
Important Announcement To Our Many Friends

In The Broadcasting And Specialty Electronics Fields

CORNELL-DUBILIER ELECTRIC CORPORATION
333 HAMILTON BOULEVARD
SO. PLAINFIELD, N.J.

To Our Customers:

We take pleasure in announcing the purchase of the Faradon Capacitor Division of the Radio Corporation of America.

Cornell-Dubilier acquired by the purchase the good will and trademark of "Faradon", the inventory, tools, dies, molds, equipment, instruments, designs, processes, and patent licenses. We have moved the Faradon equipment to our plants and are presently manufacturing the complete line of Faradon capacitors previously manufactured by the Radio Corporation of America.

Cornell-Dubilier transmitting capacitors and Faradon capacitors will be sold as separate lines, as Faradon capacitors are not always interchangeable with those of Cornell-Dubilier. Orders for Faradon capacitors, using the Faradon part numbers, may be mailed to our Sales Office at South Plainfield, New Jersey.

The high quality for which both Faradon and Cornell-Dubilier have been known for the last four decades will be meticulously maintained. The addition of the Faradon line will greatly improve our services, particularly to the broadcast stations and for those engaged in the specialty electronic fields.

The continued confidence of our customers in our product has made possible this acquisition of this additional outstanding line.

Sincerely yours,

CORNELL-DUBILIER ELECTRIC CORPORATION

President

CORNELL DUBILIER ELECTRIC CORPORATION
CAPACITORS . AUTO VIBRATORS . TV AND FM ANTENNAS . POWER CONVERTERS

April, 1949 — ELECTRONICS
RELAYS OF ADAPTABILITY

Thousands of specifications are filled by the complete line of Allied Relays—seven of which are grouped around the Allied emblem of engineering leadership.

Allied Control engineers pioneered the design of relays from signal circuits to 75 ampere contacts, coils from 12 milliwatts to 3½ watts to give the smallest mounting area and accessible wiring facilities.

*Type "BOHO" is D.P.D.T. relay sealed with standard octal plug. Contact rating of 5 to 10 amperes and coil capacity of 115 v. D.C. at 2.5 watts and 220 volts; 25 and 60 cycles at 4.5 volt-amperes.

*Type "CN" is S.P.S.T. double break relay with 50 ampere contacts and coil capacity of 115 v. D.C. at 3.5 watts and 220 volts; 60 cycles at 10.5 volt-amperes.

*Type "BN" is 6 P.D.T. relay with 15 ampere contacts and coil capacity of 115 v. D.C. at 3.5 watts (not available in A.C.).

*Type "BG" is S.P.D.T. relay with 2 ampere contacts and coil capacity of 25 v. D.C. at 50 milliwatts (not available in A.C.)

*Type "BO" is D.P.D.T. relay with 15 ampere contacts and coil capacity of 115 v. D.C. at 2.5 watts and 220 volts; 25 and 60 cycles at 4.5 volt-amperes.

*Type "F" is S.P.D.T. with 2 ampere contacts and coil capacity of 85 v. D. C. at 1.5 watts (not available in A.C.).

*Type "SK" from S.P.S.T. up to 4 P.D.T. with 1 ampere contacts and coil capacity of 60 v. D.C. at 750 milliwatts (for 4 P.D.T. relay) not available in A.C.

Allied Control representatives are located throughout the United States. A short note to our home office will give you the name of our nearest representative.

ALLIED CONTROL CO., INC. 2 EAST END AVENUE, NEW YORK

www.americanradiohistory.com
Wing vibration, nimbly controlled, keeps the humming bird in flight, enables it to feed without alighting.

Electric vibration is the essence of telephone transmission. Voice, music, pictures, teletype—no matter what type of signal—the story is told by the frequency and strength of not one, but many vibrations.

Learning how to control electric vibrations to pin-point accuracy has been one of the basic jobs of Bell Laboratories scientists in their development of the “carrier” art which enables the sending of many more conversations over existing wires. Among their inventions have been oscillators, modulators, filters, coaxials, wave-guides, and radio lenses.

Constantly Bell Laboratories scientists discover new and better ways to control and adapt electric vibrations by wire or radio to the needs of the telephone user. Their pioneer work in this field is one important reason behind today’s clear, dependable and economical telephone service.

BELL TELEPHONE LABORATORIES

Exploring and inventing, devising and perfecting, for continued improvements and economies in telephone service.
Until now, precision drilling of extremely small diameter holes (such as .0016" dia.) has been manually controlled. Even with highly skilled operators, however, drill breakage has been frequent—resulting in waste of time and effort, and damage to work and equipment.

But now comes the revolutionary Microdrill. Relying on sensitive electronic circuits, instead of the human senses of feeling and sight, it operates infallibly and precisely by means of remote electric controls.

Heart of the drill press is a spring-loaded Nichrome V wire which, when heated electrically, expands, thereby lowering the drill spindle. Conversely, when heating current is decreased, it contracts and raises the spindle. Electronic control of the heating current effects extremely smooth vertical travel, the drill being raised or lowered at a precisely adjustable rate.

Holes as small as .0016" in diameter are drilled with utmost ease—drill breakage reduced to a negligible minimum. Time is saved. Costs are cut.

Says the manufacturer, Teletronics Laboratory, Inc., Westbury, N.Y.: "The wire used in the Microdrill must have a high coefficient of linear expansion, high tensile strength, high specific resistance—and must be able to retain its physical and electrical properties at high temperatures. We know of no other wire as suitable for our purpose as Nichrome V."

If you, too, have a product-performance problem, why not consult with us. In addition to Nichrome and Nichrome V, we make over 80 alloys for the electronic and electrical industries. One or more of these may be what you are looking for.

*Nichrome* is manufactured only by Driver-Harris Company

HARRISON, NEW JERSEY

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

Manufactured and sold in Canada by The B. GREENING WIRE COMPANY, LTD., Hamilton, Ontario, Canada
When it's you have to beat the TELEVISION hookup wire by CORNISH

✓ Flame Resistant
✓ Heat Resistant
✓ High Dielectric
✓ High Insulation Resistance
✓ Easy Stripping
✓ Facilitates Positive Soldering
✓ Also unaffected by the heat of impregnation—therefore, ideal for coil and transformer leads

approved by Underwriters Laboratories at 90° CENTIGRADE 600 VOLTS

“NOFLAME-COR” Proven BEST by exhaustive tests! Leading producers of television, F-M, quality radio and all exacting electronic applications specify our Underwriter Approved “NOFLAME-COR” as a MUST. Immediate delivery. All sizes, solid and stranded. Over 200 color combinations.

made by engineers for engineers"

CORNISH WIRE COMPANY, Inc.
605 North Michigan Avenue, Chicago 11
15 Park Row, New York 7, N.Y.
1237 Public Ledger Bldg., Philadelphia 6

MANUFACTURERS OF QUALITY WIRES AND CABLES FOR THE ELECTRICAL AND ELECTRONIC INDUSTRIES

38

www.americanradiohistory.com
Variable Voltage giving you trouble?

**G-E Automatic Voltage Stabilizers provide a steady 115 volts**

Where precision equipment fails to operate satisfactorily because of ups and downs of input voltage, General Electric stabilizers supply an economical remedy. Small in size, they can easily be built into your equipment to supply automatically a constant 115 volts while line voltage varies from 95 to 130 volts.

These stabilizers have no moving parts, hence present no maintenance problem. They are available in standard ratings from 15 va to 5000 va. Stabilization is instantaneous (less than three cycles) and within ±1 per cent for fixed, unity-power-factor loads.

Contact your local G-E office for a call by one of our engineers. Or let us evaluate your problem by sending data and description of the circuit and load. Inquiries invited about special units. For general information, ask for Bulletin GEA-3634B, Apparatus Department, General Electric Company, Schenectady 5, N. Y.

**DO YOU MAKE—OR USE—ANY OF THESE?**

Here are just a few of the applications where you may find a G-E automatic voltage stabilizer valuable:

- Radio transmitters and radar equipment
- Laboratory testing equipment and precision processes
- Motion-picture projectors and sound equipment
- Telephone apparatus
- Precision photographic equipment and photometers
- Phototube equipment
- Calibration of electric devices
- Color comparators
- Electron-tube apparatus
- Electro-chemical analysis
- Rectifiers (full-wave)
- Lighting circuits

GENERAL ELECTRIC

ELECTRONICS — April, 1949
A new Magnetic Core Material with a rectangular hysteresis loop...

Commercially available in standard sizes of toroidally-wound cores, heat treated and cased, ready for your use.

Where can YOU use a Magnetic Material with these specialized, dependable characteristics?

The properties of Deltamax are invaluable for many electronic applications, such as new and improved types of mechanical rectifiers, magnetic amplifiers, saturable reactors, peaking transformers, etc. This new magnetic material is available now as “packaged” units (cased cores ready for winding and final assembly) distributed by the Arnold organization. Every step in manufacture has been fully developed; designers can rely on complete consistency in each standard size of core. Deltamax is the most recent extension of the family of special, high-quality electrical materials produced by Allegheny Ludlum, steel-makers to the electrical industry. It is an orientated 50% nickel-iron alloy, characterized by a rectangular hysteresis loop with sharply defined knees, combining high saturation with low coercivity. Call us for engineering data.
-hp- 614A UHF Signal Generator

Direct reading output, accuracy ± 1 db...Constant internal impedance, SWR 3 db...Direct frequency control...External modulation 0.5 microseconds pulses to square waves...CW, FM, pulsed output.

This new -hp- signal generator will save you hours of time and work in making UHF measurements between 800 and 2100 mc. Its many different modulation and pulsing capabilities mean these man-hour economies can be applied to a wide variety of measurements—receiver sensitivity and alignment, signal-to-noise ratio, conversion gain, standing wave ratios, antenna gain and transmission line characteristics, to name but a few.

Carrier frequency in mc can be set and read directly on the large central tuning dial. R-f output from the klystron oscillator is also directly set and read in microvolts or db. No calibration charts or tedious interpolation are necessary. And thanks to the unique -hp- automatic tracking mechanism, no voltage adjustments are needed during operation.

R-f output ranges from 0.1 volt to 0.1 microvolt. Output may be continuous, pulsed, or frequency modulated at power supply frequency. The instrument may be modulated either externally or internally and may be synchronized with positive or negative pulses or sine waves.

Because of its wide range, high stability and versatile usefulness, this new -hp- signal generator is adaptable to almost any uhf measuring need. The instrument is available for early delivery. Contact your -hp- field representative or write direct to factory for complete details and technical specifications.

HEWLETT-PACKARD CO.
1874 A Page Mill Road, Palo Alto, California
Export Agents: Frazer & Hansen, Ltd.
301 Clay Street • San Francisco, Calif., U.S.A.

SPECIFICATIONS

FREQUENCY RANGE:
800 to 2100 mc. Selection is made by means of a single directly-calibrated control covering entire range. No charts are necessary.

FREQUENCY CALIBRATION ACCURACY:
± 1%.

OUTPUT RANGE:
1 milliwatt or .223 volts to 0.1 microvolt (0 dbm to -127 dbm). Directly calibrated in microvolts and db; continuously monitored.

ATTENUATOR ACCURACY:
Within ± 1 db without correction charts. A correction chart is provided when greater accuracy is desired.

OUTPUT IMPEDANCE:
50 ohms, SWR 3 db (VSWR 1.4).

EXTERNAL MODULATION:
By external pulses, positive or negative, peak amplitude 40 to 70v., 0.5 microseconds to square wave.

FM MODULATION:
Oscillator frequency sweeps at power line frequency. Phasing and sweep range controls provided. Maximum deviation approximately ± 5 mc.

INTERNAL MODULATION:
Pulse repetition rate variable from 40 to 4000 per second; pulse length variable from 1 to 10 microseconds. Pulse rise and decay approximately 0.1 microseconds.

TRIGGER PULSES OUT:
1. Simultaneous with r-f pulse.
2. In advance of r-f pulse, variable 3 to 300 microseconds.
   (Both approximately 1 microsecond rise time, height 10 to 40 volts.)

EXTERNAL SYNC PULSE REQUIRED:
Amplitude from 10 to 50 volts of either positive or negative polarity and 1 to 20 microseconds width. May also be synchronized with sine waves.

Data subject to change without notice.
Simple Jobs... Intricate Jobs...

We Give Them All "High Hat" Quality

Whether you come to us for simple stamped-out chassis, ordinary metal boxes or the most intricate electronic apparatus housing, your job will receive the same Karp quality treatment, plus every possible economy.

The same long-experienced principals of our staff will give you intimate, personalized service, from planning and design to delivery. Your work will be done by highly skilled specialists, in a plant which is without an equal in its field for up-to-date machinery and modern facilities. Welding, when needed, will be done under precise timing controls... painting and finishing with the most modern equipment and conditions.

In most cases, our vast variety of dies will save you the cost of special dies and jigs. We will give your work accuracy and uniformity that will make your final assembly easy, time-saving and hence economical.

Try us for the plain or the precise... the everyday or the elaborate and de luxe... in modest or substantial quantity. Whatever your needs in sheet metal fabrication, it pays to get our estimate.

WRITE FOR NEW CATALOG

KARP METAL PRODUCTS CO., INC.
215 - 63rd STREET, BROOKLYN 20, NEW YORK

Custom Craftsmen in Sheet Metal
The time-tested Bendix-Pacific basic sub-miniature system illustrated above, now approved as AN/DKT-3, offers outstanding advantages for precise remote instrumentation on guided missiles, aircraft, and for industrial use where conventional means of measurement are impractical because of inaccessibility.

The entire system as shown, including pick-ups and batteries for 30 minutes operation, takes up only 130 cu. in. and weighs less than 12 1/2 pounds. The basic system provides six channels of information and with the addition of a TSC type commutator and associated equipment up to 48 channels are available. The system operates on 210-220 mc (also available on 80-84 mc).

Bendix-Pacific facilities include installation and application engineering, field operation, data reduction, and engineering consultation. Complete ground station facilities, including antennas also may be purchased. Information is available upon request.
ERIE CERAMICONS

at an economical price

Here are accurate, quality, low capacity close tolerance ceramic condensers that will go far in improving performance of front ends and other oscillator circuits.

Because of special processing methods, many popular values with capacity tolerances as close as ±0.1 MMF are available at prices comparable to wider tolerance condensers. The values and temperature coefficients of these Erie Ceramicons are listed at the left.

If you have an application for these units, we will be glad to send you samples of the capacities you select.
General Application

<table>
<thead>
<tr>
<th>Model</th>
<th>Load Range</th>
<th>Regulation Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>25-150</td>
<td>0.5%</td>
</tr>
<tr>
<td>250</td>
<td>25-250</td>
<td>0.2%</td>
</tr>
<tr>
<td>500</td>
<td>50-500</td>
<td>0.5%</td>
</tr>
<tr>
<td>1000</td>
<td>100-1000</td>
<td>0.2%</td>
</tr>
<tr>
<td>2000</td>
<td>200-2000</td>
<td>0.2%</td>
</tr>
</tbody>
</table>

*Models available with increased regulation accuracy.

Extra Heavy Loads

<table>
<thead>
<tr>
<th>Model</th>
<th>Load Range</th>
<th>Regulation Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>3,000</td>
<td>300-3000</td>
<td>0.2%</td>
</tr>
<tr>
<td>5,000</td>
<td>500-5000</td>
<td>0.5%</td>
</tr>
<tr>
<td>10,000</td>
<td>1000-10,000</td>
<td>0.5%</td>
</tr>
<tr>
<td>15,000</td>
<td>1500-15,000</td>
<td>0.5%</td>
</tr>
</tbody>
</table>

*Models available with increased regulation accuracy.

The NOBATRON Line

<table>
<thead>
<tr>
<th>Output Voltage DC</th>
<th>Load Range</th>
<th>Regulation Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>5-15-40-100</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>5-15-50</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>10-30</td>
<td></td>
</tr>
<tr>
<td>48</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>125</td>
<td>5-10</td>
<td></td>
</tr>
</tbody>
</table>

Regulation Accuracy—25% from 1/4 to full load.

400 Cycle Line

Inverter and Generator Regulators for Aircraft

<table>
<thead>
<tr>
<th>Single Phase and Three Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>D 100</td>
</tr>
<tr>
<td>D 500</td>
</tr>
<tr>
<td>D 1200</td>
</tr>
<tr>
<td>D 2000</td>
</tr>
</tbody>
</table>

3-Phase Regulation

Star-connected three-phase systems can be handled effectively. Other three-phase systems must be reviewed by our Engineering Dept.

SORENSEN & Company, Inc.
Stamford, Connecticut
Represented in all principal cities.

ELECTRONICS — April, 1949
Little lamps can help your product win top billing!

Want extra features to put your product in the limelight and to win applause from customers? It's easy with General Electric miniature lamps!

Little lamps can simplify operation, add extra convenience and safety in dozens of electronic applications. Use them as warnings to tell whether the current is on or off. Install them as "tell-tales" to check the operation of individual circuits. Apply them in novel design features that pay off in added attraction and sales value.

Whatever miniature lamps you need, General Electric makes 'em all—more than 1,000 different types and sizes. All voltages and wattages. Filament or neon glow. And every General Electric miniature lamp is made to the same high standards of quality as its bigger brothers.

For assistance in selecting the proper type for your particular applications, consult your nearest G-E lamp district office. Or write General Electric, Nela Park, Cleveland 12, Ohio.
Exclusive Manufacturers of Communications Network Components

TOROIDAL COIL FILTERS AND TOROIDAL COILS DESIGNED FOR CRITICAL APPLICATIONS

Extremely sharp side band suppression filter. Available in either low or high pass.
Size: 2½ x 4 x 2½.

Wide band sharp cutoff band pass.
Size: 2 x 3½ x 6½.

Crystal filter for narrow band pass applications too critical even for toroidal coils.

ALL INQUIRIES WILL BE PROMPTLY HANDLED. WRITE FOR FREE CATALOG.

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

www.americanradiohistory.com
Motor-Makers Know that

AMERICAN PHILLIPS SCREWS

put up a "Good Show"

On the Production Floor... and
Sales Floor, too!

GOOD SHOW IN PRODUCTION: Assembly rolls along smoothly in high gear, with fastenings made by American Phillips Screws that turn up straight and tight every time... with never a slip or a slash to spoil costly enameled surfaces. Workers do more and better work, far more easily, than they ever did with out-of-date slotted screws. And time savings run as high as 50%. That's why so many million American Phillips Screws are used in automotive plants every month.

GOOD SHOW IN SALES: The modern mark of American Phillips' cornerless, crossed recess is one of the quality insignia of top cars and trucks... a feature looked for and recognized by customers. It means no unsightly spurred heads to mar sales appeal or snag clothes and hands. And it means extra vibration-resistance to keep bodies tight and squeak-free. Does your product have this double-feature of production-economy and sales promotion? Then write:

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

AMERICAN PHILLIPS Screws

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

April, 1949 — ELECTRONICS
One Look TELLS THE STORY

... of new and better products made possible. These curves show the static and dynamic (1000 cycle) magnetization characteristics of "Permanite". This new magnetic alloy has the extremely useful property of reaching magnetic saturation with a very slight change in magnetizing current.

Utilization of this property in a core and coil assembly results in a magnetic amplifier of extreme reliability for many applications.

Permanite cores are available now. I-T-E can deliver spiral wound permanite cores of any size, all having identical magnetization characteristics. This will enable designers to predict equipment performance accurately and positively.

One look at the curve tells the story of "Permanite". But Permanite is only part of the continuing story of I-T-E research and development to bring you better equipment and better designs — first.

For additional information write — Rectifier division I-T-E or consult your local I-T-E representative.

THE LEADER IN TECHNICAL EXCELLENCE

I-T-E CIRCUIT BREAKER CO., 19TH & HAMILTON STREETS, PHILADELPHIA 30, PA.
31 OFFICES IN THE UNITED STATES. In Canada, Eastern Power Devices, Ltd., Toronto
SWITCHGEAR • UNIT SUBSTATIONS • ISOLATED PHASE BUS STRUCTURES • RESISTORS • SPECIAL PRODUCTS

ELECTRONICS — April, 1949
Pictured here is a tuning-fork frequency standard with accuracy guaranteed to one part per million per degree Centigrade. The fork is temperature-compensated and hermetically sealed against variations of barometric pressure. This standard, when combined with basic equipment, facilitates accurate speed and time control by mechanical, electrical, acoustical or optical means.

The unit is available separately or in conjunction with complete timing instruments. Our engineers are ready to cooperate on any problem.

American Time Products, Inc.
580 Fifth Avenue
New York 19, N.Y.

OPERATING UNDER PATENTS OF THE WESTERN ELECTRIC COMPANY

April, 1949 — ELECTRONICS
The big news in insulation is HARVEL 1012C, an outstanding development by IRVINGTON which provides an insulating varnish with far greater bonding and cementing qualities than the numerous thermo-setting varnishes tested. It's a very fast curing resin... absolutely oil-proof, and with excellent resistance to moisture and high temperatures. Unequalled for windings operating at high peripheral speeds as well as those subject to great stresses and strains.

Full information and generous test samples of HARVEL 1012C will be furnished on request. Write today.

IRVINGTON

Varnish & Insulator Company

Irvington 11, New Jersey

Authorized distributors in Baltimore; Berkeley, Bluefield, W. Va. Boston; Charlotte; Chicago; Cleveland; Dorall; Denver; Los Angeles; Minneapolis; New Hartford, N. Y.; New Orleans; New York; Philadelphia; Pittsburgh; Portland, Ore.; St. Louis; Seattle; Hamilton; Ontario; etc.
the Type 45 Rotary Switch

70 Steps a Second Speed
Up to 10 (or more) Bank Levels
Only 1 Field Adjustment

For all the features you want... in any remote-control application... look to Automatic Electric's Type 45 Rotary Switch!

SPEED... it's faster! It carries 10 wipers at 70 steps a second on 46 volts d.c. self-interrupted, or at 35 steps a second, externally interrupted.

CAPACITY... it's greater! Ten or more 25-point bank levels can be accommodated on the same frame, and single ended wipers can be provided for 50-point operation.

ADJUSTMENT... it's simpler! A rare readjustment of the interrupter springs is all that's normally required.

OPERATION... it's smoother! With an even load on all contacts, the Type 45 runs without galloping; there's no chatter or bounce.

ADAPTABILITY... it's more useful! With more levels, faster speed and 25- or 50-point operation, it's suitable for a wider variety of control applications.

For complete information on this switch that's new and better, write for our new circular.

AUTOMATIC ELECTRIC

Distributors in U. S. and Possessions:
Automatic Electric Sales Corporation
1033 West Van Buren Street, Chicago 7, Illinois
In Canada: Automatic Electric (Canada) Limited, Toronto

April, 1949 — ELECTRONICS
Frank Luck says, "I needed strong bars for my lion traps... so I got TEXTOLITE."

Lions have little chance of escaping from this tough General Electric Textolite lion trap. Textolite blends with the jungle surroundings... completely camouflages the trap. Lions walk in—never escape.

Of course this story of Frank Luck and his G-E Textolite lion trap is fictitious, but it does get over an important fact... General Electric Textolite is versatile.

If you have an application that requires a non-metallic material with excellent electrical, mechanical, chemical, and thermal properties, it will be to your advantage to investigate Textolite. Reduced costs and product improvement may result.

G-E Textolite offers you a choice. It is produced in many grades—over fifty. And each of these grades has an individual combination of properties. None are alike. With this wide selection you can be assured of getting a laminated plastics with the correct properties for your application. Plastics Division, Chemical Dept., General Electric Co., Pittsfield, Mass.

G-E LAMINATED TEXTOLITE IS SUPPLIED IN:

SEND FOR THIS HELPFUL BULLETIN TODAY—IT'S FREE

Write for your copy of "G-E Textolite Laminated Plastics." It lists grades, properties, fabricating instructions, and detailed information about Textolite industrial laminates.

General Electric Company
Chemical Department (9-4)
One Plastics Ave.,
Pittsfield, Mass.
Please send me the new G-E Textolite laminated plastics bulletin.
Name:..................................................
Firm:..................................................
Address:............................................
City............................................State...........................................
FRICITION...TEMPERATURE CORROSION...SHAFT SEALING AND ARC PROBLEMS...

What is YOUR application problem? Need a material that can be heated to 4000° F. and thrown into cold water without cracking...that will resist atmospheric surface action while retaining constant contact resistance...that will have low friction (graphite) or high friction (carbon) or any intermediate frictional value?

Stackpole Carbon and Graphite components handle all of these assignments—and many more. Chemically, electrically, and mechanically, Carbon and Graphite offer far flung engineering advantages—and, for almost a quarter of a century, Stackpole design and production service has paced the trend in progress along many important lines.

WRITE FOR THIS BIG CARBON GRAPHITE BOOK!
In addition to a wealth of informative data, the new Stackpole Carbon-Graphite Specialties Catalog #40 describes hundreds of items regularly produced. More particularly, it contains interesting evidence of the ability of Carbon and Graphite to solve a broad range of design, engineering and production problems—and of Stackpole's facilities for producing what is needed.

STACKPOLE CARBON COMPANY, ST. MARYS, PA.

"EVERYTHING IN CARBON BUT DIAMONDS"

April, 1949 — ELECTRONICS
Highest performance you can buy in a 250 watt AM transmitter

... but the price is competitive

THE Collins 300G gives you everything a 250 watt AM transmitter can contribute in your fight to win sponsors and influence audiences.

Engineered to today's highest standards, employing the finest components, it transmits a signal that is outstandingly clean, crisp, and inviting.

The frequency response is flat ±1 db from 30 to 10,000 cycles per second, challenging the capabilities of the best AM receivers. The noise level is more than 60 db below 100% modulation level. The distortion is less than 3% up to 95% modulation.

Yet the 300G is competitively economical to buy and operate. The power consumption is only 1.5 kw in normal operation, 85% power factor. The entire complement of but 21 tubes (including a stand-by oscillator, 6 rectifiers and 2 voltage regulators) is comprised of only eight tube types. Spare requirements are at a minimum.

This transmitter features eye-level metering, tube visibility through front door windows, instantaneous power reduction to 100 watts, complete accessibility, high safety factors, and thorough reliability. Write us for further information.

COLLINS RADIO COMPANY, CEDAR RAPIDS, IOWA

11 W. 42nd St., New York 18, N. Y.
458 S. Spring St., Los Angeles 13, Calif.

FOR BROADCAST QUALITY, IT'S...
There are three new grades of C-D Dilecto* that can withstand temperatures as high as 250°C. They are chemically inert, silicone-glass laminated plastics that offer exceptionally high heat resistance and good arc resistance, extra strength, and positive moisture resistance! At Continental-Diamond we've literally lived and worked with Silicone Dilecto—perfecting it to a point where we believe it can be highly useful in helping to solve your production problems—and improve product performance.

And this remarkable plastic is but one of many in the C-D family. They provide practical combinations of mechanical, electrical, and chemical properties—structural strength, light weight, positive moisture, heat and corrosion resistance. In hundreds of plants, C-D Plastics—Fibre, Vulcoid, Dilecto, Celoron, and Micabond—offer proof that it pays to see C-D first in your search for the right plastic for the job. For interesting, useful information on Silicone Dilecto, and other C-D high strength plastics, call or write your nearest C-D office, soon.

*Dilecto GB—112—S
Dilecto GB—128—S
Dilecto GB—261—S

Continental-Diamond FIBRE COMPANY
Established 1895—Manufacturers of Laminated Plastics since 1911—NEWARK 10—DELAWARE
TWO ways you benefit from MB Isomode* Vibration-Isolators

1. IMPROVED VIBRATION CONTROL!
2. EASIER ENGINEERING!

Experiences of two well-known manufacturers demonstrate this double benefit:

Always on the alert to improve their product, a truck maker comprehensively tested Isomode mounts. Their adoption followed quickly. Because, instead of previous, typical truck characteristics, motors mounted on Isomode units displayed passenger-car performance! Vibration was really isolated, even though the units were not at optimum locations, but placed at standard points to allow interchangeability with earlier models.

Another company, with a tough vibration control problem because they use various makes and types of engines in their own product, discovered engineering and production simplicity through Isomode units. Vibration was controlled by units placed at the regular mounting points. This accomplishment is all the more remarkable when you consider that the vibration varies with each type of engine!

There you have actual demonstrations of the value of Isomode units' outstanding advantage—"equal spring rates in all directions". The same benefits apply to many products—engines to electronic assemblies. And you not only isolate them more easily, but also gain a mounting that withstands severe shocks!


THE ADVANTAGES OF designing with ISOMODE MOUNTS

They absorb vibration in all directions equally well—vertical, as well as troublesome horizontal and rocking motions.
Non-directional—can be mounted at any angle, in any direction, simplifying design problems.
High load capacity in compact size—saving space, weight, costs.
Large rubber volume for softness—yet perfectly stable and self snubbing.

SEND FOR YOUR FREE COPY
This Isomode design chart saves you hours and effort—locates best points on your product at which to place standard mountings. For bulletin which contains chart and helpful information on vibration control, write Dept. F-5.

THE MB MANUFACTURING COMPANY, INC.
1060 State Street
New Haven 11, Conn.

VIBRATION ISOLATOR UNITS • VIBRATION TEST EQUIPMENT

ELECTRONICS — April, 1949
THE ADLAKE MIGHTY MIDGET RELAY (No. 1110) IS IDEAL FOR Flasher Service

IT IS DEPENDABLE—REQUIRES NO MAINTENANCE

The Adlake No. 1110 Relay is small enough to fit in one hand, yet it makes and breaks 30 amps. easily, and with low operating current.

Like all Adlake Relays, No. 1110 is hermetically sealed against dust, dirt, moisture and oxidation; mercury-to-mercury contact prevents burning, pitting and sticking. It’s absolutely safe, requires no maintenance, and is cushioned against impact and vibration.

These qualities make the Adlake "Mighty Midget" ideal for use with flasher installations—as well as in power circuits, motor and heater controls, traffic signals and a host of other uses.

WRITE TODAY for FREE illustrated catalog, with details on No. 1110 and other new Adlake Relays. The Adams & Westlake Company, 1107 N. Michigan, Elkhart, Indiana.

The Adlake Mighty Midget Relay gives you long, trouble-free service on outdoor installations. It’s weatherproof, shockproof and absolutely dependable! Silent and chatterless! Equipped with compression-type terminals to simplify installations.

THE Adams & Westlake COMPANY

Established 1857 • ELKHART, INDIANA • New York • Chicago

Manufacturers of Adlake Hermetically Sealed Mercury Relays for Timing, Load and Control Circuits
WINDING HORIZONTAL SWEEP COILS FOR TELEVISION RECEIVERS

FOUR COILS WOUND AT ONCE ON UNIVERSAL NO. 84 MACHINE

The tremendous interest in television all over the country has created a large and attractive market for producers of component parts for TV receiving sets.

For complete assurance of high quality and production in coils for television sets, manufacturers are using Universal Coil Winders.

One of the most difficult coils to wind is the so-called horizontal sweep or fly-back transformer coil (Fig. 1). This can best be wound on the No. 84 Universal Coil Winder (Fig. 2), which makes it possible to wind one to four coils at once for each of the three sections.

The following technical data was prepared by our engineers and

**NO. 84 MACHINE SET-UP FOR TELEVISION HORIZONTAL SWEEP TRANSFORMERS**

**FIRST SECTION**
- *Wire* 375 turns of No. 28 single nylon and enamel covered wire (.0156 in. O.D.)
- *Cam* 5/8 in. single throw.
- *Winding speed* 750 rpm.
- *Wind* 11/2, using gearing 48 or 72 with any intermediate gear to mesh.
- *Wire guides* .018 in. center slot.
- *Tension* medium spring in fourth hole from top.
- *Pressure* two weights on traverse frame cord.
- Wind four coils at a time.

**SECOND SECTION**
- *Wire* 1,000 turns No. 33 single nylon and enamel covered wire (.0099 in. O.D.)
- Cam 1/2 in. single throw.
- *Winding speed* 750 rpm.
- Wind 2/3, using gearing 119-80 with any intermediate gear to mesh.
- *Guides* .018 in. center slot.
- *Tension* sixth hole from top.
- *Pressure* two weights on traverse frame cord.
- Wind four coils at a time.

**THIRD SECTION**
- *Wire* 1,000 turns No. 38 single silk and enamel covered wire (.0065 in. O.D.)
- Cam 3/32 in. single throw.
- *Winding speed* 400 rpm.
- Wind 1/7th using gears 120-40-88-38. (With this compound gear, use any small gear on the spindle shaft on the inside of the 120-tooth gear. The second and third gears will go on the intermediate stud with the 40-tooth gear on the outside and the 88-tooth gear on the inside. The 38-tooth gear will be on the clutch shaft, and should mesh with the 88-tooth gear.)
- *Wire guides* .008 in. center slot.
- *Tensions* light spring in about the third hole from the top.
- *Pressure* one pressure weight on the traverse frame cord.
- Wind one to four coils at a time.

**COIL WINDING DEMONSTRATION ROOM**

We have in our coil winding demonstration room the following complete line of coil winding machines: 84, 96, 98, 102, 103, 104 and 105.

We invite anyone who is interested to visit our demonstration room and view these machines in operation.

**UNIVERSAL WINDING COMPANY**

P. O. Box 1605 Providence 1, R. I.

FOR WINDING COILS IN QUANTITY ACCURATELY ... AUTOMATICALLY USE UNIVERSAL WINDING MACHINES
BUILT TO MEET YOUR PROCESS REQUIREMENTS

We design, engineer, fabricate and install special High Vacuum process equipment.

In the High Vacuum field National Research Corporation offers you unified, under-one-roof control and responsibility. We not only build equipment, but also undertake development work for others in fields where the unique experience and ability of our own Research Division can be used to your advantage.

If you plan to profit from your own High Vacuum process developments—if you require assistance in developing your processes—you should become acquainted with the National Research Corporation, 70 Memorial Drive, Cambridge 42, Massachusetts.
ENGRAVING, TRANSLUCENT, GRAPHIC Lamicoid

make instrument dials readable, accurate, durable

Big calibration figures on Engraving, Translucent or Graphic Lamicoid make instrument dials easy to read, easy to set accurately. Lamicoid's dimensional stability means long-lasting service, too. It stands up to heat and cold, resists moisture, oils, solvents and corrosive vapors. Maintenance? Just wipe with a damp cloth to clean!

Engraving Lamicoid is a sandwich type material. Markings engraved through the surface to the contrasting opaque or translucent core stand out clearly, can't wear away.

Figures applied by painting, printing or silk screen process on Translucent Lamicoid show up against rear illumination. Its flexibility permits formation of simple curved shapes.

Graphic Lamicoid incorporates printed matter laminated under a transparent surface on one or both sides of the sheet.

This line of materials, ideal for dials, circuit diagrams, signs, instrument panels and charts, is unexcelled for clarity and durability. For further information about these and other products of our 56 years of experience in making highest quality electrical insulation, contact our nearest sales office.

MICA Insulator COMPANY
Schenectady 1, New York
Offices in Principal Cities

ELECTRONICS — April, 1949
ONE WAY you can save is by reducing the lost time and motion due to inferior tubing. Dieflex Varnished Tubings and Saturated Sleevings have the flexibility, smooth bore, and push-back qualities that keep assembly workers' fingers flying. And there is no fraying—of tubing or nerves.

Uniform, complete impregnation assures high dielectric strength. The base may be either finely braided cotton or glass fiber, and impregnation may be oleoresinous varnish or silicones—depending on the requirements of your products.

Would you like to try Dieflex in your assembly and prove to your own satisfaction how much difference it makes? We will gladly arrange to supply the quantities you need for a practical test.
AVIATION ASKED FOR THEM

RADIO AND TV BENEFIT!

GENERAL ELECTRIC CUSTOM MINIATURES
Made and tested for supreme reliability!

"More dependable than any miniatures yet built." That was aviation's directive... and challenge! Thousands of premium-performance GL-5654's and GL-5670's now in use, prove how well the challenge has been met. In altimeters, radio compasses, radio control equipment, and high-frequency aircraft radio receivers, these fine General Electric tubes are doing the extra-reliable job for which they were painstakingly made.

You, as designer or user of radio-TV transmitter equipment, can have the protection of G-E custom-miniature dependability now—starting with Type GL-5654 (electrically the same as the 6AK5), and Type GL-5670 (similar to the 2C51 except for improved heater design and a somewhat higher heater current). Other types are being added.

These tubes are carefully manufactured one by one, from individually gaged and inspected heaters, cathodes, grids, and plates. Each gets not less than 50 hours' operation—ample assurance that when plugged in, tube performance will be in line with ratings consistently. Ask your G-E electronics office for further facts. Or write Electronics Department, General Electric Company, Schenectady 5, New York.

**Characteristics**

<table>
<thead>
<tr>
<th>TYPE GL-5654</th>
<th>TYPE GL-5670</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heater voltage, a-c or d-c 6.3 v</td>
<td>Heater voltage, a-c or d-c 6.3 v</td>
</tr>
<tr>
<td>Heater current 0.175 amp</td>
<td>Heater current 0.350 amp</td>
</tr>
<tr>
<td>Max ratings, design center values:</td>
<td>Max ratings, design center values:</td>
</tr>
<tr>
<td>plate voltage 180 v</td>
<td>plate voltage 300 v</td>
</tr>
<tr>
<td>Grid No. 2 voltage 140 v</td>
<td>plate dissipation 1.5 w</td>
</tr>
<tr>
<td>plate dissipation 1.7 w</td>
<td>Typical operation, Class A3:</td>
</tr>
<tr>
<td>Grid No. 2 dissipation 0.5 w</td>
<td>plate voltage 300 v</td>
</tr>
<tr>
<td>Typical operation:</td>
<td>plate dissipation</td>
</tr>
<tr>
<td>plate voltage 180 v</td>
<td>1.5 w</td>
</tr>
<tr>
<td>Grid No. 2 voltage 120 v</td>
<td>Typical operation, Class A1:</td>
</tr>
<tr>
<td>cathode-bias resistor 200 ohms</td>
<td>plate voltage 150 v</td>
</tr>
<tr>
<td>plate resistance (approx) 0.69 megohms</td>
<td>cathode resistor 800 ohms</td>
</tr>
<tr>
<td>transconductance 5,100 micromhos</td>
<td>A-F grid-to-grid voltage, RMS 14 v</td>
</tr>
<tr>
<td>plate current 7.7 ma</td>
<td>zero-signal plate current, per section 4.9 ma</td>
</tr>
<tr>
<td>Grid No. 2 current 2.4 ma</td>
<td>max-signal plate current, per section 6.3 ma</td>
</tr>
<tr>
<td>(*Fixed bias operation not recommended)</td>
<td>load impedance, plate-to-plate 27,000 ohms</td>
</tr>
<tr>
<td></td>
<td>total harmonic distortion 10 per cent</td>
</tr>
<tr>
<td></td>
<td>max-signal power output 1.0 w</td>
</tr>
</tbody>
</table>

**GENERAL ELECTRIC**

FIRST AND GREATEST NAME IN ELECTRONICS

ELECTRONICS — April, 1949

63
Increased air traffic and variable weather conditions make precision control of multi-engined aircraft increasingly important. Gyroscopic controls must function accurately under many climatic conditions, depending constantly on electrical accessories for consistent service. Current loads subject accessory insulation to temperatures up to 300° F., while in operation, and must necessarily have the strength and flexibility to resist this strain.

Ben Har Special Treated Fiberglas Tubing is used on the transformers in the amplifier unit of the Sperry A-12 Gyropilot.

Accessory suppliers for some of America’s great multi-engined transports and bombers come to Bentley, Harris for this remarkable insulation. They recognize it is essential that insulation used in aircraft components have high dielectric strength and resistance.

Ben Har Special Treated Fiberglas Tubing will not crack, split or fray at the ends and will not support combustion. Won’t break down because it combines toughness with flexibility.

The wide use of Ben Har Special Treated Fiberglas Tubing by America’s leading manufacturers proves the value of this outstanding insulation. If your product requires a “special” insulation, specify Ben Har Special Treated Fiberglas Tubing.

"Give us the tools . . ."

Now is the time to FIGHT SOCIALISM in Washington

Do we want to follow Britain down the economic skids?

We Americans face that question today. For we are being advised by Administration economists in Washington to take the course which destroyed Britain industrially. It is the temporarily easy course of cutting down expenditures for tools in order to have more things to consume right away.

The President’s Council of Economic Advisers tells us we are spending too large a part of our national income on new tools and equipment. A larger share, they say, should go for goods and services used directly by consumers.

Before we take that advice, let us look at Britain. When the British once allowed their industrial plants and equipment to run down—they started down a dreary road to industrial stagnation and decay.

British industry once ruled the world. Low production costs enabled it to undersell all competitors. Efficiency gave British workers the highest living standards anywhere.

Now all that Britain has between it and economic disaster is pluck and American aid through the Marshall Plan.

The British people are living poorly—still on rations and in austerity. With practically everyone working, and working longer hours than we do in the United States, they cannot produce enough to pay for the raw materials and food they must import.

How did Britain get in this fix?

The story is complicated. British sacrifices in two wars play a tragic part in it. But another fact also stands out:

Britain began to go downhill even before World War I—when British industries allowed their plants and equipment to grow obsolete.

Once that process started, it grew steadily worse. By 1929 the share of Britain’s national income being plowed back into capital investment had shrunk to less than two-thirds of what it had been twenty years earlier. We were putting twice as big a share of our national income into capital goods at this same time.

Skimping on capital equipment—on new plants and new tools—put the skids under industrial Britain.

World War II only speeded up a process already well under way.

continued on next page
British industry today shows the results of its failure to keep up to date. Here are three examples found by Dr. Laci Rostas, Britain's leading authority on measuring workers' productivity:

An American produces four times as much pig iron as his British counterpart.

He produces more than four times as many tires.

In all industry, on the average, an American produces almost three times as much.

The real reason is the American's better tools. The British are struggling with equipment that is, on the average, forty years old.

Britain once had a big head start in industrial equipment. But she let it slip away. And as it went, Britain's industrial and political leadership slipped with it.

How could British leaders have slept while all this happened?

This, too, is a complicated story. But parts of it stand out clearly:

1. British business men put in more time perfecting cartels to avoid competition than they did in improving their plants and equipment to meet it.

2. British labor leaders concentrated on sharing the work and sharing the wealth—rather than doing the job necessary to have enough wealth to make the sharing worthwhile.

3. British governments taxed away the means to buy new equipment. By steadily increasing personal taxes, they undercut the ability of individuals to invest in new equipment. Finally, they took away the incentive to get new equipment by progressively taxing away any returns on it.

4. Farseeing socialists smiled all the while, knowing that as private industry more and more lacked the tools to do a progressive job, they would have their chance to run the country.

Now, with Britain's fate in their hands, the socialists are trying desperately to stem the nation's economic decline by rebuilding its industrial plants and equipment.

They are making a little headway, but not enough. There are several reasons. One is that Britain must export most of the new equipment she can make. Another major reason—increasingly important for her future—is that money needed to renovate Britain's run-down industry is taxed away to support welfare programs. The Economist grimly puts it this way:

“The importance of the function of saving has only been discovered now that the means of saving have largely been destroyed.”

Our own Federal and State governments, too, have dangerously whittled away incentives. They have more than tripled tax rates on personal and corporation incomes in the last twenty years. Now, the President proposes to do more whittling.

If the United States is not to go Britain's way, we must preserve our incentives to save and to invest in industry.

If the United States is to progress, we must continue to build up our industries.

The President's Economic Advisers say we can slow down. But the McGraw-Hill survey of "Business Needs for New Plants and Equipment," reported in the previous editorial in this series, produced facts to the contrary. It showed that industry now plans—if it can get the money—to spend $55 billion in the next five years for new plants and new tools. Moreover, it showed industry's needs for new facilities are large.

By cutting down the incentives to save, by giving soothing advice that we do not need to save so much, Washington is pushing us toward Britain's way—the route via industrial stagnation to socialization.

Before we skid too far, we should pull up short and ask ourselves: Do we want to go Britain's socialistic way?

There still is time to say, "No."

A complete report on our national survey, "Business' Needs for New Plants and Equipment," may be obtained by writing McGraw-Hill Publishing Co., 330 West 42nd St., New York 18, N. Y. This is the fifth editorial of a special series on industry's needs for new plants and equipment.

Sunglasses plated with stainless steel—a recent commercial application of high vacuum. Used by Bausch & Lomb Optical Co. for RAY-BAN Gradient Density sunglasses, it works wonders in killing glare, relieving eye strain and fatigue, and improving vision.

During the war, planes jockeyed to attack out of the sun—battleships maneuvered to get the sun at their backs. The sun glare impairing vision, and accuracy of optical instruments made them a poor target for the enemy.

Counter strategy developed telescopic sights, range finders, and aerial cameras whose lenses were coated under high vacuum with transparent fluoride salts. Thus treated lens surfaces were less reflective, more light was admitted, instruments could work better against the sun.

Improving aviators’ sunglasses presented a different problem. Here the same high-vacuum process was used, but the coating must serve to cut down passage of light through the lens. Experiments disclosed stainless steel as the ideal material.

The process has been adopted for commercial use. At Bausch & Lomb, in the chamber of a DPI high-vacuum coater, metallic vapor of stainless steel is deposited in a scientifically controlled "gradient" pattern of density and area. These stainless steel coated sunglasses are now available at optometrists.

This is but one of many applications of high vacuum in science and industry to make improved products at lower cost.

Do you know what high-vacuum distillation, dehydration or fusion may do to improve your products—to decrease processing costs, or to salvage waste materials into valuable commodities? DPI research men and engineers may be able to tell you. Write
Business Briefs

By W. W. MacDONALD

Parts For Tubes are being sold to quite a few people not ordinarily considered tube manufacturers. Investigation of several such cases indicates that the need for tubes having very long life is the usual reason.

Computer manufacturers, in particular, appear interested in building their own tubes. Many thousands are used in some calculating machines operating many hours a day. By virtue of the number employed alone, failures must be kept to the very minimum. So, while tube manufacturers wonder whether it would or would not pay to produce types having particularly long-lived cathodes for such specialized applications the manufacturers of the machines roll their own.

Communications Equipment Sales should increase in 1949 to $23,500,000, thinks GE's Ernie Vogel. Market analysis indicates the following breakdown: Police purchases up 16 percent to $6,000,000, taxicab business up 25 percent to $5,000,000, utilities up 30 percent to $4,000,000, petroleum industry up 75 percent to $3,500,000, forestry conservation up 25 percent, forestry industries up 160, fire departments up 50 and highway-maintenance installations up 160.

Our Washington Office thinks there is only a 50-50 chance of upsetting local laws concerning the operation of sound trucks, with Supreme Court decisions likely to go either way in individual cases. Everything, apparently, depends upon how the local law is worded.

Last Time We Mentioned mobilization planning (p 68, January) we said that a government-industry stalemate appeared likely. Latest we've heard is that one government agency recently wrote a press release giving the details of the first contingent contract but that another government agency, whose approval of the release was necessary, refused to approve it.

By the time this item sees the light of day the contract will probably be signed, but it may not be publicized.

RMA Members produced 866,832 television receivers, 1,590,046 f-m/a-m receivers and 11,675,747 a-m receivers in 1948, a total of 14,132,625 sets of all kinds. Production breakdown by months was as follows:

<table>
<thead>
<tr>
<th>Month</th>
<th>TV</th>
<th>F-M/A-M</th>
<th>A-M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>30,001</td>
<td>136,015</td>
<td>1,173,240</td>
</tr>
<tr>
<td>Feb</td>
<td>35,889</td>
<td>140,629</td>
<td>1,203,087</td>
</tr>
<tr>
<td>Mar</td>
<td>52,137</td>
<td>161,185</td>
<td>1,420,113</td>
</tr>
<tr>
<td>Apr</td>
<td>46,339</td>
<td>90,635</td>
<td>1,045,499</td>
</tr>
<tr>
<td>May</td>
<td>50,177</td>
<td>76,435</td>
<td>976,168</td>
</tr>
<tr>
<td>Jun</td>
<td>64,353</td>
<td>90,414</td>
<td>955,103</td>
</tr>
<tr>
<td>Jul</td>
<td>56,089</td>
<td>74,988</td>
<td>552,361</td>
</tr>
<tr>
<td>Aug</td>
<td>64,953</td>
<td>110,879</td>
<td>759,165</td>
</tr>
<tr>
<td>Sep</td>
<td>88,196</td>
<td>171,753</td>
<td>1,020,498</td>
</tr>
<tr>
<td>Oct</td>
<td>95,216</td>
<td>170,086</td>
<td>920,076</td>
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<tr>
<td>Nov</td>
<td>122,304</td>
<td>166,701</td>
<td>827,122</td>
</tr>
<tr>
<td>Dec</td>
<td>161,179</td>
<td>200,326</td>
<td>876,315</td>
</tr>
</tbody>
</table>

Receiving-Tube Sales by RMA members totalled 204,720,378 in 1948, five million more than in 1947. New equipment took 146,162,214 receiver-type tubes, replacements 47,056,521, export 10,686,769 and government agencies 814,874.

Ten Times As Much Tin goes into the average television receiver as into the average radio set. And the Department of Commerce plans to cut down the allocation of tin to our industry because of the shortage of this metal. Therefore, it seems that conservation, substitution and allocation within the industry itself are in order for 1949.

From What We Have Read about Gulf Oil's Gulfstream and the Coast Guard's Eastwind it seems to us that the latter has earned the unique distinction of having participated in what appears to be the first radar-assisted collision.

High-Tension Coils are being placed closer to the distributor in most new automobiles, according
Though it would seem a strange place to look for a precious stone, each Eimac 3X2500A3 triode, and modifications of this tube type, contains three sapphires... making this Eimac triode a better vacuum tube... better able to do a superior job in communication, research, and industrial applications.

It became evident in the early stages of 3X2500A3 development that the structure which provided filament tension posed a problem. The source of tension was easy... by using a conventional pusher-spring at the cool end of the center-rod, transferring the pressure to the top of the rod, and then out to the filaments.

But... somewhere in the structure, between the filaments and the center-rod there must be a non-conducting material with the ability to remain inert under high temperatures (1500 degrees to 1600 degrees C). It must be unaffected by electron bombardment and it must be physically strong.

The imaginative foresight of Eimac engineers, after exhausting the possible use of conventional materials, brought synthetic jewels under consideration... the rest of the story is vacuum tube history.

As in the past, when better vacuum tubes are made they will first bear the trademark "Eimac"... the result of engineering foresight... skill... imagination... and research.

Eitel-McCullough Inc.
728 San Mateo Ave., San Bruno, California

Export Agents: Frazier & Hansen, 301 Clay St., San Francisco, California
NOTICE
OF IMPORTANCE TO THE
ELECTRICAL INDUSTRY

VICKERS ELECTRIC DIVISION, Vickers Inc.,
Announces a complete Research and Development Section available for your technical problems in relation to the following:

MAGNETIC AMPLIFIERS
MAGNETIC AUDIO AMPLIFIERS
STATIC VOLTAGE REGULATORS
STATIC MOTOR SPEED CONTROLS
POWER SATURABLE REACTORS
RECTIFIERS
PHOTOELECTRIC CELLS
SERVOMECHANISMS
MAGNETIC FLUID CLUTCHES
SPECIAL MOTORS AND GENERATORS
TRANSFORMERS • ARC-WELDERS
CONTROLLED POWER RECTIFIERS FOR
ELECTRO-CHEMICAL PROCESSES

The fundamental schemes employed in many of the above involve general use of tubeless amplifier circuits—Magnetic Amplifiers.

For information regarding application of the above relative to your requirements, you are cordially invited to consult our Engineering Department.

VICKERS ELECTRIC DIVISION
1815 LOCUST ST. ST. LOUIS 3, MISSOURI
A UNIT OF THE SPERRY CORPORATION

BUSINESS BRIEFS
(continued)
to General Motors' Charles F. Ket-
tering. This reduces radiation of
noise, with some benefit to users
of television receivers.

Scarcely A Month Passes but
what some manufacturer asks us
for a new product idea, and the
quota has increased since we pub-
lished Paul Weiller's "Finding
New Products" in March. So sug-
gestions from readers are very
welcome indeed. We're glad to
serve as a clearing house concern-
ing things needed in our field and
not made, items that can be made
better and/or cheaper.

Suggestions should meet at least
one acid test before we are told
about them. If you had the money
to manufacture the item in ques-
tion but would have to gamble the
whole roll would you make it?

Concerning New Products, it
seems to us that what the con-
sumer wants and what he is will-
ing to pay for it are frequently
poles apart. Obviously one can-
not produce custom-made pre-
cision equipment at home-radio-
receiver prices.

Dynamotor Market-Softening
reported by several manufacturers
appears to be due largely to in-
creasing competition from inher-
ently cheaper vibrator-type power
supplies. Some day, off in the
still-distant future, vibrators will
probably face similar pressure
from all-electronic types.

Norbert Wiener's Story opening
the January issue of ELECTRONICS
proved stimulating to at least one
reader. An ad in the Personal
column of The Saturday Review's
February 5 issue read as follows:

F. Ket-

CYBERNETIC SECRETARY, efficient as
electronic equipment and twice as beauti-
ful, yearns for intriguing job, preferably
abroad.

Two-Way Radiophone licenses
have been issued in Australia to
57 motor-servicing organizations,
12 taxi-cab companies, two express
 carriers, bus services, many radio
and electrical-equipment servicing
organizations, newspapers and
manufacturing concerns. The
total number of licenses in the
commercial category is 158. In

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addition, there are 1,561 licenses in the names of the police, harbor authorities, public works, electrical supply authorities and other government instrumentalities.

Australia is experiencing the boom in portable radio sales we went through a year or so ago. Manufacturers are at present advertising 81 brands, and 48 models.

A Friend Of Ours who manufactures a bulky piece of production-testing equipment is toying with the idea of installing it in a trailer, driving the thing right into the plants of prospective customers so that its effectiveness can be demonstrated on a regular run.

Program Hours teletranscribed each week by WABD, key outlet of the Du Mont network, total between 14,000 and 20,000 feet of 16-mm film. This, according to Lawrence Phillips, is roughly twice the weekly output of all Hollywood feature films.

Direct Approach: Listening to an f-m station the other night we were somewhat startled when the announcer said ... "Planning a movie evening? Why not stay home and see a movie on your television set instead."

Thus writes the moving finger.

LP Record-Player Sales totalled 600,000, and 2,000,000 of the long-playing disks had been marketed by mid-February, according to Columbia's Edward Wallerstein.

Greatest Need of business today, according to one of the biggest wheels in the electronic component parts game, with whom we recently talked, is men for top management who have (1) common sense, (2) courage, (3) imagination and, (4) experience ... men who lead rather than drive; men who make the right decision, at the right time, in the right way.

A New Glass for television picture tubes contains no lead and will therefore be lighter and cheaper to produce. Corning, it might be said, is shaking the lead out of its glass.
The MALLORY MIDGETROL DUAL

... to help you make
MORE CONVENIENT,
MORE EFFICIENT,
BETTER LOOKING

Television Receivers

Now Mallory has produced a Dual Mallory Midgetrol with concentric shafts.

Mallory precision manufacturing PLUS small size (\(\frac{1}{2}\) in. diameter) provide a method to move several key television adjustments from the rear of the chassis to the front. Eight single controls now required to make adjustments can be changed to only four Dual Mallory Midgetrols, permitting ready adjustment at the front of the chassis.

You get a cleaner-looking set, an easier set to produce — and the Mallory Midgetrol provides the ruggedness and dependability television parts must have.

Read the highlights of the Mallory Midgetrol Dual . . . and see why those who have seen what it can do to improve quality and cut costs are so enthusiastic about its future.

P. S. The unique qualities of the Mallory Midgetrol Dual make it perfect for many applications in other fields as well. Mallory engineers will be glad to tell you more about it. Write Mallory today.

Precision Electronic Parts — Switches, Controls, Resistors

Serving Industry with

Capacitors  Rectifiers
Contacts  Switches
Controls  Vibrators
Power Supplies
Resistance Welding Materials

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA
**CROSS TALK**

**BANDWIDTH, AGAIN ...** Since the announce-
ment last year that information can be sent over a
communication channel whose bandwidth is nar-
rower than the spectrum occupied by the informa-
tion itself, provided only that the signal-noise ratio
is kept high enough, there has raged a great con-
troversy in the classrooms and laboratories. Few
venture to doubt the theory; those who can under-
stand it say it's sound. But the practical man wants
to see it done. Rumors are afloat that it has been
done, or is about to be. But the official word is that
the systems and apparatus men are busy catching
up with the theoreticians.

Good news it is, then, that W. P. Boothroyd and
E. M. Creamer, Jr. of the Philco research organiza-
tion have devised a time-division pulse-multiplex
system, suitable for telephonic communications,
which exhausts the classical theory of Hartley. That
is, this multiplex system uses a channel bandwidth
which is, within narrow tolerances, equal to the
spectrum of the modulating intelligence. In the new
system the successive pulses, equally spaced in time,
are crowded together so that their oscillatory over-
shoots overlap. The heights of the pulses are then
read by a sampling circuit, synchronized with the
transmitter, which sensitizes the indicator only when
the sum of the superimposed overshoot amplitudes
is zero. Thus the main pulse amplitudes are indi-
cated, and the overshoots are dispensed with, per-
mitting the band of the channel to be narrowed to
the Hartley limit.

While not easy to describe in three sentences, as
the above try clearly shows, the system is not overly
complicated and it does work. That leaves the Wiener-
Shannon-Tuller-Sullivan territory directly ahead. The
advance scouts are already over the border.

**F-M FOR VIDEO ...** The recent suggestion, orig-
inating with the technical staff of the FCC, that
frequency modulation might be employed for the
picture channel on the ultrahigh frequencies has
created something of a stir in Washington circles.
The FCC laboratory experiments indicate a sub-
stantial advantage in reduction of co-channel inter-
ference when narrow-band f-m is used. But the
testimony, at the time of writing, is rather meager
on another aspect, namely what happens when
multipath transmission occurs.

There is plenty of evidence, dating from the tests
made by Philco and NBC in 1940-41, and witnessed
by panel members of the National Television System
Committee, that distortion of the picture signal due
to multipath propagation is a very serious matter.
In the Philco alternate-carrier tests (f-m for sync
pulses only) multipath effects often reversed the
polarity of the sync pulses, or eradicated them alto-
gether. Thus the reduction of co-channel interfer-
ence must be balanced against possible loss of sync
and other effects of multipath distortion. No final
conclusions can be drawn before an adequate field
demonstration, in a city providing typical multipath
conditions, is held.

**LENSES ...** We are always gratified when the new
science of electronics gives a helping hand to an old
and established art. A recent noteworthy example
is the work of Otto Schade in testing optical systems,
particularly lenses and photographic films, using a
television system as the testing medium. Optics
is one of the oldest applications of science. Yet, in
over a century of work, no objective means of rating
the ability of lenses to show pictorial detail had
been devised. Mr. Schade, who has extended the
performance of television systems further than any
other engineer known to us, passes a magnified
image, formed by the lens under test, into a tele-
vision camera and analyzes the video waveform thus
produced. A neat trick, applicable to electron lenses
in camera and picture tubes no less than to glass
optics. Such techniques, carefully applied, can
assist materially in the progress of photography and
television.
Airline Test Techniques

Facilities of American Airlines at La Guardia Field permit complete overhaul of electronic gear used in 205 commercial planes and ground stations. Accessory circuits simulating those used in planes constitute an important part of the equipment.

By JOSEPH ALBIN
New York, N. Y.

The radio overhaul workshop of American Airlines at La Guardia Field, New York, handles the bulk of the aircraft and ground radio work for the entire airline system, as well as engineering changes and modifications to equipment. In addition to scheduled overhaul, the shop is prepared to aid the engineering branch of the communications department in the development of new models. A separate manufacturing section of the shop is equipped with hand-operated and power tools for fabricating accessory parts in reworking operations. A pioneer in the use of vhf for communication between ground and aircraft, the airline was interrupted in its installations of such equipment in planes by the war. Resuming in 1945, the addition of vhf gear to the entire system has been facilitated by the equipment to be described.

Test equipment has been designed to include circuits which simulate actual conditions found in a specific plane installation or at a ground station. Largely through use of adapters, a single piece of equipment has sufficient flexibility to handle a wide range of types. An employee suggestion system has been helpful in utilizing the talents of the radio overhaul crew in recognizing the need for special equipment when it arises.

ADF Receiver Test

Figure 1 shows the arrangement of American-Airlines-built equipment designed for alignment of a Bendix MN62A adf receiver. The
FIG. 1—Circuits of a Bendix adf receiver are completed by the accessories mounted in the cabinet at upper left. Operating conditions of the loop are simulated by the unit at lower left.

FIG. 2—A barber's chair provides a sturdy mount for rotating direction-finding equipment during final adjustment and performance check.

FIG. 3—Radio mechanic adjusts an AA-designed receiver test unit which simulates airplane wiring, controls and indicators.
apparatus at upper left is a control and indicating unit consisting of various adf accessories used in the airplane. The unit thus simulates the actual installation in the aircraft, making possible a test under flight conditions. A tuning unit with heavy cable is adjacent.

An interesting unit is the loop simulator, shown at lower left of Fig. 1. It consists of two loops, both mounted on the same axial line, with mechanical means for driving the smaller of the two loops, which is used for signal input. The second loop is a standard automatic direction-finder loop which picks up the signal for the adf receiver, and its rotation follows rotation of the input loop.

The rotation of the equipment due to the plane's movement under actual flight conditions is simulated by rotation of the input loop which is fed from a standard signal generator. Using the loop simulator, complete alignment of the receiver can be accomplished with one exception, the alignment of the loop stage.

To align the loop stage of the receiver, the adjustments are made with the help of equipment which includes a rotatable mount that was formerly a barber chair, illustrated in Fig. 2. An azimuth card is attached to the base of the rotating member so that a receiver can be rotated and checked for sensitivity and ability to take a bearing on a weak signal, which is picked up from a short beam antenna, directed downward, above the chair. Calibrations of correction factors for various plane shapes and sizes are recorded on the azimuth card.

Receiver Tester

Several types of communication receivers are accommodated by the special receiver test unit being operated in the photograph of Fig. 3. It is accompanied on the shelf (right) by a 75-mc signal generator having modulation frequencies of 400, 1,300 and 3,000 cycles. This is used to align marker-beacon receivers.

The circuit of the special receiver test unit is shown in Fig. 4. This simulates the wiring to accessory equipment in the aircraft. Accessories are contained in the test unit. They include a low-voltage d-c supply using selenium rectifiers to replace the 12 or 28-volt batteries used in planes, a 250-volt d-c supply to replace the dynamotors, sensitivity controls, frequency-selector switch, and indicator lamps for the marker receiver (part of the instrument landing system). These units are wired to the several plugs shown in the diagram. Socket and cable sets are available for connecting the receiver test unit to various receivers. When the proper cable set is connected, the various circuits required by the receiver are completed just as they would be in a plane. Changes in the test unit are made from time to time to accommodate new types of receivers.

The test unit also includes an audio oscillator for checking the operation of the receiver sidetone channel. This channel is provided in aircraft receivers to permit a pilot to hear his own voice in his headphones while speaking into the microphone when transmitting by radio or communicating within the plane. Relays in the plane switch

FIG. 5—A Wilcox vhf transmitter is adjusted after overhaul in the test rack

FIG. 6—Keying and dialing circuits are provided for testing ground transmitters

FIG. 4—Complete circuit of the special receiver test unit. Male plugs connect to cable sets for various receivers

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a portion of the audio signal from the transmitter to the audio channel of the receiver and disable the screen circuits of the r-f and i-f circuits of the receiver. The test unit contains similar relays for connecting the audio oscillator into the sidetone channel to check its operation. A level of 50 milliwatts is considered minimum for head- phone reception in the aircraft.

When a marker receiver for the ils is being tested, the white, blue and amber indicator lamps are automatically connected by the receiver cable set to receive the direct-current output of saturable reactors and filters in the receiver that actuate similar marker indicator lamps in the aircraft.

In Fig. 5 is a complete test rack used to adjust the Wilcox 601A vhf transmitter after overhaul. Single-channel tuning of the r-f exciter circuits is done by adjusting the plate circuit of each stage for maximum grid current in the following stage. The final amplifier tube is then inserted and its grid and plate circuits resonated. A dummy antenna is next connected, the output amplifier readjusted for resonance and all stages checked.

For testing remote transmitter control units as well as receiver installations under simulated use conditions, the test rack illustrated in Fig. 6 contains circuits which serve as equivalents of telephone lines and supplies necessary power and keying and dialing circuits for complete operation. It also can be used to test high-frequency transmitters, chiefly the 50-watt W. F. 13 ground transmitter.

Transmitter Tube Tester

The tube tester illustrated in Fig. 7 is designed for heavy-duty rectifier tubes and transmitting tubes only. The tube tester provides a low-voltage rectifier test, a high-

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**FIG. 7**—Complete tube tester for transmitting and rectifier types is contained in these three racks and section above

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**FIG. 8**—Circuit of tube tester. A power tube is operated as an r-f oscillator under load conditions. The cathode-ray tube is used in an emission test
voltage rectifier test, a transmitting-tube static test, a transmitting-tube dynamic test, and a cathode-ray test of transmitting tubes. In the latter test, a visual emission curve is provided on the screen of the cathode-ray tube.

Separate adjustable power supplies are provided in the tube tester for the control grid, screen grid, suppressor grid and plate potentials of the tube under test. These potentials are individually controlled by the operator of the tester. As shown in the photograph, voltmeters for each circuit permit continuous monitoring of potentials and precise adjustment for various types of tubes. Up to 8,000 volts can be applied to tubes under various conditions of load.

The circuit of the tube tester is shown in Fig. 8. For the dynamic test of transmitting tubes, the tube is operated as an r-f oscillator to simulate the load conditions of the tube in its normal circuit. Power generated by the tube at a frequency of approximately 200 kilocycles is dissipated in a load composed of a number of 600-ohm resistors that are connected in a series-parallel arrangement to permit obtaining loads of 120, 240 and 480 ohms. Control of the load circuits is accomplished by means of three knobs at the top of the test stand.

**Components Layout**

A series of interlocking door switches, time-delay circuits and indicator lamps act as safety devices to protect the operator of the tube tester. After he has made proper selection of operating potentials to be applied to a tube under test, it is necessary for him to step on a foot switch to actuate the circuits.

The left-hand rack shown in the photograph (Fig. 7) contains the high-voltage selector and preheater supply unit, the oscillator and master socket unit with suppressor-polarity reversing switch, tuning, load, grid excitation and coupling controls, the r-f load and associated external 500-ma and 3-amp thermocouples.

The center rack section contains the meter panel with range-selector relays, the 905 cathode-ray tube, the control unit with its warning and indicator lights, 878 rectifier, 632 thyratron and associated controls for the cathode-ray circuit, 82 rectifier, 2050 thyratron and controls for the overload circuit and meter-range selector buttons.

The third rack section contains the variable high-voltage control, the variable low-voltage control unit using two power supplies to supply the grid and suppressor grid voltages, a 15-volt power supply unit which has a time relay and uses two type LVR 2-amp mercury-vapor rectifiers to supply low voltage for the rectifier test. The 1,000-volt power supply has a master-switch circuit breaker for the entire tester and uses two type 249T rectifiers which supply the screen voltage. The 4,000-8,000-volt power supply with the low-voltage high-voltage relay supplies the plate voltage for all tubes except rectifiers, which operate directly from the high-voltage secondary.

The fourth section, across the top of the three racks, is the rectifier load with associated controls. The instrument operates from a 3-kw line.

The panels shown in Fig. 9 test...
and align radio equipment used in overseas aircraft. The apparatus on the upper shelf, from left to right, consists of an oscilloscope, audio oscillator, voltmeter, frequency standard and signal generator. The equipment below the shelf comprises control and meter panels.

The equipment used in crystal-frequency monitoring as well as testing of crystals is shown in Fig. 10. This equipment consists mostly of General Radio units and some AA-built units. Other gear, not shown in this photograph, tests crystals in their holders, measures activity, and permits grinding to proper dimensions.

**Other Equipment**

For rapid routine testing of dynamotors, the test stand of Fig. 11 has been built to check all types of dynamotors from the smallest type used in receivers to those used in transmitters. Adapters are provided to accommodate the different types so that a number of dynamotors can be connected to the instrument at one time. The test stand is arranged so that all the meters can be switched to a particular dynamotor being observed. The noise meter, actually a vacuum-tube voltmeter with preamplifier, indicates excessive ripple due to faulty commutator brushes and in some cases due to electrostatic accumulations on ball bearings which discharge through the oil film.

Headsets and microphones are tested for sensitivity and frequency range in the instrument illustrated in Fig. 12. Headsets can be matched so that two headsets will be equal in volume at all frequencies. An audio oscillator furnishes a signal audible in the headset. The signal is picked up by a special dynamic microphone which feeds an oscilloscope and a meter that measures voltage output.

The radio overhaul shop at La Guardia consists of a main area for general overhaul, a separate manufacturing section, and several smaller rooms, screened or otherwise constructed for special testing. For screening purposes, the technicians in this shop prefer a screen composed of hot-galvanized-dipped wire of 1-inch mesh instead of more closely woven copper screening. The objection found in the case of the copper is that it eventually oxidizes, resulting in incomplete screening in spots, whereas the galvanized bonded wire does not work apart or deteriorate at the joints.

Policy in connection with overhaul is the responsibility of the Director of Communications, G. E. Mears, and Stanley Irwin, Assistant Director.

The author wishes to acknowledge assistance in the preparation of this article on the part of Ralph Core, Supervisor, and Walter Grasel, Shop Foreman, of the radio overhaul shop.
VHF Telephone Link

Standard radio equipment is modified and provided with a balancing network for matching into line-telephone equipment. Resulting extension of telephone service reaches isolated homes and business enterprises, or provides short-haul toll circuit over rough or impassable terrain where wire lines can not be run.

By E. H. B. Bartelink and E. A. Slusser
Radio Engineer
General Telephone Service Corp.
New York, N. Y.

Many homes, businesses and communities in remote locations do not have telephone service because of the prohibitive expense of building the long wire lines necessary to reach them. In a number of these cases VHF radio circuits may provide the necessary telephone facilities at acceptable costs. Radio circuits offer the advantage of speed of installation and the elimination of pole lines, which are expensive to build and to maintain whenever long distances are to be bridged in remote regions. Such radio circuits, operated as part of a telephone system, are particularly advantageous where bodies of water or rough, hazardous terrain have to be crossed.

The need for a simple, reasonably priced unit to handle such cases has been indicated. For this reason, the development of a single-channel
for Isolated Communities

vhf link, operating in the 152-to-162-mc band, was undertaken in the Radio Department at General Telephone Service Corporation.

Interconnection Problems

When a radio circuit is to be used between two fixed points, there is no problem in operating a two-way system provided that four wires are furnished between the radio facilities and each operator's position. The nation's wire-telephone network, however, operates on a two-wire basis. Only two wires extend from the central office to each subscriber's instrument. In order to use radio as an extension of the telephone network, it is therefore necessary to match the four-wire radio network into the two-wire land-line telephone system.

While usable results can sometimes be obtained by paralleling transmitter input, receiver output, and line, it is generally found that the audio gain of the radio circuit must be kept down to very low values in this arrangement to prevent oscillations because of the feedback path existing around the radio-circuit loop. Owing to the variation of phase angle over the frequency band, even a transposition of the audio wires in such a feedback circuit will not eliminate this problem, although it will change the frequency of the oscillations.

To overcome these difficulties, a hybrid system for which a simplified block diagram is shown in Fig. 1, is used. In the ideal case, the balancing network is an exact replica of the impedance presented at the terminals leading into the wire-line system. Under these conditions, any voltages impressed by the receiver output will leave the points across which the transmitter is bridged at the same potential, and thus no energy is transferred to the transmitter. Incoming signals from the line, however, will produce a voltage across the transmitter. This arrangement theoretically permits high stable gain.

To obtain perfect balancing, it will be necessary to provide a special network for each of the innumerable varieties of lines that might be attached to the radio circuit through the switchboards at

FIG. 1—Block diagram of a two-way radio-telephone circuit connected to conventional two-wire telephone system

FIG. 2—Terminal equipment used to extend wire-telephone service by means of radio. It can be used in different ways, using optional interconnections
the central office. Fortunately, it is found in practice that a compromise balance may be used, that is, a balance that represents the impedance of the average wire line. By using this compromise balance, gain values may be obtained that are acceptable for telephone operations while maintaining a sufficient safety margin below the "singing" or oscillation point.

In the unit described here, hybrid circuits, as well as the signal circuits, are concentrated in a termination panel. For practical reasons, it was found desirable to interconnect all the units through a distribution panel, as shown in the block diagram of the system in Fig. 2.

Functions

There are three main functions which the radiotelephone unit can perform. It can be used to give telephone service to a single isolated subscriber; it can be used to give telephone service to a distant group of subscribers who are located sufficiently close together to permit their interconnection by means of a few miles of wire line; and the unit can be used for toll circuits between central offices. To obtain these different functions, some circuit changes must be made in the termination panel. The different circuits are obtained by changing straps on a terminal board contained in the unit.

If service is to be given to a single remote subscriber, a termination panel is needed in the central office to match the four-wire radio circuit to the two-wire telephone system. At the subscriber end, however, it is not necessary to provide a hybrid system, and accordingly the termination panel can be removed from the subscriber's radiotelephone unit. At least one standard make of subscriber instrument can easily be rewired to provide a four-wire circuit, as well as the necessary control circuits for this application. This instrument is then directly connected to the distribution panel by means of a multiconductor cable. The subscriber, through his radio circuit, can then be connected to either a manual telephone exchange (using central battery supervision) or to a dial exchange.

Radio Party Line

More than one isolated subscriber may be given service from the same central office on the same pair of frequencies. When calling, the central office may distinguish between the different subscribers on this "party line" either by using coded ringing or by harmonic ringing. In the latter case, any one of a number of different ringing frequencies can be transmitted. The subscribers' bells are mechanically tuned to these different frequencies, and only one bell will ring for each frequency transmitted.

One problem occurs when the subscriber desires to talk to another subscriber who is connected to the central office by means of the same pair of radio frequencies and through the same radiotelephone terminal at the central office. If two subscribers are transmitting simultaneously, beat notes are likely to occur in the central-office receiver. For this reason, a switch must be provided in the subscriber instrument. Operation of this switch will put the subscriber's transmitter under the control of a pushbutton in the handset, and push-to-talk operation, as used in mobile radio, is then employed.

In some cases, several potential subscribers are located close together so that the building of a short-wire line will make it possible to interconnect subscribers. The vhf radio link can then be used to connect these subscribers to the central office; termination panels are needed at both the central office and the remote terminal. In this case, the subscribers' sets are connected across the standard two-wire telephone circuit. Manual or dial operation, as well as coded or harmonic ringing, are again available in this application.

Toll Circuits

A common form of toll circuit is the ringdown type, in which the operator applies ringing voltage to the line to activate a lamp or signal at the distant end when she initiates a call. Ringing current is reapplied either to recall the other operator after the connection has been established or to signify the termination of the call. The radiotelephone unit described here provides such ringdown toll circuits. Termination panels are needed at both ends. For voice transmission, such a circuit has advantages over a physical wire line, because voice-frequency gain is available in the radio units. This feature, combined with the voice-frequency gain stability resulting from the use of frequency modulation, permits the operation of a stable zero-loss or low-loss circuit. The same advantages in transmission quality are obtained on the subscriber circuit.

Other types of toll-circuit signaling are needed in some cases; and, for this purpose, an alternate panel, permitting full two-way dialing over the radio circuits, has been developed.

Description of Equipment

The radio transmitter and receiver used operate in the 152-to-162-mc band and are materially the same as those used for the low-power land transmitter and for the land receiver in urban-mobile systems. The fact that these units are

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**FIG. 3—Carrier-operated relay circuit for dial and ringdown operation**
already in quantity production results in acceptable price and delivery schedules, which could not be obtained if special units were to be designed and built for this service. Some minor modifications are made in these units to adapt them for the particular service and specifically to provide the supervisory signals that are necessary when connection is made to the existing telephone system. Supervisory signals are transmitted in these units by controlling the r-f carrier either by switching it on or off or by recurrent interruptions which are used for the transmission of ringing and dialing.

It should be noted that while the equipment described here operates in the 152-to-162 mc band, the same modifications may be made to equipment operating at other vhf bands, such as the 72-to-76 mc band.

Apart from the antennas and r-f lines, a complete radio terminal consists of the units illustrated: receiver, termination panel, distribution panel, transmitter, and power supply for transmitter. These units are permanently interconnected.

The receiver is a modified 152-to-162-mc fixed-frequency unit (RCA CR-3B) of the double-superheterodyne type using different harmonics of a single crystal oscillator for the local oscillator frequencies. This unit is tuned at the factory to a specified frequency. The receiver contains a carrier-operated relay and associated circuits to follow dialing and ringing pulses. The tube complement is as follows: two 6AK5 tubes operating as an r-f amplifier and first detector; three 6AG5 tubes operating as the oscillator, first multiplier and second multiplier; six-6SH7 tubes operating as a second detector, first and second i-f amplifier, first and second limiter, and second audio; two 6H6 tubes operating as the discriminator rectifier and the noise rectifier; one 6SL7 squelch tube and first audio tube; one 6K6 output tube; one 6SN7 relay tube and one 5Y3 rectifier.

Relay Circuit

Normally the carrier-operated relay provided in this receiver is operated from the squelch circuit. In order to get a low distortion figure for the dial and ringing pulses, it was found desirable to energize the d-c amplifier, normally used, from limiter current instead. In addition, faster time constants were incorporated. The relay circuit is shown in Fig. 3.

A more detailed description of the termination panel would go beyond the scope of this paper. However, Fig. 2, which represents a simplified schematic diagram, shows that operation of the receiver-carrier relay will apply a-c ringing voltage to the outgoing telephone line by means of the CSR relay in toll application and for the distant unit for subscriber operation. Ringing voltages, received from the line, operate polarized relay P and will interrupt the outgoing carrier by applying cutoff bias to the transmitter. In the subscriber terminals, a wiring change is made so that P relay will put the transmitter on the air as soon as the subscriber lifts his handset. The same hybrid circuit is used in all these applications; it is also shown in Fig. 1.

The distribution panel (Fig. 2) interconnects all units as shown. It also contains a power-supply unit with its positive side grounded. This power-supply unit, by means of relay T can apply cutoff bias to the transmitter. It also provides the d-c supply for the termination panel and the microphone current for single subscribers.

Transmitter

The transmitter used is the RCA CT-5A 45-watt 152-to-162-mc unit. Like the receiver, it is modified for this specific purpose. It is also pre-tuned prior to shipment, so that only minor adjustments are necessary to place it in operation. The major modification made in this transmitter permits keying by applying negative voltage to grid of the last tripler tube and final amplifier.

The normally-used transmitting and the receiving antennas designed specifically for use with this equipment are three-element directional types consisting of a driven element, reflector, and director mounted on a subassembly. They are connected to the radio terminal by means of coaxial cables. The antenna elevation needed may vary from one situation to another but, in general, antennas should be at least 30 feet above ground level and 15 feet above surrounding buildings. Under such conditions, normal operating range is in the order of 25 to 30 miles over flat country.

Installation

To support the antennas, a single telephone pole can generally be used. Normally, sufficient spacing is obtained when the two directional antenna structures are supported at opposite ends of a 10-foot crossarm. Coaxial cables, attached to the pole at proper intervals to give mechanical support, connect these antennas with the terminal unit. The cables are equipped with coaxial fittings that are connected to corresponding receptacles in the transmitter and receiver. For use in a central office, two wires from the main distributing frame are connected to a terminal block in the unit. For remote communities, the outside interconnecting wires, having been properly fused and protected, are similarly connected to the termination panel, and a microphone-supply battery is added. For single subscribers, a specially-wired subscriber set is plugged into the distribution panel, and the termination panel is omitted. Connection of a ground wire and insertion of the power plug into the 110 volt 60-cycle outlet makes the system ready for operation.

The power requirement of this unit is 477 watts for toll-circuit operation. In subscriber operation, it is 477 watts while transmitting, and approximately 380 watts for standby operation.

Cost

Although the present cost data are still preliminary and may require further revisions, the present indications are that the cost for a complete radio circuit will be below $3,000. On this basis, such circuits may well provide the means to permit telephone companies to give service to a number of locations where it is presently impracticable to do so.

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Stable TIME and FREQUENCY STANDARD

Spectral absorption of microwaves by gases is so stable that the National Bureau of Standards is using the phenomenon as a standard of time. Oscillators for communications and measurements at uhf can also be stabilized by utilizing the absorption principle.

By using the absorption of ammonia gas at 23,870.13 megacycles as the primary standard of time in a new clock, the Bureau of Standards has shown the utility of microwave spectral absorption as a time and frequency standard. Not only does this spectrographic technique provide a more invariant time standard than heretofore available for scientific and engineering measurements, but it also provides a means for stabilizing ultra high frequency oscillators with an accuracy at least as good as that obtained at high frequencies by quartz-crystal control.

Quartz crystals (or magnetostriction bars) can be dimensioned so as to vibrate at the frequency (or one of its subharmonics) to be stabilized. On the other hand, absorption lines occur only at certain specific frequencies. Simple techniques can be used to relate any oscillator frequency to a convenient spectral absorption line. For many applications the equipment need not be elaborate; for the ultimate in refinement the system employed in the “atomic” clock (more strictly, a molecular clock) can be used.

**Stabilizing Oscillators**

There are several basic methods of stabilizing the frequency of microwave oscillators to a degree comparable with that obtained by crystal control at lower frequencies. The reasons for the arrangement and the development of the techniques used in the clock to be described here will be more readily understood if these previously described methods are briefly reviewed.

As at low frequencies, a discriminator can be used to develop a voltage whose amplitude and polarity are indicative of the deviation of an oscillator’s frequency from the center frequency of the discriminator. Such a technique has the merit that the discriminator can be more carefully stabilized in most instances than the oscillator itself. As used to stabilize microwave oscillators, a discriminator consists of two waveguide tees, a nonreflecting termination, a short waveguide and a cavity, as shown in Fig. 1A. The cavity, which determines the center frequency, can be proportioned for the highest selectivity and constructed for the greatest stability; but, were the cavity to be associated directly with the oscillator tube, its design would have to be compromised to meet the requirements of the tube.

The next step is to replace the cavity with a waveguide, containing a gas at low pressure, (Fig. 1B) whose spectral absorption line determines the center frequency of...
the microwave discriminator. The cavity discriminator is readily adjusted for complete cancellation of the signal at the center frequency. Design of the gas line is not as simple because the line cannot be made long. If it is made long absorption will also take place just each side of resonance, broadening the apparent absorption band.

Spectrum Stabilization

With a cavity discriminator operating in the 3-cm band, a stabilizing output from the discriminator of 250 millivolts per megacycle has been obtained; on the other hand, using the 3,3 spectral line of ammonia (in the 1-cm band) at a gas pressure of somewhat more than 0.1 mm of mercury in a spectrumin-line discriminator, a stabilizing output of 70 millivolts per megacycle has been obtained. Although the cavity discriminator gives the greater selectivity, the spectrum-line discriminator can be expected to have the higher stability.

The cavity discriminator can be built for any desired center frequency, or even made tunable. However, the spectrum-line discriminator can only be made for a center frequency at which there is an absorption line. (Although the absorption frequencies can be shifted by applying static electric or magnetic fields, this technique would reduce the stability of the line.) The next step, therefore, is to provide a means for relating the oscillator and discriminator frequencies.

The output from the master oscillator could be modulated or heterodyned with an auxiliary oscillator to obtain a signal at a spectral line, but this (usual) technique introduces some inherent instability from the auxiliary oscillator. (The auxiliary resonant circuit can be in either an oscillator or a tuned amplifier, the choice being one of system arrangement rather than of system stability.)

Frequency Sampling

Another method by which a microwave oscillator can be related to a spectrum line is to sweep an auxiliary oscillator through the absorption frequency of a gas and through the frequency of the master oscillator. The method, in effect, moves the discriminator from the ultra high frequency portion of the system to a low-frequency (pulse) portion.

The action of this system, indicated in Fig. 2, is briefly as follows: the search oscillator is swept across the absorption frequency of the spectrum line. The signal from the search oscillator passes through the waveguide and is detected at
the far end. At the instant that the frequency passes through the absorption line, the detector output is interrupted, thus delivering a pulse that is amplified and passed to the phase detector (pulse discriminator). In a parallel path, the output from the search oscillator is mixed with the output of the master oscillator. The output from this mixing is a variable frequency, for which the transmission characteristic of an amplifier serves as a discriminator to produce a second pulse. The two pulses are passed to the phase (or coincidence) detector to generate a stabilizing voltage proportional to the time difference between the two pulses.

**Sampling Rate**

The stabilization that can be obtained with this system depends primarily on the rate of sampling (search frequency) and the gas frequency. (The resonant circuit of the amplifier that provides the discriminator action following the mixer also introduces a residual instability. As in continuous-control systems, the resonant circuit in the mixer output could be shifted to a beating or modulating oscillator operating on the output of either the search or master oscillator without changing the hypothetical stability, although there might be practical advantages for one of these three positions.)

Whereas the systems using microwave discriminators depend on high amplification to make full use of their inherent stability, the system using sampling and pulse-coincidence discriminator relies on high time resolution in the pulse circuits to realize its inherent stability.

**Precision Time Standard**

The technique described is suitable for most communication and laboratory applications. However, for the ultimate accuracy, as is required in the standard time service provided by the National Bureau of Standards, further refinement is necessary. In particular, because of the inherent inability of the searching technique to counteract frequency changes in the master oscillator taking place faster than the sampling rate, short-term stability needs to be incorporated. This feature is provided in the clock by using a fairly stable (crystal-controlled) master oscillator. In effect, crystal control of the master oscillator adds the analog of inertia to the frequency of the oscillator so that the stabilizing circuit need only contend with the slow drifts associated with a high-inertia system. The absorption frequency of the gas can then be sampled slowly enough to assure full response to its highly selective frequency characteristic.

In the clock, for which a simplified block diagram is shown in Fig. 3, a 100-ke crystal-controlled master oscillator is the circuit to be stabilized. Its frequency is multiplied and frequency modulated and again multiplied to the frequency region of the ammonia-gas absorption line that is used as the comparison standard. By using the multiplied master-oscillator frequency as the central frequency for the searching system, the clock is further freed from instabilities of auxiliary components. As in the previously described sampling system, a pulse is obtained as the signal sweeps through the absorption line. A second pulse is obtained by mixing the multiplied frequency from the master oscillator with the auxiliary frequency-modulated oscillator to obtain a second pulse. The time interval between these two pulses generates the control voltage for correcting the frequency of the master oscillator.

There is a finite interval between the two pulses. This time interval is a function of the intermediate frequency (1.39 mc) used with the mixer and the rate at which the sawtooth generator frequency modulates the auxiliary oscillator. The tuned circuit in the intermediate-frequency output of the mixer introduces a residual instability that could be eliminated (in either sampling system) by producing the pulse at zero beat (when the output from the mixer passes through zero). This method has the added advantage of any null system.

With the highly accurate and stable time standard available from a spectrum line, precision measurements in all branches of science and engineering can be made with a higher degree of confidence than heretofore. The technique also provides, in simpler form, the means for stabilizing communication circuits so that as efficient use can be made of the microwave portion of the radio spectrum as is now possible in utilizing the lower frequencies.—F. H. R.

**REFERENCES**


High-Speed TRIGGER CIRCUIT

For microsecond flash photography and projectile and impact research, precisely timed pulses actuate equipment following a sound, flash of light or other physical event under observation and subsequent analysis

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THE EQUIPMENT to be described is useful for applications in which triggering or firing pulses are required in a predetermined time pattern following any physical event (a sound, flash of light, interruption of a beam by a bullet, or making or breaking of a circuit). The purpose of this development was originally to incorporate into the Westinghouse Micronex ultra-high-speed x-ray equipment suitable electronic circuitry to make more precise the time of generation of the x-ray pulse. The exact application cannot be released from classified status at this time, but the functioning of the equipment will be described for a hypothetical though similar application.

General Objectives

Assume that an electrical impulse of known characteristics is to be applied to a subject, and that it is desired to take three pictures of the subject, p, q, and r microseconds after the start of this pulse. The task may then be divided as follows:

(1) Reliable generation of a single low-level keying pulse.

(2) Providing three variable delays, in order that the three pictures may be taken at any desired times following the application of the impulse.

(3) Generation of three high-level firing pulses, each initiating a suitable flash equipment (a spark gap, for example).

(4) Generation of an electronically-produced impulse, which for the classified application was required to be a single square current pulse of preset height and width.

The project was undertaken with the understanding that the equipment would be made as accurate as possible in the time coordinate. For this reason, radar components used in systems involving time jitter of the order of 0.05 microsecond were brought into use.

Referring to Fig. 1, a pulse with steep rise is produced by mechanically connecting a charged capacitor into the grid circuit of a 6SN7 or 7N7 twin triode. The two triode sections are used in parallel as a cathode follower; the output pulse is coupled to a 6AG7 cathode follower, and also to a 2050 thyratron, whose firing removes essentially all voltage from the capacitor until a reset button is operated. This prevents generation of multiple pulses. Equipment used in conjunction with Fig. 1 includes meter circuits (for checking 2050 bias, 7N7 bias, regulated and unregulated power-supply voltages), and power supplies for the initial pulse generator.

and the following variable delay circuits.

**Variable Delay Circuits**

The problem of furnishing variable delay was analyzed from the standpoint of prediction, calibration, and reproducibility of delay, and therefore all R-C charging and discharging circuits were rejected in favor of artificial transmission line-type delay networks. The networks selected were designed for 125-ohm characteristic impedance, delay 1.4 µsec per unit, and a bandwidth of 8 megacycles, insuring the accurate transmission of all pulse components not exceeding that frequency. Referring to Fig. 2, 19 such networks were placed in series, giving a maximum delay of 26.6 µsec. If desired, one of the units may be unboxed, and smaller units of time delay, down to 0.05 µsec, used. Also, for more delay more units may be placed in series.

It should be borne in mind, in assembling this type of equipment, that the propagation of electromagnetic waves along normal coaxial cables takes place at a velocity of approximately 120,000 miles per second; or about 600 feet per microsecond. Pulse transmission for a distance as short as 6 feet, then, produces automatic delay of the order of 0.01 µsec, which must be taken into account if calibration to 0.05 µsec is attempted.

The input pulse, which is positive, is first inverted in one-half of a 7N7 triode, becoming negative; all positive portions are then clipped off in the second half of this same tube, which also amplifies the pulse, which then proceeds to a 6V6 (triode connected) cathode follower, of 125 ohms output impedance. Several short-time-constant interstage coupling networks are used as differentiator-peakers. The pulse at 125-ohm impedance is applied to the 125-ohm delay lines, in series; the impedance match is completed by placing a 125-ohm noninductive resistance across the output of the 26.6-µsec line.

Three pairs of switches are so arranged that three output pulses may be obtained, at any three delays (independent) from 0 to 26.6 µsec. Each pulse, attenuated in the delay line, is fed to another 7N7 inverter, clipper, shaper and 7N7 cathode follower, to provide a narrow, low-impedance, steep-rising, positive-going pulse to energize the hydrogen thyratrons which follow.

The pulse, as selected at various points on the delay line, is applied directly to the grids of negatively-biased triodes, thereby providing a high impedance which does not disturb the impedance match along the delay line. The input pulse to this delay unit is also brought out, undelayed, for use in initiating the single square current pulse.

**High-Level Firing Pulses**

Each delayed, shaped pulse is used to trigger a 5C22 hydrogen thyratron connected as in Fig. 3. This causes a charged capacitor or artificial pulse line to discharge through the primary of a pulse transformer, which may be a 1:10 trigger type for gap firing, or a magnetron type if a pulse of controlled duration is desired. In either case, a voltage pulse of height up to about 30 kilovolts and rise time of the order of 0.1 microsecond is obtained.

If a capacitor is used to discharge through the pulse transformer, the discharge shape is determined by the R, L and C constants of the circuit. To achieve minimum rise time and maximum voltage, the inductance in the circuit should be minimized by mounting the thyratron, capacitor, transformer and gap, (flash tube), as close together as possible. The peak
Voltage available is equal to the charging voltage (not to exceed 16 kv for the 5C22) times the step-up ratio of the pulse transformer. Using an artificial pulse-forming line, properly matched, the peak is one-half this value.

All 5C22's will not stand off 16 kv d-c continuously; some can be aged up to this value. In any case, they must be well shielded, or all will be fired by the first high-level pulse generated in the vicinity.

Since very little average current is drawn at the high anode voltage of the 5C22's, essentially all the pulse energy being obtained from charged capacitors, the high-voltage power supply may be a voltage doubler, as shown in Fig. 4. Type 705A were used first because of availability in an existing power supply; actually 3B24's are satisfactory.

Square Current Pulse

The undelayed pulse is applied to a pulse shaper, a clipper, and to a 3C45 hydrogen thyratron square-pulse generator as shown in Fig. 5. The load is shown as a 45-ohm resistance in the cathode circuit; for the original application, a current of up to 10 amperes was required, through a resistance of the order of 1 ohm. A total resistance of 45 ohms was provided, which allowed the current to be varied, up to the maximum, by various combinations of series and parallel circuits. In order to insure reliable firing of the 3C45, a 2,000-volt anode supply was provided, again required to supply little average current.

To provide a quick-rising, flat-top pulse, an artificial line was used in the 3C45 plate circuit as a current source. Since the requirements of this line are that it supply a 10-ampere pulse for at least 1 millisecond into a 45-ohm load, an open-end artificial line of ten L sections, of 45 ohms characteristic impedance, and delay per section of 90 microseconds was tried. The total pulse length here is 10 times 90 usec in each direction along the line, or a total of 1.8 milliseconds.

As marked on Fig. 5, each inductance along the line is 4 millihenrys; each capacitance is 2 microfarads. The inductors, however, must have low d-c resistance in order not to attenuate the 10-ampere pulse current. In the first model, these were hand wound on small filter choke cores. Ideally, at least the first 30 usec of this line should be made of small sections comparable to the commercial lines used for the variable delay, but the entire 900-usec electrical length of this line cannot conveniently be (and need not be) made up of 8-megacycle wide, 1 or even 5-microsecond delay lines.

Charging this line to 1,800 volts and discharging it into a 45-ohm load, a maximum pulse current of 20 amperes is obtained. When the thyratron conducts, the line is placed across the cathode resistance which is always maintained at 45 ohms, the characteristic impedance of the line. The voltage across the load is instantaneously 900 volts, and remains at this value until the line discharges, twice its electrical length in microseconds later.

There are many uses for this type of synchronizing and triggering equipment. These include microsecond flash photography, projectile and impact research and explosive research. The equipment was developed by the author while employed at Picatinny Arsenal, Dover, N. J., and publication of circuit details at this time does not imply release from security classification of the associated equipment connected with explosives research. It is hoped that at a later date the complete equipment, with research results, may be described.

FIG. 4—Sixteen-thousand-volt power supply

FIG. 5—Circuit of square-wave pulse generator
Eight different sets of ratio arms are switched, separately and in sequence, into a simple 1,000-cps Wheatstone bridge. Novel discriminator detects bridge balance and initiates operation of sorting mechanism. Unit construction facilitates trouble shooting.
Component Testing

Limitation.

1,400 ohms and above.

Although these limits happen to be 10-percent steps throughout, larger or smaller steps, or any combinations of larger and smaller steps, could be used, with one limitation. To realize the full accuracy of the bridge, the minimum percentage steps must be held to 1 percent.

Operating Principle

A block diagram of the instrument is shown in Fig. 1. When it is in the rest position, the bridge ratio arms are such that any unknown within 800 percent of the value of the standard will cause a balance signal to be sent to the discriminator. This signal, when combined with the reference voltage from the oscillator, causes the discriminator circuit to send a ground signal to the switching unit.

When the switching unit receives this ground signal, it starts the testing cycle which consists of switching different sets of ratio arms into the bridge circuit, separately and in sequence, until the set which produces bridge balance with the value of unknown being tested is found. When this condition occurs, the bridge sends a balance signal to the discriminator which in turn sends another ground signal to the switching unit.

Upon receipt of this second grounding signal, the switching unit initiates the following actions: (1) The testing cycle is interrupted, (2) the jig ejector mechanism is actuated and the piece falls into the sorting chute, (3) the appropriate door in the sorting chute is opened, (4) two counters are operated, one for the particular bin into which the piece falls, and a totaling counter, and (5) the bridge is returned to the rest position ready for the next piece.

Limit Bridge

Figure 2 shows the circuit diagram of the limit bridge. The limit jacks, $J_1$ through $J_n$, and the standard terminals are mounted in the rear of the instrument, while the unknown terminals are brought out through the front for connection to the test jig. The bridge has a 10-to-1 internal ratio arm (formed by $R_1$ and $R_n$) which is connected in the circuit in the rest position. This is the ratio which starts the testing cycle by sending a balance signal to the discriminator if the value of the component falls within 800 percent of the value of the standard.

If the component's value is within this range, the ground connection is moved (by the switching unit) from the center of the 10-to-1 ratio arm to the center of the arm containing $J_1$. The ground is then passed to the arm containing $J_2$, and so on until the ratio arm is reached which produces bridge balance with the piece being tested, at which time the piece is ejected. At the end of the cycle the ground is returned to the 10-to-1 ratio arm.

The entire bridge circuit and its components are carefully shielded, and low-capacitance coaxial cable is used for all bridge wiring. To reduce contact resistance in the various connectors, 12-prong plugs and sockets are used with the prongs wired in parallel for maximum contact area.

The limit bridge operates on a 1,000-cps voltage which is generated by the Wien bridge oscillator shown in Fig. 3. The oscillator is designed to operate over a wide range of frequencies, as determined by the constants contained in the plug-in phase-shift network. Under practically all kinds of operating conditions, however, the 1,000-cps bridge frequency has proved quite satisfactory.

Discriminator—Amplifier

The output signal from the bridge is fed into the circuit shown

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**FIG. 1—Block diagram of Industrial Instrument's high-speed component tester and sorter**
in Fig. 4. After passing through four 6SF5 amplifiers and a 180-degree phase-shifting network, the signal is limited by $V_n$, further amplified by $V_m$, and finally appears across $R$, in the plate circuit of $V_n$.

A reference voltage from the oscillator is introduced at the cathodes of the discriminator, $V_n$. When the voltage across $R$ has the proper phase relationship to the reference voltage (as is the case when the bridge is approximately balanced), $V_n$, which is normally cut off, will conduct, closing the relay in its plate circuit, and passing a ground signal to the switching unit.

**Switching Circuits**

The heart of the switching circuit, Fig. 5, is the free-running multivibrator, $V_n$, which is capable of running at two speeds as determined by the position of the switch in its grid circuit. The single-shot multivibrators, $V_n$, $V_m$, and $V_r$, form a frequency-dividing chain since they are triggered only by negative pulses from preceding stages.

Each of the grids of the tubes in the frequency-dividing chain is attached to the grid of one of the six paralleled-6SN7 relay-control tubes. Whenever the grid of one of the frequency-dividing multivibrators goes positive, the corresponding relay-control tube grid goes positive, the tube conducts, and the corresponding relay is energized.

The six relays which are controlled by the relay-control tubes have several functions. They connect the proper door-control thyatron (one for each limit) to the input from the discriminator, and they send the ground signals back to the bridge as previously mentioned. A schedule for the operation of these relays and several other components in the switching unit for a complete test cycle is shown in Table I.

All the limit thyatrons, except $V_m$, which corresponds to the low limit group, have door-control solenoids in their plate circuits. There is no solenoid for this first group since the piece falls into a bin at the end of the chute. These limit thyatrons also actuate the bin counters.

The grid of $V_n$ is connected to the input from the discriminator at all times so that it will operate on all ground signals from the discriminator after the test cycle has begun. Its function is to operate the jig ejector and the totalizing counter for every piece that is tested.

The thyatrons are held nonconducting, until they receive a grounding signal, by a negative voltage from the bias supply, and the cathodes of the limit thyatrons are grounded through a common resistor to prevent more than one tube's firing at a time.

The bridge is stepped off by cutting off one-half of the free-running multivibrator, $V_n$. This is done by applying a blocking bias through $V_m$ and the contacts of $R_E$, $R_m$, $R_n$, and $R_s$, when they are in the rest position, to which the switching system auto-

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**Table I—Operating Schedule for Switching and Door-Control Unit**

<table>
<thead>
<tr>
<th>Position</th>
<th>Bridge Connection</th>
<th>Relay position: E-energized, D-de-energized</th>
<th>Thyatron Connected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rest</td>
<td>A</td>
<td>E, D, E, D, E, D</td>
<td>$V_2^o$</td>
</tr>
<tr>
<td>1</td>
<td>B</td>
<td>E, D, E, D, E, D</td>
<td>$V_2^u$</td>
</tr>
<tr>
<td>2</td>
<td>C</td>
<td>E, D, E, D, E, D</td>
<td>$V_{1a}$</td>
</tr>
<tr>
<td>3</td>
<td>D</td>
<td>E, D, E, D, E, D</td>
<td>$V_{1b}$</td>
</tr>
<tr>
<td>4</td>
<td>E</td>
<td>E, D, E, D, E, D</td>
<td>$V_{1c}$</td>
</tr>
<tr>
<td>5</td>
<td>F</td>
<td>E, D, E, D, E, D</td>
<td>$V_{1d}$</td>
</tr>
<tr>
<td>6</td>
<td>G</td>
<td>E, D, E, D, E, D</td>
<td>$V_{1e}$</td>
</tr>
<tr>
<td>7</td>
<td>H</td>
<td>E, D, E, D, E, D</td>
<td>$V_{1f}$</td>
</tr>
<tr>
<td>Rest</td>
<td>A</td>
<td>E, D, E, D, E, D</td>
<td>$V_2^o$</td>
</tr>
</tbody>
</table>

**FIG. 4**—Discriminator-amplifier circuit diagram. Crystal diode provides bias for discriminator by rectifying 6.3-volt filament supply

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**FIG. 2**—Bridge circuit. Limit plugs in $J_1$ through $J_7$ determine range of tolerance groups into which components are sorted. Resistors $R_i$ and $R_j$ form 10-to-1 ratio arm which is connected when bridge is in rest position

**FIG. 3**—Circuit diagram of Wien bridge oscillator which produces bridge voltage and discriminator reference voltage

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matically returns after each testing cycle. The function of \( V_m \) is to keep the multivibrator \( V_t \) from stepping the bridge beyond the first test position until \( RE \), has applied plate voltage to the thyratrons.

The only way the blocking bias can be removed from \( V_t \) is by putting a test piece in the jig, which will cause a ground signal to be sent from the discriminator to the grids of \( V_m \) and \( V_t \). When \( V_t \) conducts, \( RE \) is energized, and the bias is removed from \( V_t \). Relay \( RE \), is immediately deenergized, but the circuit connecting the blocking bias to \( V_t \), is interrupted as \( RE_m, RE_r, \) and \( RE \), move out of the rest position.

Relay \( RE \), switches the 120-volt supply from \( V_t \) to the plate circuits of the thyratrons during the testing cycle. This arrangement makes only \( V_t \), sensitive to the initial ground signal from the discriminator, which starts the cycle; and the other thyratrons become sensitive to the second ground signal which indicates bridge balance. When the frequency-dividing multivibrators cease to operate, the 120-volt supply is returned to \( V_t \).

This switching arrangement is accomplished by \( V_m \) and \( V_m \), which control the operation of \( RE \). The same negative bias which cuts off \( V_t \), is applied to the plates of \( V_m \) and indirectly to \( C_n \), charging it negatively to hold \( V_m \) cut off. When this negative bias is removed, \( V_m \) conducts and \( C_n \), discharges through it, allowing \( V_m \) to conduct. Relay \( RE \), is thus energized. When the testing cycle is completed, the negative bias again appears, and the grid-cathode capacitor begins to charge. The time delay introduced by the charging of this capacitor is provided to allow the piece being tested to fall down the chute and into the proper bin before the door closes. The capacitor discharges rapidly, ensuring that the plate voltage is on the thyratrons as soon as the testing cycle begins, so that the door can open.

The 4 and 8-group switch effectively disconnects \( V_t \), in the multivibrator chain for testing cycles where only 4 groups are required, instead of 8.

**General**

When capacitors are being tested, special sets of limit plugs must be used if the capacitors are to be sorted according to their deviation in terms of capacitance, because of the inverse ratio between capacitance and capacitive reactance. Proper operation of the bridge on capacitors and inductors is possible only when the units being tested have nearly the same phase angle as the standard.

The model AB-1 Auto Bridge was developed by Industrial Instruments Inc. of Jersey City for use by manufacturers and consumers of large numbers of component parts. Special jigs have been developed for testing and sorting such things as potentiometer elements, and experiments show promise for a jig which will permit automatic feed as the components leave their assembly lines.—J.D.F.
TELEVISION FRONT-END

Design equations for several types of r-f amplifier stages of a television receiver are derived and illustrated. Emphasis is placed on the problem of optimizing the signal-to-noise ratio while satisfying gain, bandwidth and adjacent-channel rejection requirements. Mixer stages are discussed in Part 2 to follow.

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THE CIRCUITS to be considered in this paper are the r-f amplifier and mixer portions of a receiver intended to operate in the standard 12 television channels.

The design is based on inductive tuning, the design process being the same whether the tuning is continuous or in steps. It is not intended to prove the superiority of certain circuit configurations over others, but rather to indicate the factors to be considered and the method of evaluating them in the design process.

Initial Premises

Initial premises in the design are the exclusive use of 6.3-volt miniature tubes, the use of 75-ohm coaxial-cable input and output and the use of a 26-mc intermediate frequency.

To review FCC standards, the vestigial sideband character of the transmitted signal is such that the receiver would ideally have the response characteristic shown in Fig. 1 for reception of signals on channel 2. Note that the sloping response in the vicinity of the picture carrier is linear and that the response is 50 percent at picture-carrier frequency.

It is not important what the frequency is at A and at D, but only that A be within the channel and that the curve between A and D is such that when the area ABC is pivoted about B until A coincides with D the resultant response curve is flat from 55.25 mc up to 59.25 mc. (For instance, the dashed curve ABD would be quite acceptable.) The reason for this is that the equivalent video response curve for any modulated-carrier amplifier is obtained by adding the percent response at fc + fm (where fc is the carrier frequency and fm is the modulating frequency) to the response at fc - fm and plotting the resulting sum against fm, for all values of fm between zero and the frequency corresponding to full sideband width. Thus, for the example of Fig. 1, the equivalent video response at 100 kc is equal to the sum of the r-f response at 55.15 and that at 55.35 mc, while the equivalent video response at 1 mc is the sum of that at 54.25 mc and that at 56.25 mc. Invariably the smoothest curve AD implies the best phase response.

Figure 1 shows that the maximum possible equivalent video bandwidth would be slightly less than 4.5 mc since the best that can be done below 55.25 mc is to provide a response supplementing the upper sideband to give a flat equivalent video response, and since the response of the picture channel is necessarily zero at the sound transmitter frequency. The maximum realizable equivalent video bandwidth will therefore be taken as 4,

![FIG. 1—Ideal response characteristic for receiving channel 2. For other channels, substitute the appropriate frequencies.](image1)

![FIG. 2—Plot of normalized scalar impedance of parallel RLC network having a Q of 10 at resonance.](image2)

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DESIGN

Part I of a two-part article

mc wide at the 6-db-down points.
With 55.25 mc as the bottom of the received band (the frequency below midband at which gain is 6 db down) which is 4 mc wide, the band center for this channel is 57.25 mc, and the band center of the receiver will correspondingly be 3.25 mc above the bottom of any channel to which the receiver is tuned. As will be shown later, maximum gain and bandwidth are obtained with minimum capacitance shunting the load circuit of an amplifier stage, so the circuits will be resonated by tube and wiring capacitances alone and the circuit inductance will be changed to change stations.

Synchronous single-tuned interstage networks will be considered rather than coupled circuits or stagger-tuned circuits, even though the latter two are theoretically better. It has been proven that both of the latter circuits provide a greater usable bandwidth for a given gain, but the stagger-tuned system is difficult to track properly over the specified range, and the coupled-circuit system requires one additional tuning element per interstage.

Figure 2 shows the computed variation in scalar impedance of a parallel RLC circuit over a band of frequencies centered at the antiresonant frequency of the LC combination. The scalar impedance has been shown in terms of 20 log \( \frac{|Z|}{R} \), or simply db down from the impedance at resonance, and frequency has been presented as Q times the percent deviation from antiresonant frequency.

For this circuit, Q is defined as the ratio \( R/\omega L \) where \( \omega \) is the antiresonant radian frequency.

The significance of Fig. 2 is that in any system of cascaded amplifiers having single-tuned load circuits, the gain of each stage will vary with frequency in the manner shown by the curve. If each of three identical stages were 3 db down in gain at the extremes of a band of width \( \Delta f \) centered about a frequency \( f_0 \), the unit as a whole would have a gain 9 db down (from that at \( f_0 \)) at the extremes of the band \( \Delta f \).

Data derived from the curve have been tabulated to the right of the curve, showing the bandwidth per stage required for an \( N \) stage system to have an overall bandwidth of \( \Delta f \) between the -3 db points.

Preliminary investigation shows that two tuned circuits (through which the signal must pass) will be used in any r-f head using a grounded-grid r-f amplifier, and three tuned circuits will be used in other r-f head configurations. It will be assumed arbitrarily that for an overall receiver bandwidth of 4 mc between -6 db points, the i-f amplifier will be allowed -3 db from maximum gain and the r-f head will be allowed -3 db from maximum gain at the edges of the 4-mc band. According to the table of Fig. 2, each tuned circuit in an r-f head having a grounded grid r-f stage must be 6 mc wide, and each tuned circuit must be 8 mc wide in other r-f heads.

So far, the discussion has neglected the matter of reception of the 59.75-mc sound carrier with its ±25-kc deviation under 100-percent modulation. Since the sound carrier is 2.5 mc from the resonant frequency of the tuned circuits, a study of Fig. 2 reveals that the gain is down 4.4 db from maximum gain at sound carrier frequency for an r-f head having a grounded-grid stage, and 4.2 db down for other heads. This loss relative to picture-channel midband gain can be made up in the high-gain sound i-f amplifier since it is relatively easy to obtain extra gain in narrow-band circuits.

Noise Considerations

In practice, the designer considers each noise source along the path of the signal from the input up to the point in the circuit at which new noise contributions are trivial in importance due to the increasing magnitude of the signal and the noise from earlier circuits. We must start, therefore, with a block
Pentode R-F Amplifier

There are four basic circuits from which to choose: the conventional pentode r-f amplifier of Fig. 4, the grounded-grid amplifier of Fig. 5, the cathode-follower amplifier of Fig. 6, and the cathode-coupled amplifier of Fig. 7, the latter discussed in Part II. The pentode amplifier will be discussed first, calculating the tube-noise equivalent resistance referred to the grid, then the optimum antiresonant resistance of the circuit connected to the grid will be computed. Then it will be shown how the noise powers from the real and the equivalent resistances combine, the optimum plate circuit antiresonant resistance will be computed and signal and noise voltages will be referred from the grid to the plate.

To facilitate calculation, the actual tube with its shot effect, current-division noise, and other sources of noise voltage is replaced by a theoretically noiseless tube in whose grid circuit there is a fictitious resistor having a thermal-agitation noise voltage which produces the same noise voltage in the output of the theoretical tube as there is in the output of the actual tube. This fictitious resistor, the grid-equivalent noise resistor of the tube, is a legitimate and accurate equivalent because the noise energy of a resistor has essentially the same flat frequency spectrum as the tube noise. The value of the use of an equivalent noise resistor lies in the fact that noise powers add directly, rather than noise voltages adding directly. Therefore, noise-resistance values may be added directly as though the resistors were in series, and the total noise voltage computed accordingly.

As an equivalent of the situation wherein noise-powers from a real and a fictitious resistor must be added together, assume that two different resistors of value \( R_a \) and \( R_s \) generate noise in the grids of two identical noiseless amplifiers using pentodes having infinite \( r_t \). Assume that each amplifier has a voltage gain, \( A \), and that the amplifiers have a common load of \( R_L \). Then the total noise voltage across the load resistor is given by

\[ E_{np} = (P_s R_L)^{1/2} \]

(1)

where \( P_s \) is the total noise power produced in \( R_s \) by the two tubes. As shown later, the thermal-agitation noise voltage from a resistor \( R \) can be expressed as

\[ E_a = K(R_a)^{1/2} \]

(2)

The power produced in the plate load due to a noise voltage \( E_a \) at the grid is

\[ P_a = \frac{A^2 E_a}{R_L} \]

(3)

The total power \( P_a \) can be expressed as

\[ P_a = P_s + P_b \]

(4)

where \( P_b \) is defined by Eq. 3 with subscript \( b \) substituted for \( a \). Substituting for \( P_s \) and \( P_b \) from Eq. 3 in Eq. 4,

\[ P_a = \frac{A^2}{R_L} (E_a^2 + E_b^2) \]

(5)

We can now substitute Eq. 5 in Eq. 1,

\[ E_{np} = (A^2(E_a^2 + E_b^2))^{1/2} \]

(6)

\[ E_{np} = A(E_a + E_b)^{1/2} \]

(7)

Now, substituting from Eq. 2 in Eq. 7,

\[ E_{np} = A(K(R_a + R_s))^{1/2} \]

But \( E_{np} = A E_x \)

so \( E_x = K(R_a + R_s)^{1/2} \)

(10)

The artifice of two tubes having a common load resistor emphasizes the fact that these two noise contributions (one from a real resistor, one from a fictitious resistor) could not react on each other earlier in the circuit than the plate load. In the case of two real resistors connected in parallel in a given circuit, the equivalent resistance of the two is computed from the well-known parallel relationship

\[ R = \frac{R_a R_b}{R_a + R_b} \]

(11)

and the noise voltage is simply computed for the equivalent resistor.

Further Development

For the grounded-cathode pentode amplifier circuit of Fig. 4, the grid-equivalent noise resistance is given by

\[ R_{eq} = \frac{I_p}{I_k} \left( \frac{2.5 \times 10^{-9}}{G_a} + \frac{20 \times 10^{-9}}{G_m} \right) \]

(12)

where \( I_p \), \( I_k \), and \( I \) are the d-c plate current, d-c cathode current, and d-c screen current respectively, and \( G_a \) is the plate transconductance in mhos. In the case of a 6AK5 tube operated at \( E_g = 75 \) v, \( E_r = 75 \), \( E_s = -0.6 \), \( I_s = 6.0 \) ma, \( I = 1.5 \), \( G_a = 5,000 \) micromhos, then \( R_{eq} = 1,360 \) ohms.

From the thermal-noise-voltage equation,

\[ E = 2KT\Delta f^{1/2} \times (K)^{1/2} \]

(13)

where

\[ K = \text{Boltzman's constant} = 1.374 \times 10^{-24} \text{ joules per degree K.} \]

\[ T = \text{absolute temperature of resistor in degrees Kelvin.} \]

\[ R = \text{resistive component of impedance across which voltage is developed.} \]

\[ \Delta f = \text{bandwidth of circuit through which noise voltage is transmitted.} \]

(This definition of \( \Delta f \) as the overall receiver bandwidth differs from that shown ordinarily because we have specified that the receiver as a whole has a bandwidth of 4 mc, which makes it unimportant whether noise components exist in the r-f section over a greater band than 4 mc.)

We find that for \( T = 300 \) degrees Kelvin and \( \Delta f = 4 \) mc,

\[ E = 0.26 (K)^{1/2} \text{ microvolts} \]

(14)

For the calculated value of \( R \) for the 6AK5, \( E = 9.6 \) microvolts. This is the tube-noise voltage referred to the grid, not the grid-circuit noise voltage.
From classical transformer theory, $E_{rfr}$, the signal voltage at the grid of the r-f stage is:

$$E_{rfr} = E_{ext} \left( \frac{R_s}{R_{ext}} \right)^{1/2} \tag{15}$$

where $E_{ext}$ is signal voltage from the antenna, $R_{ext}$ characteristic resistance of the antenna transmission line, $R_s$ antiresonant resistance of the grid circuit (this quantity is directly measurable with an r-f impedance bridge as opposed to $R$ in Eq. 12). It is evident that for maximum signal at the grid the value of $R_s$ should be as high as possible. Further, if we compare Eq. 14 with Eq. 15 we see that the ratio of signal voltage at the grid to noise voltage from $R_s$ is not dependent on the value of $R_s$. On the other hand, an increase of $R_s$ will bring about an increase in $E_{rfr}$ and noise voltage from $R_s$ together, with respect to the tube-noise voltage which is not dependent on $R_s$. As a result, the net $S/N$ ratio is improved due to the tendency for the tube-noise voltage to become relatively insignificant. Thus an increase in $R_s$ improves both gain and $S/N$. We must now determine just how large $R_s$ can be made without violating any of the design requirements.

H. W. Bode shows that for a constant-shunt $C$ and $R_s$ regardless of location of the pass band of a network in the frequency spectrum,

$$\Delta f = \frac{1}{RC} \tag{16}$$

where $f$ is the bandwidth of the circuit in cps, $R$ is the shunt resistance of the circuit, and $C$ is the shunt capacitance of the circuit. In the case of a simple parallel $RLC$ circuit,

$$\Delta f = \frac{1}{2\pi RC} \tag{17}$$

where $f$ is the frequency at which the scalar impedance is 3 db down from maximum value, or

$$R = \frac{1}{2\pi f} (\Delta f/C) \tag{18}$$

From the equation it is evident that since the required bandwidth is fixed, $R$ will be maximum for minimum shunt $C$. Since both the circuit gain and $S/N$ are maximum for maximum $R$, it is imperative that $C$ be held to the absolute minimum. The input capacitance for a 6AK5 tube and wiring in the circuit shown in Fig. 4 can be held to 7 $\mu F$ total. For an 8-mc bandwidth, from Eq. 18, $R = 2,850$ ohms, the maximum permissible value of $R_s$ for 8-mc bandwidth.

The shunt impedance of the antenna as seen looking into the grid side of the input transformer may have sufficient variation of its reactive component over the band of a given channel to render it worthy of close scrutiny. It has been found that the reactance variation is small enough that the antenna does not narrow the receiver pass band, but on the other hand it is not small enough to allow the antenna to be properly treated as a pure resistance over the pass band of a given channel.

Inasmuch as it is necessary to match the antenna to the grid circuit to prevent reflections on the line, if the antenna impedance were purely resistive over the band the effective resistance shunting the circuit would be halved by connecting the antenna into the circuit, and the reactance would be unaffected. In such an event the r-f stage grid circuit would have twice the bandwidth previously computed. With present antennas it appears not to be good design practice to depend on the antenna for the band widening, but it is surely permissible to use the reduced grid circuit antiresonant resistance in computing resistor noise voltage. The latter voltage is therefore 9.8 microvolts. The total noise voltage at the grid of the 6AK5 amplifier is then $E_{n} = 13.7$ microvolts.

If the impedance of the antenna transmission line is 75 ohms, from Eq. 15, $E_{n} = 6.16 \times E_{ext}$ microvolts. Thus, a signal of 22.2 microvolts at the antenna would yield a $S/N$ ratio of 10 if there were no noise contributions of importance beyond the r-f amplifier grid.

Gain

To assess the importance of noise sources beyond the first grid, we must next compute the gain of the first stage. The total shunt capacitance of the interstage circuit between a 6AK5 r-f amplifier and a 6AK5 mixer is about 14 $\mu F$ for a carefully designed circuit. The interstage antiresonant resistance for an 8-mc bandwidth is 1,425 ohms. The gain of a pentode of transconductance 5,000 microhms operating into a tuned tank circuit of antiresonant resistance $R$ is given at the resonant frequency by

$$A = G_{rr}R = 7.12 \tag{19}$$

The signal voltage at the 6AK5 amplifier plate is then

$$E_{s} = A_{E_{pp}} = 43.8 E_{ext} \tag{20}$$

Similarly, the noise voltage at the plate due to r-f stage tube noise and grid-circuit noise is

$$E_{n} = A_{E_{nn}} = 97.5 \text{ microvolts} \tag{21}$$

The most convenient process for introducing the noise contribution of the interstage circuit resistance and the mixer tube is to compute the noise-equivalent resistance for the noise power transmitted from the r-f grid to the r-f plate, and then add to this quantity the interstage circuit resistance and the noise-equivalent resistance of the mixer tube. The r-f stage noise-equivalent resistance referred to the plate can be computed from Eq. 14 as follows:

$$R_{eq} = \left( \frac{E_{s}}{A_{E_{pp}}} \right)^{2} \tag{22}$$

where $E_{s}$ is the desired resistance referred to the plate, and $E_{ext}$ is the noise voltage at the plate from the grid, as before. Substituting from Eq. 21 in Eq. 22,

$$R_{eq} = A^{2}(E_{ext})^{2}/(0.26)^{2} \tag{23}$$

and, substituting for $E_{s}$, from Eq. 14,

$$R_{eq} = A^{2}R_{eq} \tag{24}$$

wherein $R_{eq}$ represents the total noise resistance in the r-f grid circuit and tube. Then $R_{eq} = 141,200$ ohms.

This value of equivalent noise resistance is quite large compared to the values of circuit impedance and equivalent tube-noise resistance encountered so far. Therefore we can at least make a good first approximation to the correct $S/N$ ratio of the complete unit without any further data. This approximate r-f head $S/N$ ratio can be computed from the data given, $S/N = E_{s}/E_{n} = 0.450 E_{ext}$. Although it is current practice to express the $S/N$ characteristic of a receiving system by use of the system noise figure, it is more convenient to use $S/N$ voltage ratio as defined above for purposes of calculation, and then convert to noise figure as a final basis for comparison.

To summarize the data computed
on the 6AK5 grounded-cathode r-f amplifier, $E_{ns} = 43.8 \, E_{ns}, \, R_{n} = 141,200 \, \text{ohms.}$ We find later that for the case of a 6AK5 grounded-cathode amplifier coupled to a grounded-grid mixer the interstage capacitance is only 7 $\mu\text{f}$, so that the interstage resistance level can be doubled, which doubles the r-f gain and yields $E'_{ns} = 87.6 \, E_{ns}, \, R'_{n} = 564,800 \, \text{ohms.}$

**Triode Grounded-Grid Amplifier**

Next consider the grounded-grid triode amplifier circuit of Fig. 5. The noise-equivalent resistance of a triode grounded-cathode amplifier referred to the grid is given by Terman7 as

$$R_{c} = 3/G_{m} \, \text{ohms} \quad (25)$$

Using Eq. 14 the equivalent noise voltage at the grid of the tube is

$$E_{ve} = 0.26 (R_{c})^{1/2} \, \text{microvolts} \quad (26)$$

However, in the grounded-grid amplifier, as in any other amplifier having impedance in the cathode circuit, the application of an a-c voltage $e_{a}$ between grid and ground will produce an a-c plate current,

$$I_{p} = \frac{\mu e_{a}}{r_{p} + Z_{L} + Z_{K} (\mu + 1)} \quad (27)$$

where $I_{p}$ is the resultant plate current, $r_{p}$ is the a-c plate resistance of the tube, $Z_{L}$ is the load impedance between plate and ground, $Z_{K}$ is the impedance connected between cathode and ground, and $\mu$ is the amplification factor of the tube. In response to the current $I_{p}$, there will be a voltage $E'_{ve}$ from cathode to ground,

$$E'_{ve} = \frac{\mu Z_{K}}{r_{p} + Z_{L} + Z_{K} (\mu + 1)} \quad (28)$$

which refers the noise voltage to the true input of the grounded-grid amplifier. Since both plate load and cathode circuit are resonant at the same frequency, at the center of the transmission band of the amplifier, Eq. 28 becomes

$$E'_{ve} = \frac{E_{ve}}{r_{p} + Z_{L} + Z_{K} (\mu + 1)} \quad (29)$$

where $R_{c}$ is the resistive component of impedance connected between cathode and ground. However, the input impedance of a grounded-grid amplifier at resonant frequency is given by Jones$^{6}$ as

$$R_{i} = \frac{r_{p} + R_{L}}{\mu + 1} \quad (30)$$

and the input transformer must match this resistance if reflections are to be avoided in the transmission line to the antenna. Then,

$$R_{e} = \frac{r_{p} + R_{L}}{\mu + 1} \quad (31)$$

Substituting for $R_{e}$ from Eq. 31 in Eq. 29 we have,

$$E'_{ve} = \frac{E_{ve}}{r_{p} + R_{L} + (\mu + 1) (r_{p} + R_{L}) (\mu + 1)} \quad (32)$$

It can be shown in general that

$$E'_{ve} = \frac{E_{ve} \mu A_{m}}{2 (\mu + 1)} \quad (32.1)$$

where $A_{m}$ is the gain from grid to cathode that would be obtained if a signal were injected between grid and ground. Equation 32 shows the value of the tube noise voltage of a grounded-grid triode amplifier referred to the cathode circuit for the particular case where the cathode load resistance matches the input resistance of the tube. To simplify the equation for circuits using a tube of $\mu$ appreciably greater than 1,

$$E'_{ve} = \frac{E_{ve} \mu}{2} \quad (33)$$

Comparing Eq. 33 to Eq. 26 and 25, for the particular value of $R_{e}$ selected,

$$R'_{e} = \frac{R_{e}}{4} \quad (34)$$

and

$$R'_{e} = \frac{0.75}{G_{m}} \quad (35)$$

where $R'_{e}$ is the noise equivalent resistance (of a grounded-grid amplifier stage) referred to the cathode.

If desirable or necessary to provide a different cathode impedance than $R_{i}$ in Eq. 30 the noise resistance changes. In general, referring to Eq. 26 and 32.1 we have

$$R'_{e} = 1.27 \frac{R_{e} A_{m}}{G_{m}} \quad (24.2)$$

From inspection of Eq. 29, if $\mu$ is much greater than one, then for those circuits in which $R_{e}$ is of the same order as, or greater than, $(r_{p} + R_{L})$, we can write approximately,

$$E'_{ve} = \frac{E_{ve}}{\mu} \quad (36)$$

For this grounded-grid r-f amplifier circuit, however, we must match the input circuit to the antenna, so the equivalent noise resistance is given by Eq. 35. For a 6J4 operated at 15 ma of plate current, $G_{m} = 0.012 \, \text{mho}$, $r_{p} = 4,500 \, \text{ohms}$, and $\mu = 54$, so that $R'_{e} = 62.5 \, \text{ohms}$. Since the plate-circuit impedance of a class-A amplifier is the actual load impedance shunted by the a-c plate resistance of the tube, in the case of the triode amplifier the correct antiresonant impedance of the load circuit proper is appreciably higher (for a given bandwidth) than for a pentode. The 6J4 triode has substantially the same output capacitance as the 6AK5, so that the same interstage antiresonant resistance of 1,425 ohms is required. With an a-c plate resistance of 4,500 ohms, the load circuit itself should have an antiresonant resistance of 2,080 ohms ($R_{L}$ in Eq. 30). Substituting the proper values in Eq. 31, $R_{e} = 120 \, \text{ohms}$. The total noise resistance in the input (cathode) circuit is then 122.5 ohms, since $\frac{1}{R_{t}}$ (because of the shunting effect of the antenna) and $R'_{e}$ add directly as required by Eq. 11.

If we change notation in Eq. 15 to refer to $R_{e}$ instead of $R_{n}$, and $E_{ve}$ instead of $E_{r}$, we have

$$E_{ve}/R_{e} = R_{e} (R_{e}/R_{n})^{1/2} \quad (37)$$

The tube gain is simply the ratio of $R_{t}$ to $R_{e}$, since the same signal current flows through both plate load and cathode circuit. Thus,

$$A = R_{t}/R_{e} = 17.35 \quad (37)$$

The signal voltage at the plate of the grounded-grid r-f amplifier is then

$$E_{ve} = A \ E_{ve} = 22.0 \ E_{ve} \quad (38)$$

The total cathode noise resistance referred to the plate circuit is, Eq. 24, $R'_{n} = 36,800 \, \text{ohms.}$ To perform
The grid-to-ground voltage that was required to produce this cathode voltage is

\[ V_g = E_{gr} + V_k = E_{gr} (1 + \frac{1}{2} \frac{G_k}{R_k}) \]  

and the gain from grid to cathode is

\[ A_{d} = \frac{E_d}{E_c} = \frac{G_k R_k}{1 + G_k R_k} \]

From Eq. 15 the step-up from antenna to grid is

\[ A_1 = \left( \frac{R_c}{R_{ant}} \right) \]

and the step-up from cathode to output resistor is

\[ A_2 = \left( \frac{R_o}{R_c} \right) \]

where \( R_k \) is the load resistance presented to the cathode by the output transformer.

The total gain of the cathode-follower amplifier from antenna to load is

\[ A = A_1 A_2 \]

Substituting for \( A_1 \) and \( A_2 \) each of which is dependent on \( R_k \),

\[ A = \frac{A_1 G_k (R_c R_k)^2}{1 + G_k R_k} \]

To determine the value of \( R_k \) for maximum gain of the derivative of \( A \) with respect to \( R_k \) is set equal to zero. The gain \( A \) is dependent on \( R_k \) only by virtue of the dependence of input capacitance of the tube on the grid-to-cathode gain, \( A_1 \), which is in turn dependent on \( R_k \). The degree of dependence of \( A \) on \( R_k \) is so slight that \( A_1 \) changes only 20 percent as \( R_k \) goes from zero to infinity, so we shall assume \( A_1 \) to be invariant with \( R_k \) in performing the differentiation. Then

\[ \frac{dA}{dR_k} = \frac{A_1 G_k (R_c R_k)^2}{1 + G_k R_k} \]

and it can be found that

\[ R_k = 1/G_k \]

The driving impedance seen by the load of a cathode follower is equal to 1/\( G_k \), so the above result is quite in keeping with the usual relationship for matching a load to a generator for maximum power transfer. Note that the above condition has no relation to the condition for maximum power output from a cathode follower when the available input signal is unrestricted. Substituting for \( R_k \) from Eq. 44 in Eq. 43.1, we have

\[ A = \frac{1}{2} \frac{A_1 G_k (R_c R_k)^2}{1 + G_k R_k} \]

\[ A = \frac{1}{2} \frac{(G_o R_o R_k)^2}{1 + G_k R_k} \]

Having obtained the basic gain equation for the circuit, we can evaluate the signal and noise transmissions to the output. The cathode-follower r-f amplifier grounded-grid mixer combination would not require an interstage transformer, so we need only consider the combinations involving a straight pentode mixer or a cathode-coupled mixer in computing the value for \( R_k \). For both the 6AK5 pentode mixer and the 6J6 cathode-coupled mixer, the input capacitance of tube, socket, and wiring is about 7 \( \mu F \), so \( R_k \) must be 2,850 ohms for an 8-mc bandwidth. Using either the 6J6 (sections paralleled) or the 6J4 as r-f stage, the \( G_k \) is 12,000 microhms for an obtainable operating condition. The output transformer ratio \( R_c R_k = R_c G_k = 34.2 \) impedance ratio. With such an impedance step-up, the 5 \( \mu F \) cathode-to-ground capacitance of the cathode-follower adds only 0.146 \( \mu F \) to the capacitance loading across \( R_o \), so we may neglect it.

The input capacitance to either a 6J6 or a 6J4 cathode follower is about 6 \( \mu F \) so \( R_k \) is 3,320 ohms for an 8-mc bandwidth.

The cathode follower gain is then

\[ A = 19.5 \]

Computing the tube noise-equivalent resistance from Eq. 25, since the presence of cathode feedback does not modify the inherent \( S/N \) of the tube, \( R_c = 3/G_{o} = 250 \) ohms. The grid-circuit antiresonant resistance is made up of the transformed antenna resistance in parallel with the 3,320-ohm damping resistor, or 1,660 ohms net noise resistance. The total noise resistance effective in the input circuit is

\[ R_{in} = R_c + R + R_k = 1,910 \] ohms.

The amplified and transformed total noise resistance at the output side of the output transformer can be computed with the aid of Eq. 24.

\[ R_{out} = (A_o A_2)^2 R_k \]

By Eq. 43, 45, 47,

\[ R_{out} = 16,350 \text{ ohms} \]

From Eq. 26 the noise voltage across \( R_c \) (excluding the noise from \( R_o \), itself as well as the mixer noise which is yet to be computed) is

\[ E_{n1} = 33.3 \text{ microvolts} \]

Since the gain is 19.5, \( S/N = AE_{in}/E_{n1} = 5.885 E_{n1} \). A signal of 17.1 microvolts at the antenna would produce an \( S/N \) of 10 for this circuit if there were no further noise contributions.

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**FIG. 6—Cathode-follower r-f amplifier**

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Stabilized Decade-Gain

With an input impedance of over 200 megohms and less than 6-µµf shunt capacitance, this single-probe instrument permits simultaneous observation of voltage, waveshape, and other characteristics of signals on high-impedance circuits with practically negligible loading effect.

By JOSEPH F. KEITHLEY
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Input impedance of an electrical test instrument is a major factor in considering its applications and general usefulness. It is axiomatic of all sciences that a process which is being observed should not be affected by the means of observation; and for electrical work, it is necessary that indicating and recording devices have no great effect on a circuit whose characteristics and performance are being measured. Otherwise, no knowledge would be gained of the circuit in its normal operating condition, and the results obtained in the test condition would be untrue and misleading.

The Problem

More specifically, a measuring instrument should have an input impedance which is large compared with the circuits to which it is connected and take only a small fraction of the power available. If the low audio-frequency output voltage of a pentode amplifier stage which has a 10,000-ohm plate load resistor were measured with a 10,000-ohm voltmeter, a large error would be expected. But only a 1-percent error results with a 1-megohm voltmeter. If, however, a 1-megohm plate load resistor were used in the amplifier, a 50 to 100-megohm voltmeter would be required for a 1-percent loading error. Capacitance loading introduces similar errors at the higher frequencies.

Instruments have been built more and more sensitive to keep the loading errors small. Meters now commonly used for d-c voltages have D’Arsonval movements of 20,000 ohms per volt, and various electronic voltmeters have input resistances of from 10 to 1,000 megohms. Sensitive a-c voltmeters and cathode-ray oscilloscopes have inputs of 0.5 to 10 megohms shunted by about 20 to 50 µµf at their input terminals.

For measuring the output signal voltages of high-impedance circuits, such as the pentode amplifier with the 1-megohm load resistor, the direct connection of 1-megohm and 35-µµf voltmeters and oscilloscopes plus an extra 10 to 60 µµf added by the test leads causes a large loading error. Most coupling means commonly used between the signal source and the test instrument in order to reduce the loading error are not wholly satisfactory. Inherent capacitances can cause undesirable loading on the circuit being tested as well as a nonuniform response of the test instrument to frequencies of interest. Unshielded high-impedance leads pick up spurious voltages, and shielding adds to the capacitance errors. Also, the desired signal is often reduced below the capabilities of the measuring instrument; and, in general, each test instrument requires its own coupling network.

The Answer

A proposed circuit has a much higher impedance than usual at the working end of the test leads, and a modification of this circuit in conjunction with a stabilized amplifier produces an instrument with a number of desirable features. Its high-impedance input of greater than 200 megohms shunted by less than 6 µµf for frequencies up to 150 ke can be connected to almost any circuit with small loading effects, no loss of signal, or introduction of hum.

The stabilized amplifier has a low dynamic output impedance, so that one or several measuring instruments can be connected to it with-

Amplifier being used for simultaneous voltage and waveshape observation

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Isolation Amplifier

Under-chassis view. The type-75 tube is mounted inside the insulated shield box.

out error. It is thus possible to observe simultaneously and accurately the voltage, waveshape, tone, or other characteristics of signals on high-impedance circuits. Only one pair of test leads is required for all observations. In addition, gains of 10.0 and 100 as well as 1.00 are available, and the noise-level is low enough so that 100 microvolts can be measured with reasonable accuracy.

The circuit diagram is shown in Fig. 1. Tubes V₁ and V₂ are used for the input circuit, and V₃ and V₄ form the stabilized amplifier. The high input impedance is obtained by enclosing the input circuit in a shield, shown dotted in Fig. 1, which is driven at almost the same instantaneous potential as the test signal conductor. The circuit being tested, therefore, supplies only a fraction of the usual charge, thus the apparent capacitance is greatly reduced. Similarly, only a fraction of the usual current flows through the resistive paths, greatly increasing the apparent resistance. Another point of view is that the instrument, in driving the inner shielding, is providing the charging and leakage current for the cable, relieving the circuit being tested of that function, thus creating the illusion of high impedance. Undesirable electrostatic fields are eliminated by enclosing the driven shield by a second cable shield and by the metal cabinet which are maintained at ground potential.

Figure 2 shows a cross-section of the signal probe test lead, with the central signal conductor enclosed by the driven shield, which in turn is enclosed by the shield at ground potential. An insulating jacket covers the cable so that no metallic grounds are present along the lead. A Bakelite ferrule holding the banana-plug probe insulates the end of the cable. The test leads are 30 inches long, allowing convenient separation between the circuit being measured and the test equipment.

**Input Capacitance**

The input capacitance is the sum of three components: the grid-plate capacitance of V₁; the capacitance of the grid and signal wiring to all other conductors at a-c ground potential; and the capacitance due to the test cable. If C is the actual cable capacitance between the signal conductor and the driven shield, E_s the potential of the signal conductor, and E_r the potential of the driven shielding, then the contribution of the test cable to the input capacitance is C₁ [1 - (E_s/E_r)]. The resistive component of the input impedance is made up almost entirely by the current flowing through R₁ and leakage effects within V₁. The contribution of R₁ is R₁ = R₁ [1 - (E_s/E_r)], where E_r is the potential at A in Fig. 1, and E_s is the potential of the signal conductor.

In order to obtain a high impedance, the ratios of E_s/E_r and E_r/E_s should be as high as possible, which requires V₁ and V₂ each to have a high µ and a high load im-

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**FIG. 1—Isolation amplifier circuit diagram. See text for resistor tolerances**
The impedance compared with \( r_p \). Inside the instrument, the signal conductor and the grid are isolated by the driven shielding from as many other conductors at different a-c potentials as possible. The grid-plate capacitance of \( V_p \) should be as small as possible, and the tube should have high leakage resistance. With these conditions in mind, a type 75 tube was chosen for \( V_p \), a triode-connected 6AC7 selected for \( V_s \), and the circuit elements shown in Fig. 1 were worked out. Each stage has a gain of approximately 0.98. The 75 has its grid connection at the top of the bulb, isolating it from the filament leads, which would add capacitance and induce hum potentials onto the high-impedance conductor if a single ended tube had been used. The driven shield box, shown in the illustration fastened by porcelain insulators to the front of the chassis, completely encloses \( V_p \) and its circuit, and eliminates as much grid-ground capacitance as possible. The 75 also has a low grid-plate capacitance.

The sole function of \( V_s \) is to provide signal to the driven shielding. Its load at low frequencies is \( R_s \), and is the reactance of all the capacitance between the driven shielding and ground at the higher frequencies.

The input impedance of the unit measures about 300 megohms shunted by 5.7 \( \mu F \). Figure 3 shows the response of a circuit with 1.0-megohm series resistance shunted by 20 \( \mu F \) when measured with a probe having such an impedance. The network is representative of a high-gain amplifier stage with the plate and load resistances shunted by tube capacitances, socket leads, and wiring and component capacitances. For comparison, probe impedances of 10 megohms shunted by 20 \( \mu F \) and 1 megohm shunted by 50 \( \mu F \) are also included. The upper curves (B) show the apparent response of the network if measured with instruments having the input impedances shown, and the lower curves (C) give the percent error resulting from the loading.

**Stabilized Amplifier**

In addition to driving \( V_s \), \( V \), also drives the stabilized amplifier portion of the instrument. It might be noted that the coupling capacitors \( C_p \) and \( C_s \) are included in the shield box to lessen the capacitive load on \( V_s \), making higher gains with uniform frequency response possible. The amplifier has two functions. First it provides overall gain steps of 1.00, 10.0, and 100, and second it has a low dynamic output impedance so that several test instruments can be connected to it. The design is conventional for a two-stage feedback circuit. Tube \( V_s \) is a 6AG5 and \( V \) is a 6AC7 connected as a triode in a resistance-capacitance amplifier. The degenerative cathode circuits of \( V_s \) and \( V \) introduce feedback as well as that obtained by coupling the plate of \( V_s \) to the cathode of \( V \), through \( C_p \), \( R_p \), \( R_p \), \( R_p \), \( R_p \), and \( R_p \). In each position of the gain switch, the plate-cathode contribution is approximately 20 db.

Because of the gain of 0.98 in \( V_s \), the \( V_p \), \( V_s \), amplifier circuit has gains of 1.02, 10.2, and 102 to produce decade gains overall. The choice of working gain is made with the selector switch on the panel. The gains are controlled by varying both the amount of plate-cathode feedback and the degeneration in \( V_s \) by connecting the cathode of \( V_s \) to various points on the voltage divider formed by \( R_p \), \( R_p \), \( R_p \), and \( R_p \). The tolerances in percent are: \( R_p \) ± 1, \( R_p \) ± 0.1, \( R_p \) ± 0.1 and \( R_p \) ± 0.5. By using close tolerance resistors, the gains of 1 and 10 fall within a small fraction of a percent of their nominal values, and it is not necessary to adjust each instrument.

Parameter variations, principally the 6AG5 tubes, make an individual alignment of the gain of 100 necessary if the initial error is to be less than 2 or 3 percent. Resistor \( R_p \) is selected to bring the gain to its correct value with nominal line voltage. There is sufficient feedback so that instruments which have operated almost daily for a year show no measurable variation. Line voltage changes from about 100 to 130 volts cause a 2-percent change in gain. The gain of the amplifier is constant within 2 percent below 5 cps to above 150 kc, which corresponds with the frequency region of high input impedance.

Output tube \( V \), can deliver 10 volts rms into a 3,000-ohm load connected to the output terminals with distortion well below 0.1 percent. The dynamic output impedance depends upon the amount of feedback, thus upon the gain setting, and is 300 ohms at 100, 70 ohms at 10, and 10 ohms at 1. At the highest value, 300 ohms, three indicating instruments each with 0.2-megohm resistance and 200-\( \mu F \) shunt capacitance, including the connecting cable, cause less than 2 percent loading error of the amplifier for frequencies less than 150,000 cps. Three sets of output terminals are provided on the panel, so that three instruments can be connected easily.

The instrument is housed in a cabinet 6 x 4 x 10 in. and it is intended to be set on a laboratory bench alongside the instruments which it drives. In use, a voltmeter and a cathode-ray oscilloscope are the usual instruments connected to the output, and the test leads are moved about the circuit being measured. The small probe is convenient to handle, and the one connection provides signal for both indicating instruments.

**REFERENCE**

Directional Antennas for A-M Broadcasting

Simplified and practical method of calculating radiation patterns for two and three-tower arrays when determining coverage and protection. An example is given that provides a convenient check list of the operations involved in plotting a complete pattern.

Although directional antennas have long been in use by a-m broadcasting stations, some engineers regard them with awe, and surround them with an aura of mystery. Many regard the calculations involved as being beyond their capabilities when, in fact, nothing more than an elementary knowledge of the basic operation of a single antenna and the ability to perform simple trigonometry is required. It is the object of this article to dispense some misconceptions, and simplify directional-antenna calculations for two and three-tower arrays.

Almost every textbook opens its antenna section with an illustration of the fundamental laws of radiation from an antenna and these laws will not be repeated here. Since the radio engineer is usually more interested and concerned with the effect of his antenna on co-channel and adjacent-channel stations he will, presumably, prefer to see how to design an antenna to do a specific job.

Two-Tower Array

Figure 1 shows the basic diagram for the field at one point caused by two antennas. The nomenclature used to perform the functions is given below, although all engineers do not necessarily use exactly the same symbols for some parameters.

\[ \theta_1 = \text{angle between reference line } R-R' \text{ and axis of array} \]
\[ I_1 = \text{current in tower 1} \]
\[ I_2 = \text{current in tower 2} \]
\[ T = \text{ratio of } I_2 \text{ to } I_1 \text{ (current ratio for similar towers, or field ratio for dissimilar)} \]
\[ \phi = \text{phase angle of tower 2 with reference to tower 1} \]

By John H. Battison

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Pattern from two antenna elements of equal height spaced 45 degrees, with equal currents in each element and phase angle of 180 degrees.

\[ \phi_1 = \text{phase difference between tower 2 and tower 1 at point } P \]
\[ P_s = \text{point at infinity, or such distance that lines drawn from the towers to } P_s \text{ may be considered parallel (horizontal)} \]
\[ P_r = \text{same as } P_s \text{ except above the horizon in vertical plane} \]
\[ a = \text{vertical angle to } P_r \text{ in space} \]
\[ \theta_1 = \text{angle between } R-R' \text{ and line to } P_r \]
\[ S = \text{spacing between towers in degrees} \]
\[ \theta = \text{angle between axis of array and true north, used when plotting on chart to obtain correct orientation for coverage required and protection} \]
\[ G = \text{height of tower in degrees} \]

When calculating the radiation pattern for a two-tower array, it is usual to number the towers 1 and 2, and to place them at random. "Random" is used in the sense of being an arbitrary placement dependent on the whim of the engineer, subject to the dictates of common sense and necessity. In practice, the engineer usually has an approximate idea of the basic pattern obtainable from certain standard combinations of tower spacing and phasing. From these he can estimate how the final pattern will appear. But eventually the problem boils down to one of trial and error until a pattern is obtained, with reasonable constants, which gives the protection required.

Tower 1 is taken as the reference tower and all quantities are stated with reference to this tower. The reference line \( R-R' \) is drawn through tower 1, at random. A point \( P_s \) is located on a circle whose center is equidistant between towers 1 and 2, and such a distance that lines joining \( P_s-tower 1 \) and \( P_s \)-tower 2 may be regarded as parallel (actually the error is so slight that it may be ignored in practice).

Calculation

The basic information has now been presented in a form which enables the designer to see what he is doing and how each step may be taken. Consider the field at \( P_s \). The radiation from tower 1 has to travel farther than the radiation from tower 2 by a distance \( S \cos (\theta_1 - \theta) \). This is also the case if \( P_s \) is on the other side of the axis. Line \( A-A' \) of the array, that is for values of \( (\theta_1 - \theta) \) between \(-90 \) degrees and \(+90 \) degrees, \( S \cos (\theta_1 - \theta) \) is plus, but when it is between \(+90 \) and \(+270 \) \( S \cos (\theta_1 - \theta) \) is negative. This provides the first clue to the manner in which the pattern is obtained, since, depending on the length of the paths to \( P_s \), all signals arriving at
the magnitudes of $I_1$ and $I_2$ makes possible the addition of vector $I_1$ to the reference $I$, at the phase difference angle $\phi$. A vector $I_2$ is produced, which represents the resulting field strength. In that direction

$$I_R = I_1 + I_2 \angle \phi$$

To obtain the antenna pattern necessary to determine the direction of the lobes of radiation of various values it is necessary to compute the field at $P_2$ for all angles from the radiation from towers 1 and 2 is due to the different path lengths. Therefore the tower phase difference must be added to the phase difference to obtain the total phase difference. The total phase difference between towers is referred to tower 1. If the current in tower 1 leads the current in 2, the phase angle $\psi$ is negative; if it lags in tower 1 then $\psi$ is positive. Thus the total phase difference at point $P_2$ is given by the expression:

$$\phi = \psi + S \cos (\theta_2 - \theta_1)$$

For the purpose of this discussion it will be assumed that the antennas are identical, although it often happens that due to a desire to use an existing tower in conjunction with a new one, two dissimilar towers will be used. With this assumption the field from each tower is proportional only to the magnitude of the current in the respective towers, and since they are identical the only thing which can cause the fields to differ is a current difference. From this we have a measure of the field strength at $P_2$ in the magnitude of the relative tower currents. Vectorial representation of the component fields by the array root mean square value.

General engineering experience has determined over a long period of time that under average conditions of efficiency a given power into the antenna will produce a known field strength at one mile. The FCC has incorporated these figures into the Standards of Good Engineering Practice, and so by multiplying the field intensity at one mile produced by one kilowatt, by the square root of the power increase, the assumed rms value for the array will be found. In practice, the FCC will not usually approve an array below this minimum efficiency. The horizontal pattern is now obtained by plotting the values of absolute field intensity ($E_r$) for 360 degrees at intervals of 10 degrees (or less in critical directions). From this it can be determined whether the required protection or coverage is being obtained.

**Vertical Pattern**

The method of calculating the vertical radiation pattern of a two-element array is very similar to that for the horizontal pattern, the only difference being a slight modification of the horizontal method, and the application of the radiation characteristic of a vertical antenna. Most readers are familiar with the fact that a single vertical antenna does not radiate equally in all vertical directions, but, as is shown in Fig. 2, the intensity varies with the angle of elevation above the horizon. If it is assumed that an antenna is operated with its lower end

![FIG. 1—Basic diagram of field created by a two-tower array](image)

![FIG. 2—Vertical radiation patterns of vertical antennas](image)
grounded and that the current distribution is sinusoidal, then the radiation pattern is given by

\[ F = \frac{\cos(G \cos \psi) - \cos G}{\sin \alpha (1 - \cos G)} \]

where \( G \) is antenna height in degrees.

As was done in computing the horizontal patterns, the radiation at any point \( P \), in the vertical plane is obtained by adding vectorially \( I_1 \) and \( I_2 \), at the pertinent phase angle, and then multiplying this result by the vertical radiation factor.

Just as for horizontal patterns, the total phase difference of the component fields observed at point \( P \), is obtained by adding the phase difference caused by the difference in the length of the radiation paths, and the initial phase difference of the antennas. This is given by

\[ \phi = \phi_0 + S \cos (\theta - \theta_0) \cos \alpha \]

As in the case of the horizontal pattern the vectors \( I_1 \) and \( I_2 \) are added at the phase angle \( \phi \). The resulting vector is then multiplied by \( F \), the radiation factor, and the same conversion factor \( K \) as was used in the horizontal pattern. The resulting signal strength at one mile \( E \), is plotted in mv per m on polar paper as a vertical section through 90 degrees in the horizontal direction involved.

Thus

\[ E = I_1 + I_2 \angle \phi_0 \times F \times K \]

Three-Tower Array

The method of calculation for a three-tower array is exactly the same as for two towers except that the third tower has to be included in the formulas. Figure 3 shows the basic form for calculating the field at \( P \), from a three-tower directional array. Tower 1 is the reference tower and is in the center. The same nomenclature as before is used with the addition of the following symbols to take care of the third tower:

- \( I_3 \) = current in tower 3
- \( T_3 \) = ratio of current in \( I_3 \) to \( I_1 \)
- \( \phi_0 = \) phase difference between tower 1 and tower 3
- \( \psi \) = phase angle of tower 3 with reference to tower 1
- \( S \) = spacing between towers 3 and 1 in degrees
- \( \theta_4 \) = angle between \( R \)-\( \psi \) and axis of towers 1 and 3

The field at any point will be determined by the magnitudes of the currents in the three towers and their phases. Radiation from tower 1 travels a distance of \( S \cos (\theta_3 - \theta_0) \) more or less than radiation from tower 2. Also radiation from tower 1 travels a distance of \( S \cos (\theta_4 - \theta_0) \) more or less than radiation from tower 3. If \( \theta_3 - \theta_0 \) or \( \theta_4 - \theta_0 \) is between -90 and 90 degrees the distance is greater: if \( \theta_3 - \theta_0 \) or \( \theta_4 - \theta_0 \) is between 90 and 270 degrees, the distance is shorter.

As in the case of a two-tower array, the initial phase differences must be added to those resulting from the different distances to \( P \). Thus the total phase difference with reference to tower 1 from towers 2 and 3 is given by

\[ \phi_2 = \phi_0 + S \cos (\theta_3 - \theta_0) \]

\[ \phi_3 = \phi_0 + S \cos (\theta_4 - \theta_0) \]

If the three towers are similar, adding the vectors for the currents in the three towers at the correct phase angle will produce a vector representing the resultant field strength of the unit pattern \( I_u \)

\[ I_H = I_1 + I_2 + I_3 \angle \phi_0 \]

From here on the method is exactly the same as for two towers, with the exception that in all but special cases the pattern is not symmetrical and therefore all values of \( \theta \) from 0 to 360 degrees have to be computed.

The vertical radiation factor \( F \) is computed from

\[ F = \frac{\cos(G \cos \psi) - \cos G}{\sin \alpha (1 - \cos G)} \]

The phase difference at point \( P \), is computed from

\[ \phi = \psi + S \cos (\theta - \theta_0) \cos \alpha \]

Adding \( I_1, I_2, I_3 \angle \phi_0 \), then

\[ \psi = \psi + S \cos (\theta - \theta_0) \cos \alpha \]

Then the absolute signal strength at one mile at any angle \( \alpha \) above the horizon in any direction \( \theta \), is:

\[ E = I \times K \times F \]

Example

The following example of the method shows the calculation of the radiation in one azimuth for the array with the constants shown below:

\( I_1 = I_2 = I_3 = 4 \) amperes
\( S = 45 \) degrees
\( \psi = 180 \) degrees
\( G = 0.311 \) (112 degrees) \( G_1 = G \)

To obtain the unit horizontal pattern, the radiation at every 10 degrees is calculated. For example: suppose \( \theta = 40 \) degrees: \( \theta = 20 \) degrees:

Then

\[ \phi_0 = \psi + S \cos (\theta - \theta_0) \cos \alpha \]

Simplifying: \( R - R' \) is made to coincide with the axis of the array. Then

\[ \phi_3 = \psi + (\theta - \theta_0) \]

Adding vectors = 2.367

This is the scalar length of a horizontal vector at 40 degrees. To obtain the complete pattern, this operation is repeated every 10 degrees. To obtain the absolute field at one mile the factor \( K \) must be applied.

\[ K = \frac{\text{rms array}}{\text{rms unit}} \]

Then

\[ E_H = K \times I_H = 325 \times 2.4 \times 780 \text{ mv per m at azimuth 40 degrees.} \]

To obtain the vertical pattern (unit) at 20 degrees the procedure is the same except that the vertical formula is used and the vertical radiation factor \( F \) has to be calculated from:

\[ F = \frac{\cos(G \cos \alpha) - \cos G}{\sin \alpha (1 - \cos G)} \]

This is then applied to \( I \times K \), becoming

\[ E = I_1 \times K \times F \]

substituting: \( E = I_1 \times 325 \times 1.36 \]

\[ = I_1 \times (448) \]

FIG. 3—For calculating the field of a three-tower array, the center tower is used as the reference point.
Complete Lenkurt type-32 three-channel carrier repeater

By W. S. CHASKIN

In the field of carrier communication on open-wire lines, the three-channel, 30-kc carrier system is widely used to add three voice circuits without affecting operation of the existing physical circuit.

Where these lines are long in terms of total attenuation, repeaters are placed at suitable intervals to restore operable levels in the audio material transmitted. Attenuation on such lines, however, is not a constant. It varies in two ways: (1) it increases from dry-to-wet and cold-to-warm weather; (2) it increases more at the high end of the frequency spectrum, in an effect known as twist. This causes the higher-frequency channels to operate in unfavorable weather at relatively lower levels than the lower-frequency channels of the same carrier system.

Automatic regulators have been used to compensate for these effects. However, the pilot regulator described here is one of the first to perform these functions with an all-electronic circuit which permits the elimination of all moving parts, relays, motors and physical contacts from the regulating circuit.

The regulator forms part of a standard rack-mounted carrier unit and consists of three equipment panels: (1) a pilot oscillator which produces pilot-frequency current for transmission on the line from one terminal of the system to another; (2) the regulator itself, which determines attenuation of the pilot frequency on that line and adjusts the level of the terminal or repeater for constant output level regardless of attenuation or twist ahead of it; (3) an alarm which signals the attendant with light and bell when any abnormal operating conditions have exceeded the scope of the regulator.

Pilot Oscillator

The pilot oscillator circuit is given in Fig. 1. One oscillator is used in the transmitting branch of each terminal of a system. When installed in an East terminal (transmitting to the West) it operates on 5.9 kc, whereas at a West terminal it generates a frequency of 29.6 kc.

Stability of both output level and frequency are most important considerations in this oscillator. It
Level Regulator

All-electronic control unit corrects twist and maintains constant level for three-channel carrier telephone or telegraph communication on open-wire lines despite varying weather conditions. Variations up to 20 db are held within 2 db without adding distortion products

uses two 6N7 triodes in a push-pull-parallel circuit, with inductor \( L_1 \) and capacitor \( C_1 \) in a parallel frequency-determining circuit. Inductor \( L_1 \) has an iron-powder pot and adjustable core for fine setting of the pilot-oscillator frequency. Fixed bias is provided by cathode resistor \( R_n \). This resistor is wired to test points as shown to facilitate measurement of plate current in terms of voltage drop.

Positive feedback goes through capacitor \( C \) and variable resistor \( R_n \). A stabilizing variable-bias network maintains constant output level by picking up a voltage from the secondary of transformer \( T_n \), rectifying it in germanium diodes, and filtering it in \( R \), and \( C \), before feeding it to the grids to create automatic correction for any tendency toward output-level variation.

Jacks \( J_1 \) and \( J_2 \) are provided for patching-in a 600-ohm db meter for adjusting feedback control \( R_n \) to give correct oscillator level. Pilot-frequency output-level adjustment is made with resistor \( R_n \) to establish the conventional output of minus 49 dbm at jacks \( J_1 \) and \( J_2 \). This output circuit, consisting mainly of \( R_n \) and \( R_1 \) in series, has an impedance high enough to allow bridging across the input of the transmitting amplifier of the carrier terminal with negligible loss to through transmission. When the pilot-frequency signal leaves the transmitting amplifier its level is 8 dbm.

Arrangement of the output jacks is designed to permit disconnecting the pilot oscillator from the transmitting amplifier when necessary for adjustments or substitution of a test oscillator. An additional carrier-frequency output is provided to supply current at pilot-oscillator frequency for modulating an extra reduced-fidelity channel available in these systems for use as a service circuit or as a voice-frequency channel for subdivision into a total of nine telegraph subchannels.

Pilot-transmitting filter \( PTF \), consisting of \( L_1 \) and \( C_1 \), is series resonant at the pilot frequency. This precludes the possibility of appreciable pilot-frequency harmonics being present at the transmitting-amplifier input.

**Pilot Regulator**

The pilot regulator, shown in block form in Fig. 2, is essentially a variable attenuator. One regulator is connected into the carrier-receiving branch of each terminal of a system. Additionally, two are required for each intervening repeater—one to handle each direction of transmission. The circuit arrangement permits switching of the regulating action to either the manual or the automatic section. This provides for emergency opera-

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**FIG. 1**—Pilot oscillator circuit. Pilot-frequency currents originating here are transmitted over the line to determine the amount and kind of attenuation and then control the succeeding repeater or terminal to restore normal level and correct twist.

**FIG. 2**—Block diagram of pilot regulator. Control of attenuation is achieved in the hybrid transformer by the sampled pilot frequency derived from the carrier-frequency receiving amplifier.
tion and for servicing the automatic circuit.

When the control is set for automatic operation, all carrier-band frequencies enter the attenuator pad, a hybrid transformer, and an amplifier. The output of this amplifier is applied to the input of the terminal receiving amplifier whose output is sampled and fed back to the regulator through a pilot-frequency filter, a one-stage pilot-frequency amplifier, a rectifier and a d-c amplifier. The output of the latter is used to control passage of carrier-band frequencies through the hybrid transformer by the degree of unbalance of the hybrid-bridge circuit.

As bridge balance increases, carrier-band level at the regulator output terminals increases. The bridge in Fig. 2 is composed of $R$, and $C$, balanced by lamp $VR$, $R$, the twist-adjusting network and $C$. Thus, the level of carrier-band frequencies reaching the terminal receiving amplifier, and consequently the subscriber's handset, is determined by the received level of the pilot frequency.

**Action of Regulator Circuit**

Figure 3 shows the regulator circuit in detail. Again the regulator input is at the upper right. The attenuator is a five-element T pad arranged for strapping into the input with 1, 2, 4, and 8-dB attenuation factors which can be combined to match the manual attenuator at the center of its range. The output of the hybrid transformer passes through the carrier-frequency amplifier consisting of $V$, and goes through switch $SW$, to the carrier terminal receiving amplifier, which is not shown. The amplified output of this amplifier returns to the regulator at the lower right, entering the pilot-regulator filter. This sharp-tuned network feeds the paralleled grids of $V$, the pilot-frequency amplifier. Cathode degeneration and bias in this stage is controlled by $C$ and $R$, to provide gain adjustment over a 6-dB range for centering the pointer of meter-relay $RE$, a Weston type-730 sensitive relay which serves to actuate the alarm when the pilot-frequency level varies beyond the automatic-regulating range for any reason. This combination is also used in adjusting the regulator from time to time as required during normal operation.

After passing through the pilot-regulator filter, which selects the pilot frequency from the carrier band, the pilot frequency is amplified in $V$, and fed to transformer $T$. The output of the main secondary winding is rectified in $V$, a 6H6. Resistor $R$, the 6H6 load, feeds an adjustable portion of this rectified signal to the grids of the d-c amplifier stage ($V$ and $V$, in parallel) by way of the adjustable-time-constant network. An additional secondary on transformer $T$, supplies demodulating carrier voltage for the fourth or service carrier channel previously mentioned.

The d-c potential on the grids of $V$, and $V$, is proportional to the received level of the pilot frequency, which thus controls the current flow through lamp $VR$. As current varies, the lamp-filament temperature—and thus resistance—varies and the hybrid-bridge balance is altered, changing attenuation of the carrier frequencies in the hybrid and providing regulation. Because $V$, and $V$, operate as a d-c amplifier, small changes in rectified pilot voltage cause larger changes in current flow through $VR$.

**Weather Conditions**

Under normal weather conditions the pilot regulator is customarily set for an overall loss of 16 db between regulator input and output circuits. This loss includes pilot-regulator pad loss, regulator-hybrid-bridge loss, and regulator-amplifier gain. At a West terminal the regulator pad is normally
strapped for a 10-db loss, the bridge introduces a 31-db loss under normal conditions, and the amplifier contributes a 25-db gain. The result is a 16-db loss. At an East terminal the regulator pad is strapped for a 6-db loss, the bridge operates at a 35-db loss, and the amplifier has a 25-db gain—making the net loss again 16 db. The difference in bridge-circuit attenuation results from the different frequencies utilized in opposite directions of transmission.

The twist network is a reactance circuit in series with the current-sensitive resistor VR, in one arm of the hybrid bridge in Fig. 3. This introduction of reactance makes the attenuation introduced by the bridge circuit dependent on frequency to a degree that can be preset by changing the resonant frequency of the network. Maximum twist correction is obtained when the impedance of the right side of the bridge varies most with frequency or when maximum reactance is in the circuit. No twist correction occurs when the twist network contains no reactance.

Under favorable weather conditions, current through VR, is relatively low, and is adjusted by R10 to give maximum bridge balance and attenuation (35 db) and increased high-frequency attenuation. The normal slope of the preceding line section adds to this high-frequency attenuation and both are offset by a slope-correction network contained in another portion of the carrier terminal. The resulting level to the amplifier is uniform as to frequency.

Under unfavorable weather conditions, pilot-current level is reduced, along with all other signals, by increased line attenuation. This raises plate current from the d-c amplifier and increases the resistance of VR, unbalancing the bridge to reduce attenuation in the hybrid transformer. Bridge unbalance, however, is most effective at higher frequencies due to action of the series-resonant circuit of the twist network. Thus, the higher-frequency attenuation which occurs here when the bridge is balanced tends to disappear most rapidly as the bridge becomes unbalanced. Since the line twist increases as the bridge twist decreases, the net effect on signals at the receiving amplifier is nil. The curves of Fig. 4 show this effect graphically.

**Alarm System**

The meter-type sensitive relay shown in the output circuit of the 6H6 in Fig. 3 acts to set alarm signals if the regulator is unable, for longer than 30 sec, to maintain normal operating conditions. The alarm is shown schematically in Fig. 5. It utilizes a 6N7 with both sections in parallel to actuate a 30-second time-delay circuit KE on either high or low pilot level and thereby give a visual alarm. Terminals are provided for the attachment of external lamps or an alarm bell. Means are incorporated for silencing the bell but the visual signal remains until the pilot current is restored to a proper level. In repeater installations, where there are regulators for both directions of transmission, both can be connected to a single alarm panel.
A Compact Direct-Reading Audio-Frequency Meter

Simple, low-cost instrument with sufficient accuracy for most industrial or communications measurements employs a squaring amplifier, integrator, and pulse counter. It can be calibrated in the field from WWV transmissions.

Designed primarily for the measurement of audio frequencies in the range from 10 to 5,000 cycles the instrument to be described comprises part of the technique for obtaining and measuring an audible beat between a received, radio-frequency carrier of unknown frequency and a known or identifiable 10-kc marker derived from a 100-kc crystal clock.

Although exact carrier-frequency determination by this general method would require more precise instrumentation, it was desired to obtain a direct indication to show quickly at least the order of magnitude. The sense of the audio beat (whether the unknown is beating with the high or the low 10-kc marker) is also apparent with a minimum of ambiguity when the crystal standard or a following divider is varied slightly in frequency. The upper frequency limit of the direct-reading device is set by the fact that the unknown signal can never be farther than 5 kc removed from one of a pair of sequential 10-kc markers. The lower limit is set by practical considerations of circuit complexity and attendant cost.

Because of the potential usefulness of the meter for work with audio or industrial devices, it was constructed to read up to 10,000 cycles. Some redesign of the circuit is necessary to make it indicate reliably at frequencies much above this arbitrary limit. The ranges are 10 to 1,000; 10 to 5,000; and 10 to 10,000 cycles as constructed. The circuit shown in Fig. 1 comprises a cascade amplifier followed by a cascade squaring amplifier. The output is differentiated and the resultant pips used to trigger a blocking oscillator. The oscillator grid is biased so that only the positive-going half of the oscillation appears at the grid of the final triode. This tube, initially biased to cutoff, has a microammeter shunted by a capacitor in its cathode circuit. The meter reads the integrated space current that is directly a function of frequency. Provided only that sufficient signal is furnished to the square-wave clipper tubes, the meter indications are independent of audio amplitude. Wave shapes normally encountered in continu-
ous-wave radio are sufficiently close to sine wave shape to produce correct meter readings. The ultimate limitations resulting from wide departures from sine-wave input have not been examined.

The audio amplifier was found desirable, particularly at frequencies below some 200 cycles, because the poor low-frequency response of the circuits caused the square wave to deteriorate unless the instrument was furnished an inordinately large input signal. The addition of the cascade amplifier has reduced the input signal requirement to a maximum of less than 5 volts, about half this value being required at the higher frequencies.

Layout of the circuit is not critical provided normal precautions are observed. Oscillations (the meter reading about 800 cycles) were noted with the input circuit unloaded. The trouble was diagnosed as feedback from the blocking oscillator to the square-wave tube. A tube shield cured the trouble. Later, oscillations caused by feedback in the cascade amplifier were simply cured by bending the interstage coupling capacitor leads slightly so that the capacitor was farther from the input jack.

Initial tests and calibration of the meter were carried out with a cathode-ray oscilloscope and a laboratory-type commercial frequency meter. Using the laboratory oscillator as a standard, the scale of the 50-microampere meter was found to have a reasonably linear relationship to frequency. At no point is the deviation worse than 5 percent of full-scale deflection.

The electrical zero setting of the indicating meter is adjusted by cutoff bias on the last tube, with full-scale setting determined by the 50,000-ohm resistor. This latter control is necessary owing to the varying characteristics of replacement tubes of the same type. The meter multiplying shunts have been so chosen, using a variable resistor and matching its setting with fortuitous combinations of carbon resistors, that the top-scale adjustment will be essentially correct for each scale.

In the field or small laboratory the top-scale adjustment can be accurately set using the 440-cycle tone broadcast on 2.5 and 5 mc from WWV. Since this setting occurs at nearly midscale, the accuracy of the setting is sufficient. In regions where the 10-mc and higher frequencies broadcast from WWV can be heard, either the 440-cycle or 4,000-cycle tones can be used for field standardization, using either a low- or high-pass filter to separate the desired tones.

The seconds pulse superimposed upon the tone signal causes the meter needle to deflect slightly, but this momentary movement should not prove troublesome. It can be filtered out if desired.

It will be noted from the circuit diagram that the meter is shunted by a section of the power switch and also one of the positions of the selector switch. Whenever power is turned off the bias on the final tube is almost instantaneously removed whereas the plate voltage bleeds down more slowly, causing the meter to deflect violently. The automatic shunt removes the effect. A somewhat similar effect when the instrument is turned on can likewise be avoided by shunting the meter through the selector switch.

Acknowledgments

The author is indebted to Martin Blumberg of Stanford University for the basic circuit and to F. H. Rockett, Jr. and other friends for suggestions in adapting it to the desired form, and for assistance in the initial calibration.—A. A. McK.
Atmospheric Noise

Observations of atmospheric noise down to 0.3 microvolt per meter between 75 kilocycles and 30 megacycles require receivers with special preamplifiers. Antennas are integrally mounted with the remote preamplifiers and connected by coaxial cables to recording equipment. Design data are given for a noise signal generator.

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Because of the scarcity of long-term information on radio propagation and atmospheric noise in Canada, there has been, within the last few years, an accelerated program of research in this field.

The equipment to be described is used for the continuous measurement of noise levels as low as 0.3 microvolt per meter over the frequency range from 75 kilocycles to 30 megacycles. It comprises six modified communication receivers, a control chassis for channel selection and all major switching operations, attenuators, a graphic recorder, and a noise-signal generator. The antennas shown at the left in the photograph are mounted on the boxes that house the wide-band amplifiers, and are remotely located, being connected to the measuring equipment through coaxial cables.

The apparatus illustrated is outlined in the block diagram of Fig. 1.

Preamplifier Design

Because no suitable antenna could be obtained having a flat characteristic over the required frequency range, the frequency spectrum was divided into three ranges, each covering about 10 megacycles. By making the lengths of the antennas 15, 22, and 30 feet respectively, it was possible to keep the sensitivity of each individual antenna reasonably constant over its frequency range without resonance at any frequency. Variations in gain are known and taken into account when making final calculations for the noise strength.

The main problem in the design of a suitable amplifier lies in the fact that the noise figure for such a system must be kept at a minimum and the total equivalent noise from all sources including the receiver shall not exceed 0.3 microvolt. Experience has shown that the noise...
level encountered in the Canadian North is very low, especially in the region of the frequencies above 15 mc.

The expression for the noise figure of a combination of two units in cascade is given by

$$N_{eq} = N_a + (N_x - 1)/G_a \quad (1)$$

when \(N_a\) is the noise figure of amplifier and receiver in cascade, and \(G_a\) is the amplifier gain. It follows that the gain of the amplifier should be high. The first amplifier stage is the major noise contributing factor and should have good stability and low noise level.

Sources of Noise

The principal noise sources of the first stage are shot-effect noise, developed in the plate of the tube, and thermal agitation noise, which results from the equivalent input noise resistance of the tube and circuit. Thermal agitation noise becomes negligible if the equivalent noise resistance is not higher than 400 ohms. Numbers of different tubes were subjected to tests to determine their equivalent noise resistance and suitability for use in the first preamplifier stage. The noise resistance of a pentode showed approximately 700 to 1,500 ohms and, therefore, such a tube could not be used for this purpose. A 6AC7 connected as a triode showed a noise resistance of only 200 ohms, making this tube suitable for the first stage of the amplifier. The 6AK5 is a similar type of tube and may be used if connected as a triode. Although the triode has the advantage of a low noise level, the Miller effect presents a problem in the design. The grid-to-plate capacitance is increased by a factor of \((G + 1)/G\) being the voltage gain of the stage. Using a 6AC7 as a triode with an input capacitance of 11 \(\mu\)F and a gain of 7, this capacitance becomes about 70 \(\mu\)F because of the Miller effect. By making the gain of the first stage unity, the capacitance increases only to twice its value through the Miller effect, and any variations in the input capacitance are small when performing such operations as changing tubes. Having thus selected the design, in Fig. 2, of the first stage, the following circuit is a grounded-grid amplifier, employing another 6AC7 as a triode. This tube provides full amplification. The complete arrangement represented by triodes \(V_1\) and \(V_2\), is termed the Wallman circuit.

The noise level of such an amplifier can be calculated and from the obtained results it may be seen that the thermal noise is of very small magnitude as long as the input resistance is kept low.

The equivalent thermal agitation noise current can be computed from the following equation:

$$\bar{I} = 4 K T G \frac{df}{f} \quad (2)$$

\begin{equation}
\bar{I} = 4 K T S_a \frac{df}{f}
\end{equation}

where \(\bar{I}\) = mean-square current
\(K\) = Boltzmann's constant
\(T\) = absolute temperature (usually assumed 293° C)
\(G\) = total conductance at tube input
\(df\) = bandwidth in cycles
\(R\) = equivalent shot-noise resistance
\(S_a\) = tube mutual conductance

Assuming the bandwidth to be 10 kc we obtain from Eq. 2

$$\bar{I} = 1.62 \times 10^4 G$$

and if the input resistance, \(R_i = 1/G\), we obtain a thermal agitation noise of \(I_0 = 0.0127 \times R_i\) micromicroamperes. For the equivalent mean-square shot noise we get

$$\bar{I} = 1.62 \times 10^4 R S$$

Assume the equivalent shot-noise resistance \(R\) is 200 ohms and \(S_i\) is 12 \(\times\) 10^{-6} micromhos. Substituting these values in Eq. 3 the noise current of the first tube is then

$$I_0 = 0.286 \text{ microampere}$$

The plate load impedance is equal to 1 \(S_i\) or 83 ohms.

To obtain the required bandwidth and amplification, the Wallman circuit is followed by a wide-band amplifier. To achieve a bandwidth of about 10 mc with a frequency response of \(\pm 0.5\) db over the entire range, a degenerative amplifier employing voltage feedback and staggered tuning was designed. The output was taken from a cathode

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**FIG. 1—Block diagram of the atmospheric noise-recording setup. Receivers are automatically switched**

**Measurement**

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follower, $V_o$, to match the 73-ohm impedance of the succeeding attenuators. The network consisting of $R_o$, $R_s$, and $R_v$ serves the purpose of providing proper match to the noise signal generator which is fed into the preamplifier at that point. The complete amplifier is housed in a watertight case with a strip-heater included to prevent condensation when operating the equipment at low temperature.

Receivers

Because the amount of noise passing through the receivers will depend on the effective noise bandwidth of the circuits, the six sets were carefully aligned to eliminate any possibility of variation in this bandwidth. For this purpose the selectivity control and AVC control were fixed and the bfo was cut out entirely. The effective noise bandwidth $B$ of the i-f amplifier of each set was then calculated from the equation

$$B = \int_0^\infty |G/G_o|^2 \, df$$

where $G$ is the gain at frequency $f$ and $G_o$ the gain at resonant frequency.

The input resistance of a type AR88LF receiver, while nominally 200 ohms, actually varies widely around this value. On a typical set, values as low as 60 ohms at 4.4 mc and as high as 350 ohms at 30 mc have been measured with an impedance bridge. Therefore it is necessary to introduce a resistance network at the input to reduce these variations. The resistance seen by the input cable in this case varies only from 71.5 to 78.0 ohms. Although this arrangement involves a considerable loss of signal strength at all frequencies, the overall gain available is ample to take care of it. The noise output of the receiver is taken from the second detector stage as a rectified d-c voltage.

The major components of the control chassis are the sequence timing motor and selector switches that allow the six sets to be sampled in any required sequence. Each receiver is sampled for a period of 25 seconds, one complete sequence being completed in 3 minutes. A conventional R-C time constant provides a 60-second time delay for measuring average noise level. The time constant can be switched off for recording noise peaks. The recording meter is connected to the output of the time constant network by way of a balanced bridge circuit. The diagram in Fig. 3 shows this circuit which can be adjusted by varying the screen voltages on the tubes with the control $R_v$.

Recording the Noise

A sample of the recording chart illustrated shows two complete cycles of recorded noise levels, using six different frequencies. The markings on the left side of the chart indicate the amount of attenuation for each receiver used. In this case each little square wave indicates an attenuation of 20 decibels. Two sidepens, one for each margin, are available and can be used to record such information
as attenuation, time, or recording sequence.

The noise signal generator serves to calibrate the equipment and to compare the unknown incoming atmospheric noise with a known, calibrated noise signal. A temperature limited noise diode with an amplifier and monitor forms the basis of the generator. The noise diode is a tube specially constructed for this application. It has a pure tungsten filament with high current capacity. The load impedance of the noise diode consists of a 3,300-ohm resistance in parallel with 40 nuf capacitance, as shown in Fig. 4.

Noise Generator Connection

At frequencies from 2 to 30 mc, this network is connected in series with the tuned circuit at the grid of the first r-f stage. The tuned circuit is shorted out for the lower frequencies. Thus at low frequencies, the effective input grid impedance is near 3,300 ohms; at higher frequencies, the resonant impedance of the tuned circuit becomes the dominating factor. This circuit was chosen to achieve reasonable constancy of noise output over the entire frequency spectrum.

Plate Choke

The plate supply lead to the noise diode is effectively choked over the entire range by a network consisting of two resistors, a special choke and a bypass capacitor. The noise diode is followed by two r-f sections and the output is taken from a cathode follower stage to the preamplifiers.

The i-f section of a receiver is used for monitoring purposes. Its gain has been made invariable by introducing cathode biasing. The conversion gain of the mixer stage in front of the i-f amplifier remains satisfactorily constant over the frequency range. One meter indicates the noise diode current, and another shows the noise output of the generator.

The calibration will depend on the accuracy and stability of the equipment. If M microvolts of a sinusoidal signal are required at the input of the monitor mixer for full scale output and the noise bandwidth of the monitor is Bc cycles per second, then M/(Bc)\(^1\) is the monitored noise voltage in rms microvolts per cycle bandwidth. The atmospheric noise signals are usually expressed in terms of microvolts per meter for a noise bandwidth of Bc. Therefore the atmospheric noise signal that gives the same recorded reading as a signal from the generator is in rms microvolts

\[
(Bc)\sqrt{M} = \text{Noise in rms (5) microvolts per } Bc \text{ cycles bandwidth}
\]

Conversion of microvolts to microvolts per meter can be made via the formula relating the two units. For a given antenna length h and given wavelength \(\lambda\) we obtain

\[
\text{Microvolts} = \frac{h}{2} \frac{\tan \frac{\pi h}{\lambda}}{\pi} \text{ microvolts per meter (6)}
\]

A number of other factors have to be taken into account when calibrating the equipment but a detailed description of the entire calibration procedure would be beyond the scope of this paper.

Acknowledgement

The writer wishes to express his thanks to R. A. Chipman of McGill University for his contribution and suggestions.

Reference

Radar Range Calibrator

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RADAR EQUIPMENTS utilizing the
plan position indicator (ppi)
type of visual presentation have
superimposed upon the polar dia-
gram a series of concentric circles
or range rings which enable range
estimations to be made to particu-
lar targets of interest. Depending
upon the range scale in use, these
rings are generally spaced 0.5, 1.0,
5.0, or 10 statute or nautical miles
apart. Those objects which appear
on the ppi between range rings may
be fixed in range by interpolation.
In order to insure the maximum in
accuracy, the indicated distance to
any ring as measured from the cen-
ter of the cathode-ray tube, or zero
range, is maintained well within
one percent of the true range.

Range ring pulses, which inten-
sity-modulate the ppi tube to form
the rings, are generally formed by
squaring the output of a shock-
excited ringing oscillator by means
of several amplifiers and differenti-
ation of the resultant square wave.
By correct choice of parallel reso-
nant oscillator circuit components,
the period of sine-wave output is
made equal to the desired time in-
terval between successive range
rings. In production testing of
radars it is necessary to utilize a
simple and rapid system for pre-
cisely tuning the resonant circuit
to the correct frequency.

Applications

The test instrument to be de-
scribed permits range ring pulses
generated in the radar to be com-
pared with spaced pulses generated
by a highly accurate calibrator.
Thus, when the radar range ring
pulses are in exact time coincidence
with those obtained from the cali-
brator, the slug-tuned inductance in
the radar range ring generator that
determines the resonant frequency
of the ringing is precisely adjusted.
A standard triggered-sweep oscil-
loscope is used for making the nec-
essary visual comparison checks.
The range calibrator may be con-
veniently used with any radar sys-
tem that can be locked in synchron-
ism with some submultiple of the
test instrument's nautical or stat-
ute mile fundamental frequency of
either 50.86 or 93.12 kilocycles. Ra-
dars utilizing free-running multi-
vibrators or blocking oscillators to
establish their pulse recurrence fre-
cuencies (prf) may be locked in
step with the calibrator without
altering repetition rates by more
than a few hundred cycles during
the calibration period. When both
the radar and the calibrator are
locked in synchronism, it is possi-
ble to align fixed and variable range
rings as well as to measure the time
duration of various waveforms
throughout the radar. By modu-
lating the Z-axis of a triggered os-
cilloscope with the calibrator pulses,
a waveform under observation will
be intensity-modulated by a series

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Design of an instrument for calibrating in production the concentric rings of a ppi indicator used for estimating distance. Range ring pulses generated in the radar are compared on a triggered oscilloscope with spaced pulses from a crystal-controlled calibrator of dots spaced one or five miles apart, selected at will. Time intervals can then be accurately measured with a minimum of difficulty.

Systems used to generate range ring pulses are described in the literature. However, it is well to review one common type briefly. In Fig. 1, a typical circuit is shown wherein a pulsed ringing oscillator produces a damped sine wave. The period of the sine wave is made equal to the desired time interval between the range ring pulses which are developed by the following squaring, differentiating and blocking oscillator circuits. By the use of a reasonably high-Q resonant circuit in the cathode of the ringing oscillator, it is possible to produce five or more usable cycles having, for example, a period of five nautical miles, or 62.4 microseconds, between successive cycles. By center-tapping the inductance and adding a feedback triode, the oscillator can be made to have constant amplitude output for each cycle during the ringing time. Sufficient amplification following the damped ringing oscillator will produce a practically perfect square wave.

Range ring oscillators of this type oscillate only during the application of a large negative square wave to the grid of a normally conducting tube. The abrupt cutoff of plate current flowing through the triode and the associated cathode inductance at the onset of the negative gate causes the parallel resonant LC circuit to oscillate. Since the onset of the gate pulse to the ringing oscillator stage is made to coincide with the pulsing instant of the radar transmitter, the time interval elapsing while the radio-frequency pulse travels out to a target and thence back as an echo can be compared on the ppi with the interval between successive range rings.

Accuracy

Neglecting such factors as the linearity of the ppi sweep, accuracy of the range rings is dependent upon the following factors:

(A) The resonant frequency of the ringing oscillator.

(B) The degree of amplification following the pulsed oscillator.

(C) The leading edge fall time of the negative gate used to ring the oscillator.

(D) The preciseness of all timing sequences throughout the radar system, generally known as system time delay.

It is the purpose of this paper to deal with an extremely accurate method for adjusting the resonant frequency, A, of the ringing oscillator. Factors B, C, and D may be accounted for by careful design so end result will be the production of pulses coinciding with both the radio-frequency transmitted pulse and the start of the ringing, and the following 2π, 4π, 6π, and so on, points of the sine wave.

Inasmuch as the ringing oscillator is pulsed but part of the time, a direct comparison between the
damped sine-wave frequency and a known frequency standard is cumbersome unless some provision is made for phasing and synchronizing the two waveforms. It is also impractical and inaccurate to preset the slug-tuned inductance against its particular capacitor outside the chassis by methods normally used for adjusting resonant circuits.

A practical device for calibrating range ring pulses is the instrument shown in Fig. 2 as a block diagram. Functionally, the range calibrator delivers a continuous series of sharp negative calibration pulses spaced either one or five miles apart, and a simultaneous series of negative synchronizing pulses occurring at a repetition rate one-fifth the frequency of the precision crystal oscillator. The synchronizing pulses are used in one application to lock a free-running radar master multivibrator into step with the sequence of operations occurring in the calibrator. Thus, the calibration pulses may be compared directly with those generated by the radar range ring generator.

**Circuit Details**

The complete circuit is given in Fig. 3. A 6V6 tetrode crystal oscillator, \( V_o \), is used in the calibrator as the range ring frequency standard. The fundamental frequency is 80.86 kilocycles for nautical and 93.12 kilocycles for statute miles. (81.84 kilocycles corresponds to 2,000 yards.)

Following the crystal oscillator is a 6AC7 squaring amplifier, \( V_s \) and a free-running blocking oscillator, \( V_{bo} \), locked, one for one, to the fundamental crystal frequency. Output of this blocking oscillator is fed out of the unit through a single amplifier, \( V_A \), as negative calibration pulses spaced one mile apart. Alternately, pulses spaced five miles apart can be obtained by interposing a counting-down blocking oscillator, \( V_{bo} \), and an isolation cathode follower, \( V_{fo} \), between the one mile pulse generator, \( V_{bo} \), and the output amplifier, \( V_A \). The additional blocking oscillator counts down by a factor of five to deliver 5-mile calibration pulses.

As shown in Fig. 3, part of the crystal oscillator output is also applied to a 360-degree phase shift network composed of a phase-shifting transformer and a precision variable phase-shift capacitor. By the use of this network, a voltage is developed at the grid of \( V_{bo} \) which may differ in phase with the output of the oscillator anywhere from zero to 360 degrees, depending upon the position of the rotor. To secure linear phase shift against rotor rotation, with little if any change in amplitude, the circuit must be carefully balanced. The 90-degree phase shift elements must be chosen so that at the fundamental frequency, the resistance, \( R \), equals the capacitive reactance of capacitor \( C \).

![Circuit Diagram](image)

**FIG. 3**—Complete circuit of the instrument. All switches are ganged. The phasing network contains a butterfly-type capacitor

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The phase-shifted sine-wave at $V_{as}$ is amplified, as before, to synchronize the free-running blocking oscillator, $V_{as}$, for one to the fundamental frequency. Output pulses from $V_{as}$ are divided in repetition frequency by five in the following blocking oscillator, $V_{as}$, to produce radar synchronizing pulses occurring at a frequency of 18.62 or 16.17 kilocycles, respectively, for the statute and nautical mile cases. Tube $V_{as}$ amplifies and inverts the synchronizing pulses, the control sync determining pulse amplitude delivered to the radar.

A great advantage in placing the phase shift network in the synchronizing pulse generator section, as compared to the original approach which located the shifter in the calibrating pulse section, is the elimination of errors created by phasing network distortion. Since it is imperative that the sine wave fed to the calibration pulse section be kept absolutely free from distortion for precise results, the location of the phase shift device to the non-critical synchronizing pulse circuit, in the final design, helped to improve the linear relationship between phase shift and the physical position of the rotor.

**Radar Calibration Procedure**

The phase-shifted synchronizing pulses are fed out of the calibrator at intervals of 72.0 microseconds, when using the nautical mile crystal. The free-running multivibrator in the Radiomarine CR-101 Radar, for example, operates at a prf of approximately 3,000 cycles per second on the shorter ranges of 1.5 and 5 miles, equivalent to a period of about 333 microseconds. By coupling the synchronizing pulses into the multivibrator at correct amplitude, the radar will lock in at a somewhat higher pulse recurrence frequency of about 3,470 cycles on every fourth sync pulse. This prf increase is of minor consequence, since higher recurrence frequency is maintained only during the calibration period.

Similarly, when the CR-101 is operated on its longer ranges of 15 and 50 miles, the prf of the radar system is quartered to 750 cycles, corresponding to a period of 1,233 microseconds. Every 18th sync pulse then locks the unit in step, a change of about 115 cycles in the pulse recurrence frequency.

The procedure used to adjust the radar range rings is relatively simple. Negative synchronizing pulses from the calibrator are applied to the radar master multivibrator. Meanwhile, positive radar range ring pulses are fed to the upper vertical deflection plate of a triggered-sweep oscilloscope. Negative calibration pulses are then applied to the lower vertical deflection plate. After the radar has been locked to the calibrator by adjusting the synchronizing pulse amplitude, both sets of marker pulses will be visible on the oscilloscope, inverted in polarity.

Adjusting the phase-shifting capacitor appears to move the calibration pulses along the sweep. This is done until two pairs of successive pulses are coincident or close to coincidence above one another. The slug-tuned inductance in the ringing oscillator circuit is then adjusted so that the spacing between radar range ring pulses approaches that between the precision pips.

Slight adjustments must be made in phasing during this operation to insure that the reference markers remain coincident. At the exact alignment point, all the leading edges of all the various pulses will coincide. The synchronoscope during this operation is triggered by the radar system so that its sweep and the radar trigger start simultaneously.

For estimating the duration of various pulse waveforms through the radar, the procedure is slightly altered. A waveform of interest is observed on a triggered-sweep oscilloscope intensity modulated in the Z-axis by the markers from the calibrator. At intervals of either one or five miles, the sweep will brighten up, forming a series of bright spots superimposed on the waveform. The phase-shift capacitor is rotated until any one spot coincides with the start time of the waveform. The time duration to any point of interest thereafter can be read in 1 or 5 mile steps. Interpolation between one-mile markers can be fairly accurately performed by noting the traverse of the phase-shift capacitor. Since every 360 degrees of rotation corresponds to one additional mile of spot movement, small angular displacements are practically proportional to equivalent fractions of a mile, providing that the phase-shift network is accurately aligned.

**References**

(2) "Pulsed Oscillator and Phase Shifter," MIT Radiation Laboratory Report 64-2, July 24, 1943, Available from O.T.S., Dept. of Commerce, PB-No. 3942, Title E-11.
Low-Distortion

One-hundred-percent modulation is obtained by combining out-of-phase carrier voltage with partially modulated signal in cancellation circuit. Uses exalted-carrier detector in overall feedback circuit. Regulated oscillator insures constant output amplitude.

A LOW-DISTORTION amplitude-modulated signal source is essential for such jobs as adjusting a-m station monitors and testing high-quality broadcast receivers. With the signal generator described, audio distortions of better than 0.1 percent at 100 percent modulation are obtained by the use of several special circuits not commonly found in commercial testing equipment.

Referring to the block diagram in Fig. 1 and the circuit diagram in Fig. 2, it may be seen that the outputs of the a-f amplifier and r-f oscillator are combined in the modulator to produce an r-f signal which is about 75 percent modulated. One hundred percent modulation is effectively obtained by adding an out of phase component of the carrier signal through the cancellation amplifier. Negative feedback is employed in both the audio amplifier and modulator, and an exalted-carrier detector is used in an overall feedback circuit.

Circuit Details

The two-stage audio amplifier, whose function is to raise the level of the audio input signal to a value suitable for driving the modulator, employs about 25 db negative feedback from the plate of the second tube to the grid of the first. The amplifier distortion is less than 0.1 percent, and its gain is about 100 with 10 volts rms output.

The tunable broadcast-frequency oscillator which supplies the carrier component to the modulator and drives the exalted amplifier and the cancellation amplifier is a Hartley oscillator. Its output is regulated at 80 volts rms by the 6A7 regulator circuit which eliminates the need for an amplitude control.

Modulator

A portion of the oscillator signal and the output of the audio amplifier are impressed on the control grid of the 829B modulator tube. The action is very similar to that of an ordinary grid-modulated amplifier.

The constants of the circuit were chosen to give a 75 percent modulated signal at the output of the modulator without the necessity of driving the grid positive. This eliminates the necessity of a low-impedance grid driving source and greatly reduces a source of modulation distortion.

The cathode circuit of the modulator is unique in that it provides a large amount of degeneration which effectively reduces the modulation distortion.

The cathode circuit not only furnishes a d-c bias voltage for the

FIG. 2—Circuit diagram of signal generator. Value of cathode capacitor for modulator is determined by formula derived in text

FIG. 3—Modulator cathode waveform showing the modulation envelope

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A-M Signal Generator

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correct operation of the modulator but its action is much the same as that of an ordinary peak detector. The R-C time constant is long enough to maintain the peak r-f voltage between the r-f current pulses. It is important to make this time constant short enough to prevent audio negative peak clipping. Since a maximum of only 75 percent modulation is required from the modulator, the design of this circuit to prevent peak clipping is simple. Once the resistance R is determined by the value of d-c bias required for the modulator the following equation may be used to determine the capacitance C:

\[ C = \frac{\sqrt{1 - K^2}}{R \omega K} \]

where \( K \) is the maximum percent modulation divided by 100, \( \omega a = 2\pi f_a \), and \( f_a \) is the highest audio modulation frequency in cps.

The above equation is derived in the following manner: From Fig. 3, let \( e_m = E \sin \omega_m t \), where \( e_m \) is the modulation signal. Then the envelope of the peak r-f voltages applied across the R-C circuit will be represented by the equation

\[ E' = \frac{E}{K} + E \sin \omega t \]

Differentiating the equation of the modulating signal to find its slope

\[ \frac{de_m}{dt} = \omega E \cos \omega t \]

The slope of the voltage decay across the R-C circuit at the beginning of each decay period is \(-E'/RC\). It is assumed that the voltage decay is linear for the short period between the r-f pulses. In order to prevent distortion due to negative peak clipping, it is necessary that the slope of the R-C circuit voltage decay always be equal to or slightly greater than the slope of the modulation envelope. Therefore,

\[ \frac{1}{K} + \frac{\sin \omega t}{RC} = \cos \omega t \]

Since there is only one instant during the audio cycle that the above equation can be true, that time may be determined by differentiating with respect to \( t \), then

\[ RC = \frac{\cos \omega t}{\sin \omega t} \]

Substituting this in the previous equation and solving for \( C \), we obtain

\[ \sin \omega t = -K \]

\[ \cos \omega t = \sqrt{1 - K^2} \]

\[ C = \frac{\sqrt{1 - K^2}}{KR \omega} \]

**Cancellation Amplifier**

The modulator output signal is added to the output signal of the cancellation amplifier in the cancellation circuit. The addition of these two signals results in a sum signal which has its modulation percentage increased to 100 percent from the 75 percent level at the modulator. The cancellation amplifier signal has a 180 degree phase relation with respect to the carrier of the modulator output signal.

This 180-degree phase relation is very accurately controlled by the tunable capacitor in the parallel resonant circuit which is the load impedance of the cancellation amplifier. To adjust accurately the phase of this amplifier, it is necessary to view the generator output waveform with an oscilloscope with slightly more audio applied to the generator input than is necessary for 100 percent modulation. This procedure will produce on the oscilloscope a picture which is similar to that of Fig. 4A. Perfect phase relationship reveals two sharp crossover points in the trough of the modulated signal as shown in Fig. 4B.

Since the voltage gain of the cancellation amplifier is not constant over the tunable frequency band, it is necessary to control the screen grid voltage of the amplifier for this purpose. Approximately the
correct phase for proper cancellation is obtained at the amplifier output by driving its grid from the grid circuit of the oscillator. Good r-f waveshape is obtained not only by using the highly frequency selective tuned circuit in the plate circuit of the 6AC7 amplifier, but also by operating the amplifier class A with degeneration in the cathode circuit. Figure 4C shows a 100-percent modulated signal with perfect cancellation phase.

Power Output Amplifier

The power output amplifier is driven by the cancellation circuit and is a cathode follower. The 829B tube was chosen because of its high current-conducting capacity and its high transconductance. The grid input capacitance is greatly reduced by driving the screen grid at the same a-c potential as the cathode through the 0.01-µf screen to cathode capacitor. Expressed by an equation, the gain of a cathode follower amplifier is:

\[ G = \frac{g_m r_s}{g_m r_s + 1} \]

where \( g_m \) is the transconductance of the tube and \( r_s \) is the equivalent cathode resistance. The grid input capacitance will be

\[ C_i = C_s (1 - G) \]

where \( C_i \) is the new input capacitance and \( C_s \) is the input capacitance with the cathode and screen at ground potential. The grid input capacitance to the 829B is reduced from 29 µf to 3 µf with the above mentioned arrangement.

The power output amplifier drives an air-core r-f transformer which is used to reduce the peak to peak amplifier current swing by a factor of 2.5 to 1. The air-core type of transformer was used because it made possible an impedance transformation without r-f waveform distortion which would result from an iron-core transformer. A tuned transformer could have been used but it would have meant an additional tuning control. The primary winding of the transformer is wound in a single layer on a cylindrical 1.5-inch diameter Bakelite coliform. The secondary winding is wound directly on top of the primary winding. The wire used for the secondary coil has a diameter

large unmodulated r-f signal in phase with the modulated r-f signal at the detector. This effectively reduces the percent modulation. If the ratio of unmodulated to modulated signals is made large, the phase relation between the two signals does not have to be adjusted accurately. Improper phase relation introduces audio distortion but of small magnitude when a ratio of voltages of 30 to 1 is used in this generator detector. A 10-degree phase relation for the specified conditions will introduce 0.02 percent second harmonic component and zero third harmonic component for a 100 percent modulated signal.

The output of the modulation detector is applied to the input of the audio amplifier through an r-f filter circuit. The overall negative feedback is approximately 20 db and serves to reduce noise and distortion by that factor.

Operation and Performance

In aligning the signal generator to a particular frequency an oscilloscope must be used for viewing the modulated output. There are six controls that must be adjusted for alignment to a particular carrier frequency. The oscillator is adjusted to the desired r-f frequency. The modulator tuning control is adjusted to give maximum oscilloscope deflection, while the modulator bias control sets the desired output level. Cancellation tuning is set to give minimum r-f output level at the correct phase, and the cancellation gain is adjusted to give approximately 25 percent reduction in output level due to the cancellation amplifier. The exaltation tuning adjustment is set to give a minimum modulation while maintaining a fixed audio input level.

The r-f output level is variable between 6 and 8 volts rms across a termination of 60 to 100 ohms. The writer acknowledges the important contributions of H. R. Summerhayes, Jr., of the General Electric Company in connection with the development of this signal generator.

Reference

C. A. Cady, Methods of Obtaining Low Distortion at High Modulation Levels, General Radio Experimental, April, 1942.
Eighteen years ago Cinch Engineers developed an idea... gave the Radio Industry its first terminal strips for practicable production.

The Industry's acceptance and use of Cinch terminal strip design established Cinch as the standard over the years.

Today, the exacting quality requirements of Television demand terminal strips—made by Cinch—assemblies insuring necessary higher quality in insulation, tooling, fabrication, plating, vacuum waxing and workmanship. Lug types include: tear drop, T-slot, wrap around, (as illustrated) and many other modifications... in standard spaced 3/8", 15/32" and 1/2" strips 3/8" wide; other bakelite strip, panel, board and block assemblies available.

AVAILABLE AT LEADING ELECTRONIC JOBBERS... everywhere
Permits rapid determination of maximum required voltage gain when bandwidth and noise figure, required input to detector and antenna resistance are known

By PETER G. SULZER
Department of Electrical Engineering
The Pennsylvania State College, Pennsylvania

The nomograph permits rapid determination of the maximum required voltage gain of a radio receiver. Factors which enter into such a calculation are the resistive component of the antenna impedance, the bandwidth and noise figure of the receiver, and the required input to the detector.

The available power from the resistive component \( R \) of the antenna impedance is \( 4 \times 10^{-6} \) watts per cycle of bandwidth at 290 Kelvin. This permits calculation of the equivalent rms noise voltage \( E_i \) at the receiver antenna terminals. The receiver, however, will have noise sources of its own, making the true equivalent input voltage greater than \( E_i \). If \( E_i \) is multiplied by \( F^\alpha \), where \( F \) is the noise figure of the receiver, the true equivalent input voltage \( E_s \) is obtained. The maximum useful voltage gain of the receiver is that which will bring \( E_s \) up to the level at which it is desired to operate the detector. Then, if the detector is to operate at a level \( E_d \), the voltage gain \( A \) can be found by dividing \( E_d \) by \( E_s \). These operations are carried out on the nomograph, as illustrated by the following example:

Suppose it is desired to design a radar receiver to work from a 50-ohm transmission line. The i-f bandwidth is to be 1 mc and the detector is to operate at a level of 2 volts so that signals weaker than noise will not be discriminated against by the curved detector characteristic. It is hoped to obtain a noise figure \( F \) of 10, and it is desired to find the required voltage gain with that assumed noise figure. Joining 50 ohms on the \( R \) scale with 1 mc on the \( BW \) scale by means of a straight-edge, it is found that \( E_i = 0.44 \) microvolts. Connecting this point on the \( E_i \) scale with 10 on the \( F \) scale, \( E_s = 1.4 \) microvolts. Then, joining 1.4 microvolts on the \( E_s \) scale with 2 volts on the \( E_d \) scale, \( A \) is found to be \( 1.4 \times 10^3 \). Thus a voltage gain of more than 1,000,000 is required between the antenna terminals and the output of the last i-f stage.

It should be noted that the above calculations assume an impedance match at the antenna terminals. For best noise figure, a mismatch is usually desirable. The resulting error in design can usually be absorbed by the necessarily large tolerance in gain which must be made to allow for variations in tubes and components.

Reference
TELEVISION DEMANDS PERFECTION

There can be no compromise with quality—in television. New standards are essential for long life, dependability and trouble-free operation.

Mallory FP Capacitors are accustomed to severe service—have been operating at 85° C. for years. Even though this extreme temperature may not be apparent in your particular model, it's good to know that Mallory gives you an extra margin of safety.

The fact that no human hand* touches any vital part during processing and assembly shows the extreme care taken to insure the long life so characteristic of this remarkable Mallory product.

*The chlorides present in perspiration cause destructive corrosion and shorten the capacitor's life in the field.

FP is the type designation of the Mallory developed electrolytic capacitor having the characteristic design pictured. Adapted as standard by RM 4, it is famous for dependable performance.
Long-distance calls to distant cities, direct switching operations at intermediate points along a route, and complete connections automatically in a matter of seconds.

Long-distance calls now go through in about 2 minutes on the average. When the new system has become nationwide in scope and all the circuits now planned by the Bell System are in service, the average speed of all long-distance calls is expected to be about 1 minute.

The entire country is being divided into about 80 numbering plan areas and each of these will be designated by a distinctive three-digit code. Then each office within an area will be designated by a three-digit office code, one which does not conflict with the code of any office within the area nor with any other area code.

The operator will usually be able to complete any toll call by dialing a maximum of 10 digits—the six
The 25B is a mighty good buy!

Here are some of the reasons why

General Advantages:

1. The Western Electric 25B Speech Input Console provides highest quality studio control for AM, FM and TV audio.
2. It is versatile... handles two studios... provides duplicate channel operation without interference.
3. It's easy to operate... all controls are functionally located for convenience of operator in controlling programs.
4. It's a complete unit with its own table... attractive, sturdy, well designed... and it's moderately priced.

Technical Advantages:

1. It covers complete FM frequency range. Has high signal-to-noise ratio and exceptionally low distortion.
2. It is easy and economical to install... plug-in cables carry all external leads to wall boxes (included with 25B)
3. It's fully accessible... opens up to expose all components.
4. It includes 7-position mixer; line and microphone transfer keys; dual line amplifiers and volume indicators; separate built-in tube check meter; regulated power supply.

For immediate delivery of one or more 25B Speech Input Consoles, call your nearest Graybar Broadcast Representative— or write Graybar Electric Company, 420 Lexington Avenue, New York 17, N. Y.
THE FRONT COVER

Moisture content of cloth emerging from a textile dryer is indicated directly and continuously by the Fielden Drimeter pictured on the front cover of this issue. Accuracy is within ±1 percent irrespective of the speed at which the cloth moves between the sensing electrodes, and readings are not affected by salts, dyes, size or other finishing materials used on the cloth. The instrument was developed in England, and is now being introduced here by Fielden Electronics, Inc., Huntington, Long Island, N. Y.

Changeover from sense of touch to electronic moisture measurement has boosted output an average of 25 percent on slashers or driers through elimination of overdrying. In addition, drying only to normal moisture content saves fuel and power, lowers operating costs and improves quality of fabrics. Over 800 installations of the instrument have been made in textile mills throughout the world. In one instance, machine output was increased enough to pay for the entire installation in one month.

Operation depends on detection of minute changes in the capacitance of a two-plate condenser through which the cloth passes. Capacitance charges as small as 0.001 pf are readily detected. The greater the amount of moisture in the fabric, the greater is the capacitance because the specific capacitance of water is high in relation to that of cellulose and animal fibers. Voltage between the electrodes is less than 0.1 volt hence there is no shock hazard.

Electronic circuitry employed is indicated in the block diagram below. The instrument employs a special drift-free bridge circuit and amplifier having sufficient stability to permit furnishing the meter with standard precalibrated percentage-moisture scales. Scales now in production are 0–20 percent for cotton, 0–40 percent for wool, 0–20 percent for viscose, 0–20 percent for jute, and 0–20 percent for linen. A duplicate meter can be provided for remote indication.

Adjustment for operation merely involves running the machine dead-slow for a few minutes (or using a dry sample between electrodes) so that out-turn is definitely dry, and adjusting a knob on the instrument panel until the indicator points to dry on the scale. An accessory calibration unit permits resetting without use of dry samples, as is desirable during constant processing of short runs of various standard materials.

An accessory automatic control unit is also available for coupling the moisture meter to the speed-changing mechanism of the drying machine. Two variables are fed into the automatic control—a voltage varying with moisture content, derived from the Drimeter, and a voltage varying with drying machine speed, obtained from a small alternator belted to the machine. The control unit applies a speed correction proportional to deviation from desired moisture content. The higher the speed of the machine, the more frequent are corrections in speed. If the machine stops or if the warp or fabric runs out, the control becomes inactive. Integration of sensing element output over a period of 2 to 3 seconds makes the control insensitive to wet patches such as are produced by damp seams. Atmospheric humidity has no effect on accuracy, because 100-percent humidity is small compared to 5-percent moisture in fabric.

Ten keys on each of these switchboards in New York City permit the operator to ring telephones in many cities without the aid of other operators.

digits of the area and office codes and the four digits of the called telephone number. In calling distant cities, the operator does not actually dial the numbers. Instead she uses a ten-button key set which operates about twice as fast as an ordinary dial. For each punch of a key, a tone pulse is sent out over the voice channels to the switching center.

Each tone pulse is a combination of two different audible frequencies, which are sorted out and classified by the brains in the switching equipment, which then interprets their meaning. This switching equipment also provides the electronic hands which assume much of the complex switching operation.

Six frequencies spaced 200 cycles apart from 700 to 1,700, inclusive, are employed. Two of these frequencies are used for each pulse and each pulse represents one digit. Piquant harmonies are not in store for most long-distance telephone users, however. The equipment practically never makes the tones audible to the calling party.

Called No. 4 equipment, the new switching equipment is capable of performing all types of toll-office switching. It handles incoming calls from distant cities, outgoing calls to other cities, or calls routed through it between two other cities. After dialing by the long-distance operator, a call proceeds entirely automatically. All connections are

(continued on p 140)
**INPUT VOLTAGE RANGE: 1,000,000 TO 1**

**SPECIFICATIONS**
- **FREQUENCY RANGE:** 20 to 16,000 cycles
- **SELECTIVITY:** About 4 cycles flat-top band width. Response is down 15 db at 5 cycles, 30 db at 10 cycles, 60 db at 30 cycles from peak.
- **VOLTAGE RANGE:** 300 microvolts to 300 volts full scale. Over-all range is divided into four major ranges, each of which is divided into seven scale ranges.
- **VOLTAGE ACCURACY:** Within ±5% on all ranges.
- **HUM:** Suppressed by at least 75 db.
- **INPUT IMPEDANCE:** 1 megohm for direct voltage measurements; 100,000 ohms with input potentiometer.
- **ACCURACY OF FREQUENCY CALIBRATION:** ± (2% + 1 cycle).
- **BUILT-IN CALIBRATORS:** For both voltage and frequency.
- **PRICE:** TYPE 736-A WAVE ANALYZER $920.00

This analyzer offers the simplest, most accurate and most direct method of measuring the amplitude and frequency of the components of any complex electrical waveform.

In its essentials it consists of a heterodyne-type vacuum-tube voltmeter with a highly selective i-f filter using three quartz bars. At only 60 cycles from resonance the attenuation is down by 75 decibels, yet tuning is very easy by virtue of the 4-cycle flat-top characteristic at resonance. Standards for both voltage and frequency are built into the analyzer and can be used to check its calibration at any time.

The Type 736-A Wave Analyzer is ideally suited for hundreds of types of harmonic-distortion measurements on any type of audio apparatus, broadcast receivers and transmitters, telephone and public address systems, oscillators, amplifiers and other vacuum-tube circuits; hum measurements on a-c operated communications equipment; harmonic induction studies on telephone lines.

**WRITE FOR COMPLETE DATA**

**GENERAL RADIO COMPANY**

Cambridge 39, Massachusetts

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ELECTRONICS — April, 1949
Electrostatic Cathode-Ray Memory for Computers

A NEW electronic storage system making use of an ordinary cathode-ray tube screen was described recently at a meeting of the British Institute of Electrical Engineers. The new electrostatic memory was developed by F. C. Williams and T. Kilburn of the University of Manchester for use with the electronic digital computer being built at the Royal Society Computing Machine Laboratory. Present plans also call for its use as the high-speed memory for the NBS Interim Counter, a small-scale electronic computing machine being built at the National Bureau of Standards for use until several large-scale machines become available.

The storage of information is accomplished by static charges built up on the screen of an ordinary cathode-ray tube. The binary digits 0 and 1 are stored as a "dot and dash" of charge respectively. The information is obtained from the screen by scanning with the cathode-ray beam, then picking up the signals induced on a metallic foil cemented to the face of the tube. These signals are characteristic of the digits stored. Because the charges slowly leak from the screen, it is necessary that they be continually regenerated by reading the information every 1/25 second and recording on the screen.

While the processes involved in storage, reading and scanning are complicated, the equipment needed for construction of this memory device is said to be simple and ready obtained. It is reported that as many as 2,048 digits have been stored for periods of hours on an area of 154 square centimeters of a cathode-ray tube screen.

Cam Tracking Mechanism

ADJUSTABLE CAMS are used to obtain proper tracking and to avoid the necessity for holding the associated equipment to excessively close tolerances in production in an ingenious mechanism developed at Airborne Instruments Laboratory. The accompanying cutaway drawing shows the construction of such a cam arrangement used for single-control tracking of a klystron oscillator and radio-frequency preselector. The cams maintain the correct reflector voltage of the local reflex oscillator, proper tuning of oscillator and preselector, and give a linear dial frequency calibration. Two cams coupled by antiback-
For the MEASUREMENT of
Q, INDUCTANCE and CAPACITANCE

Radio frequency circuit design often requires the accurate measurement of Q, inductance, and capacitance values. For this application, the 160-A Q-Meter has become the universal choice of radio and electronic engineers throughout the country.

Each component part and assembly used in the manufacture of this instrument is designed with the utmost care and exactness. Circuit tolerances are held to values attainable only in custom built instruments.

Consider, for example, the Q tuning capacitor assembly of the 160-A Q-Meter, specially manufactured for maximum range, low loss, and minimum residual inductance. The ultimate design of this unit was reached after months of intensive engineering research to produce the finest in performance, quality, and workmanship.

This is but one of the many desirable features of the 160-A Q-Meter which contribute to its outstanding accuracy and dependability.

Be sure to include the 160-A Q-Meter in your new equipment plans for 1948.

Write for Catalog "F"

BOONTON RADIO Corporation
BOONTON, N.J.-U.S.A.

The 160-A Q-METER
50 KC. to 75 MC.

Shown above is the Q tuning capacitor assembly of the 160-A Q-Meter. Note the following design features of this unit—features which insure reliable, trouble-free operation.

A. Periclét connection of dual rotor and stator assemblies minimizes internal inductance and resistance.

B. Spring silver fingers contact both sides of silver disc to provide low series resistance.

C. Three point pyrex ball stator suspension reduces losses and permits accurate stator alignment.

D. Four point panel mounting designed to produce maximum structural rigidity and capacitance stability.

E. Precision-cut brass spur gears and stainless steel shafts, mounted in oversize bearings, assure long, trouble-free service.

F. Common stator mounting for main and vernier stator plates reduces loss and internal series resistance of vernier capacitor section.

G. Positive shaft stop protects main rotor assembly and gears against mechanical overload.

SPECIFICATIONS

Oscillator Frequency Range: 50 kc. to 75 mc. in 8 ranges.

Oscillator Frequency Accuracy: ±1%, 50 kc.—50 mc.

±3%, 50 mc.—75 mc.

Q Measurement Range: Directly calibrated in Q, 20-250. "Multiply-Q-by" Meter calibrated at intervals from x1 to x2, and also at x2.5, extending Q range to 625.

Q Measurement Accuracy: Approximately 5% for direct reading measurement, for frequencies up to 30 mc. Accuracy less at higher frequencies.

Capacitance Calibration Range: Main capacitor section 30-450 mfd., accuracy 1% or 1 mfd. whichever is greater. Vernier capacitor section +3 mfd., zero, -3 mfd., calibrated in 0.1 mfd. steps. Accuracy = 0.1 mfd.

DESIGNERS AND MANUFACTURERS OF THE Q METER - QX CHECKER FREQUENCY MODULATED SIGNAL GENERATOR - BEAT FREQUENCY GENERATOR AND OTHER DIRECT READING INSTRUMENTS
Adjustable cams relieve production tolerances and simplify tuning adjustments. lash gears provide these functions. The preselector cam contour covers about 270 degrees of rotation and is adjustable at approximately every 14 degrees. To permit this adjustability, the cam track is formed by a flexible ribbon held against adjustable supports by spring tension. Each support is held in a guide hole in the cam frame and rests on a screw by which its radial position can be adjusted. A locking screw then holds the supports fixed. Final adjustment of the cam track is made by centering the plunger on a support, then feeding in a signal of the frequency indicated by the dial reading and adjusting the support until maximum output is obtained. The process is repeated for each support.

The oscillator tuning cam, which covers about 180 degrees of rotation, is precut to the average klystron tuning characteristic and made adjustable at three points. When the oscillator is first placed in service, and when the tube is replaced, the cam is adjusted for proper tracking at each end and at the center of the tuning range. The end adjustments are made by spreading the two hinged plates of which the cam is formed, using the angle slide blocks for fine adjustments. The center adjustment is made by the differential screw on the plunger.

Pulsed Reflex Oscillator

The range of microwave frequencies from 2,000 to 12,000 megacycles can be generated by a velocity-modulated external-cavity reflex oscillator, type QK-205, that has been developed recently by Raytheon Mfg. Co. as type QK-205 (RMA type 5721). A special feature of the tube is the high-impedance modulation grid which permits pulsed operation from a low-potential source.

Some of the tube's operating characteristics are given in the accompanying table and the graph. The wide frequency range and high efficiency have been obtained by careful study of the electron behavior in the interaction gap and the drift space. Power loss due to the presence of the glass envelope in the cavity has been minimized by controlling the shape of the glass in the portion of the tube entering the resonant cavity.

Mechanically the tube has been made sufficiently sturdy so that, for example, the grid rings that contact the coaxial cavity can be machined after the tube is assembled. This machining assures concentricity of the rings. The protruding repeller contact, which often is responsible for breakage of conventional tubes, has been replaced by a female jack. The miniature size of the tube makes it readily adaptable to compact equipment.

This new tube is intended for use as a wide-band oscillator in conjunction with tunable coaxial cavities. The choice of cavity dimensions is determined by the possibility of exciting the $T_{E_{x,y}}$ or circumferential mode; a noncontacting plunger is recommended. The diagram shows a suitable cavity for the 4,290 to 8,340-mc range that operates without mode interference.

**Typical Operating Characteristics of Wide-Range Reflex Oscillator**

<table>
<thead>
<tr>
<th>Mode conditions</th>
<th>1/4 cavity modes</th>
<th>3/4 cavity modes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency in mc$^a$</td>
<td>2,000-5,000</td>
<td>4,290-8,340, 7,500-12,000</td>
</tr>
<tr>
<td>Grid No. 2 and No. 1</td>
<td>7,000</td>
<td>1,000</td>
</tr>
<tr>
<td>Potential in volts$^b$</td>
<td>13</td>
<td>20</td>
</tr>
<tr>
<td>Cathode current in ma</td>
<td>40-600</td>
<td>60-600</td>
</tr>
<tr>
<td>Reflector potential in direct volts$^c$</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>Power output, milliwatts</td>
<td>0.14</td>
<td>0.9</td>
</tr>
<tr>
<td>Average efficiency in percent</td>
<td>40</td>
<td>400</td>
</tr>
</tbody>
</table>

$^a$ With suitable cavity, which for the 3 3/4 repeller mode requires quarter-wave cavity mode for suppression. Cavity for 4,290-8,340 mc range has 0.393-inch diameter inner conductor and 0.757-inch inner diameter for outer conductor. Cavity is caused by noncontacting Z choke type plunger that is chrome finished to minimize wear of silver-plated cavity walls.

$^b$ Control grid is adjusted for desired cathode current, which will require a positive direct voltage between about 10 and 25 volts; control grid current is approximately 5 ma.

$^c$ Adjust for maximum power output.

Note: For pulsed operation pulse repetition rate is 40 to 4,000 pps with pulse duration from 0.5 to 10 microseconds.

**Curves showing performance of QK-205 tube in the middle region of its operating range**

**Brightness and Contrast in Television**

The effects of different degrees of brightness and contrast on television pictures were described by Peter C. Goldmark of CBS at the AIEE Winter General Meeting in

(continued on p 161)
This new tubing with a new synthetic coating of General Electric Permafil on Fiberglas braid is . . .

So FLEXIBLE that it can be twisted, bent, wrapped, tied in knots . . . without cracking or peeling.

So TOUGH that severe use will not destroy its dielectric property — 7000 volts.

So HEAT-RESISTANT that it will withstand high temperatures and can be after-treated in baking and varnishing operations.

Made in standard colors, in a wide range of sizes. It is available in coils—so that you can cut the exact lengths you need, without waste.

And . . . this is a premium tubing at a reasonable price. Send coupon for free sample and full information.

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Makers of Electrical Insulating Tubing and Sleeving

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**VARFLEX Corporation, 308 Joy St., Rome, N. Y.**

Please send me full information as well as a free sample of your new Varglas Tubing impregnated with G. E. Permafil. I am particularly interested in samples suitable for . . .

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NEW PRODUCTS

Edited by A. A. McKENZIE

Radiation Survey Meter

PRECISION RADIATION INSTRUMENTS, INC., 1101 N. Paulina St., Chicago 22, Ill. Model 102 allows measurement of low-energy beta particles and alpha particles as well as gamma and X-radiations. The new counter tube has a thin mica window 1.5 mg per sq cm, allowing detection of Carbon 14 and other radioactive tracers. The tube is self-quenching with a Geiger threshold at 825 volts plus or minus 25 volts, and has a 200-volt plateau. The tube itself is mounted within a specially designed probe that enables differentiation between alpha, beta, and gamma radiations. Utilizing a plug-in circuit for easy servicing, the instrument has a battery life in excess of 400 hours. Price is $289.50 delivered complete.

Microwave Power Meter

HEWLETT-PACKARD CO., 395 Page Mill Road, Palo Alto, Calif. Type 430A microwave power meter directly indicates on a large meter the power developed in a standard barreter. The instrument is self-balancing and can be used over any frequency depending upon the associated barreter and mount. The unit comprises an a-c bridge, one arm of which is a barreter. The bridge is in balance with zero r-f power in the barreter. As r-f power is applied to the barreter, an equivalent a-c audio power is automatically removed. Thus the bridge remains in balance. A vacuum-tube voltmeter reads the change in audio power level. It is this meter, calibrated in milliwatts that gives a direct indication of the r-f power in the barreter. The new meter covers a power range from 0.02 to 10 milliwatts. Ranges are related in 5-db steps and continuous readings are available from minus 20 dbm to plus 10 dbm. The power range can be extended by use of attenuators or directional couplers. Accuracy of the meter is within plus or minus 5 percent of full-scale readings.

Carbon Resistors

WELWYN ELECTRONIC COMPONENTS INC., 234 East 46th St., New York 17, N. Y. High stability resistors are now offered in a range from 100 to 50,000 ohms in 1-percent tolerance, and in wider ranges in a 5-percent tolerance of resistance values. Available in 5, 1, and 2-watt sizes, these resistors are stocked in decade and RMA preferred values. In manufacture, the resistor element is a homogenous film of pure carbon deposited on a porcelain tube. After aging, fitted brass end caps are applied, into which the terminal leads are staked and soldered. The completed resistor is brought to the required resistance value by spiralling in automatic machinery.

F-M Antenna

ANDREW CORP., 363 East 75th St., Chicago 19, Ill. The Multi-V is a new two-bay f-m broadcast antenna with a power gain of 1.6 and a power-handling capacity of 10 kw. It can be either top or side mounted. Electrically, the antenna consists of two radiating elements spaced at one wavelength. Each element is essentially an unbalanced folded dipole formed in the shape of a vee. The configuration results in an omnidirectional horizontal pattern. The elements are fed in phase by a single transmission line through a full-wave phasing length and are matched to the feed line by means of a quarter-wave matching section. Voltage standing-wave ratio varies from a maximum of 1.4 at 88 mc to less than 1.2 from 93 to 108 mc. Bulletin 86 gives complete details.

Microwave Dielectrometer

CENTRAL RESEARCH LABORATORIES, INC., Red Wing, Minn. Now available for measuring the dielectric constant and loss of a wide variety of materials at nominal frequencies of 1,000, 3,000, and 9,000 mega-
This Scott Sound Level Meter made by Hermon Hosmer Scott, Inc., Cambridge, Mass., employs four Raytheon Type CK512AX and one Type CK526AX Tubes with a normal filament current of 0.06 amps. Battery life is approximately 50 hours with intermittent use. Yet the complete assembly is only 11\(\frac{1}{2}\)" long and 2\(\frac{3}{4}\)" in diameter—only slightly larger than a flashlight!

Handy size...increased product serviceability and salability...are only some of the advantages of Raytheon Subminiatures with their flat shape and extremely low filament drain that permits the use of tiny batteries.

All Raytheon Subminiatures can either be soldered in or plugged into readily available sockets.

Raytheon Subminiatures are reliable—the result of nine years of continuous production and application experience. Raytheon's are readily available from nearby stock—over half a million on tap at all times. They are standard throughout the world—more are in use than all other makes combined! Over three hundred Raytheon Special Purpose Tube Distributors are ready to serve you quickly and intelligently.

Let us send you detailed information on Raytheon Special Purpose and Subminiature Tubes

Raytheon Manufacturing Company

Excellence in Electronics
cycles is the microwave dielectric meter illustrated. The instrument comprises a slotted waveguide, precision traveling probe, modulated klystron oscillators, probe output amplifier, and associated power supply. The sample to be measured is inserted ahead of a short-circuiting plug and the effect of this arrangement on the standing-wave pattern in the guide provides data for calculating the dielectric constant and loss of the material. At 1,000 and 3,000 megacycles the waveguide is used as a coaxial line operating in the TEM mode, and at 9,000 mc either as a circular pipe operating in the TEo mode or as a coaxial line operating in the TE1 mode. The range of measurements of dielectric constant extends from 1 to 100; dissipation factor can be determined between 0.0001 and 1.0. Accuracy in the order of 2 percent is possible for most materials.

**Standard Signal Generator**

**Marconi Instruments Ltd., St. Albans, Herts., England.** Standard signal generator type TF 867 has a frequency coverage from 16 kc to 30 mc and the calibration is displayed on an expanded scale giving a discrimination of one part in ten thousand of the total scale length. Output is continuously variable from 0.4 microvolt to 4 volts. A crystal oscillator is provided for frequency calibration. Amplitude modulation up to 100 percent at 400 cycles or 1,000 cycles internally is possible, or any frequency from 50 cycles to 10 kc can be applied externally. Meters show output level and modulation depth.

**College Broadcaster**

**Gates Radio Co., Quincy, Ill.** Type BF-E-10 transmitter illustrated has been designed for f-m broadcasting in the noncommercial educational band. Power output is nominally 10 watts. Direct crystal control gives a frequency stability of plus or minus 500 cycles. The phase shift modulator has a modulation capability of 100 kc. Frequency response is within 1.5 db of the standard 75-microsecond preemphasis curve. Distortion is less than 1.5 percent from 50 to 100 cycles and less than 1 percent above 100 cycles. Power input is about 165 watts. Transmitter sells for $1,750 complete with one set of tubes, one crystal and oven.

**Polarized Relay**

**Sigma Instruments, Inc., 70 Ceylon St., Boston, Mass.** Type 7JOZ miniature polarized high-speed telegraph keying relay has spdt contacts. It is hermetically sealed and fits an octal tube socket. Designed for operation at 50 to 150 words per minute, it is serviceable up to 250 wpm. Transfer time, dependent upon the driving circuit, is generally less than 1 millisecond. Windings available include a matched pair with resistance around 150 ohms each for differential, polar, or polarental service as well as other combinations up to 14,000 ohms in a single winding. The standard twin-150-ohm model operates satisfactorily on 5-ma reversals in one winding, and just trips at approximately 1 ma.

**Magnetic Tape Splicer**

**Elken Mfg. Co., Hollywood, Calif.** An automatic splicer for cutting and patching magnetic tape can be used to edit program material in about ten seconds. In operating the splicer, the magnetized tape is placed in a groove and any selected spot is cut to an accuracy of a few thousandths of an inch, using a spring-loaded blade controlled by a thumb-pressure trigger knob. The final operation issues the proper amount of cellulose tape to join the butted ends and at the same time trims the excess binder.

**Record Camera Accessories**

**Fairchild Camera and Instrument Corp., 88-06 Van Wyck Boulevard, Jamaica 1, N. Y.** A new universal mount for the Oscilloscope-Record camera eliminates the need for extra standard mounts for different types of oscilloscopes and is especially recommended when a 1,000-foot external magazine is to be used. A new adapter for mounting a standard 35-mm 1,000-foot or 400-foot magazine on the camera (Continued on page 179)
3 WAYS PHOTOGRAPHY STOPS TIME

1. HIGH SPEED STILLS—taken in as little as a millionth of a second—give you sharpest possible detail of a flash of fast action. They can be timed to catch the important instant of continuous motion. In the illustration, taken at 1/100,000 second, spray from a lacquer gun has been “stopped” to study dispersion of material.

2. HIGH SPEED MOVIES—slow down action far too fast to see otherwise—expand 1 second of operation into 4 minutes of viewing time. They allow the study of fast moving parts in operation—show why they stand up or fail. The illustration shows three frames of a high speed film made to study the action of a tire meeting an obstacle at high speed.

3. RECORDING OSCILLOGRAPH TRACES. When fast actions can be translated into electrical impulses, they can be traced on the oscillograph and photographed. In the illustration, the upper trace represents the pressure of detonation in the cylinder of a knocking gasoline engine—the vibrations in the lower trace have a period of about 1/100,000 second.

FUNCTIONAL PHOTOGRAPHY

... is advancing industrial technics

Camera close-ups, like these from the automotive industry, are helping unravel problems for all kinds of industries and businesses. They are pointing the way to better products at less cost—to more efficient production methods—to greater ability to lead competition.

You can use such photographic technics in your business, either with facilities of your own or through one of the many fine commercial laboratories. In either case, Kodak will be glad to help with information or suggestions.

Eastman Kodak Company, Rochester 4, N. Y.

“Kodak” is a trade-mark
The NEW "dag" CRT Interior Wall Coating, a colloidal graphite dispersion, is widely used to improve the performance of television viewing tubes.

Specifically developed by Acheson Colloids engineers for CRT interior surface coating, this dispersion provides a colloidal graphite film which serves as a final high voltage anode, and improves screen contrast by absorbing reflected light.

"dag" CRT Wall Coating sticks fast to all types of glass. A simple adjustable applicator gives a uniform coating from tube face to tube neck while the envelope is turned in a lathe.

Electrical and electronic manufacturers use "dag" colloidal graphite because it is opaque, electrically conductive, chemically inactive, diamagnetic, resistant to electron bombardment, low in photoelectric sensitivity and a gas adsorbent. Can this unique combination of properties be helpful to you? Mail coupon TODAY for more information.

ACHESON COLLOIDS CORPORATION
PORT HURON, MICHIGAN

Send me more information on "dag" colloidal graphite in electronics.

Send an Acheson Colloids engineer at my convenience.

Name

Company Name

Address

City Zone State
RMA-IRE Spring Meeting

Radio Engineers of the RMA and IRE will hold their fourth annual spring meeting April 25, 26 and 27 at the Benjamin Franklin Hotel, Philadelphia. Mornings during the three-day conference will be devoted to technical sessions; afternoons will be occupied by committee meetings and inspection trips.

Technical program is as follows:

Monday, April 25
10:00 A. M. Chairman—A. N. Curtis
The Use of the Cavity Resonator in the Mobile Communications Field, by Henry Magnuski of Motorola, Inc.
The Symmetron 50 Kilowatt F-M Broadcast Amplifier, by L. D. Balthis of Westinghouse Electric Corp.
An Instantaneous Deviation Control for Phase Modulation Transmitters, by Marion Winkler of Motorola Inc.

Tuesday, April 26
9:30 A. M. Chairman—M. R. Briggs
Television Recording Technique, by R. V. Little, Jr. of RCA.
The Utiloscope, Pioneer of Industrial Television Systems, by M. Cawein and A. A. Good of Farnsworth Television & Radio Corp.
A New Television Visual Modulator, by A. J. W. Rhodehamel of GE.
The Reality of Invisible Forces, by E. Pinley Carter of Sylvania Electric Products Inc.

Wednesday, April 27
9:30 A. M. Chairman—O. W. Pike
High-Efficiency Cooler for Forced-Air-Cooled Power Tubes, by M. B. Lemeshtka and A. G. Nekut of RCA.
Audio Power Amplifier with Positive and Negative Feedback, by John M. Miller, Jr. of Bendix Radio.
Longitudinal Interference in Audio Circuits, by H. W. Auguststadt of Bell Labs.
Commercial PTM Telephone Microwave Link, by N. J. Gottfried of Federal Telecommunication Labs and W. J. Logan of Maritime Telephone & Telegraph Co.

Terminology for Acoustics

A Proposed American Standard Acoustical Terminology was recently published for a year’s trial and study. Those interested are invited to make use of the proposed dictionary during the next year and to comment upon their experiences with it. The new trial edition was prepared by a sectional committee sponsored by the ASA with cooperation of the IRE.

New material in the proposed revision of the 1942 edition defines terms used in work on ultrasonics, recording and reproducing, underwater sound, general acoustical instruments, and shock and vibration. Sections appearing in the earlier edition also contain new material.

The proposed standard can be obtained at one dollar per copy from the Subcommittee on Acoustical Terminology, Z24A, of the ASA, Inc., 70 E. 45th St., New York 17, N. Y.

Tube Committee Reorganization

The American Standards Association Sectional Committee on Electron Tubes C-60, formerly sponsored by the Electrical Standards Committee, is now sponsored by the Joint Electron Tube Engineering Council. While originally the unit was concerned only with industrial electron tubes, it has been reorganized and its scope is being broadened to include definitions, classifications, methods of rating and testing, dimensions and interchangeability of electron tubes for all applications.

This new committee includes representatives of the American Association of Electrical Engineers, the American Association of Railroads, Electric Light and

Line-of-Sight TV Transmission from Mountain-Tops

Largest concentration of television transmitters is at Mt. Wilson, Calif., twenty-five miles from Los Angeles and 5,700 feet high at the tower locations. Maximum line-of-sight range is provided for six transmitters, a seventh expected to be ready soon, and two relay towers. Pictured above are, right to left: KTTV; KLAC; KMBH; KTLA; KECA; a Pacific Tel. & Tel. Co. relay tower; KFI, with KXMF (f-tam only) in front of it; and a Pacific Tel. & Tel. relay tower. At left (base of small knoll) KTSK is building a transmitter.

Giant parabolic reflector above KTSK atop 1,600-ft Mt. Lee, Calif. Television shows originating in Hollywood studios, whose lights are seen in the background, are beamed directly to the 16-ft saucer, which has a focal length of four feet.
MEETINGS

MARCH 28-29: Third Annual Meeting, Armed Forces Communications Association, Shoreham Hotel and Naval installations, Washington, D. C.

APRIL 4-8: SMPE 65th Semiannual Convention, Hotel Statler, New York.

APRIL 6-12: 37th Annual Convention of the National Association of Broadcasters, Stevens Hotel, Chicago, Ill.

APRIL 11-12: AIEE Conference on the Industrial Application of Electron Tubes, Statler Hotel, Buffalo, N. Y.

APRIL 11-15: Sixth Western Metal Congress and Exposition, Shrine Auditorium, Los Angeles, Calif.

APRIL 18-20: Eleventh annual Midwest Power Conference, Sherman Hotel, Chicago, Ill.


MAY 16-20: Radio Parts Industry Trade Show and RMA Silver Anniversary Convention, Hotel Stevens, Chicago, Ill.


AUG. 30-SEPT. 1: Fifth Annual Pacific Electronic Exhibit sponsored by the WCEMA, and the 1949 IRE western regional convention, Civic Center, San Francisco, Calif.

SEPT. 12-16: Instrument Society of America National Conference and Exhibits, Municipal Auditorium, St. Louis, Mo.


Power Group; the Institute of Radio Engineers; the Joint Electron Tube Engineering Council; the National Bureau of Standards, the National Electrical Manufacturers Association; the Radio Manufacturer's Association; Telephone Group; the Army-Navy Electronic Engineering Agency, and liaison from the Canadian Standards Association. Chairman is O. W. Fike of GE's Electronics Department.

Precision Resistors

Characteristics and measurements of precision resistance apparatus are covered in a new 32-page booklet entitled "Precision Resistors and Their Measurement", NBS Circular 470. Contained herein are chapters on resistance materials and construction methods, methods of comparison of resistors, special apparatus for precision measurements, calibration of precision bridges and resistivity of solid conductors.


Storms Forecast Here by Radiophoto from Sweden

Even when the sun is obscured in New York, uninterrupted daily forecasts of sunspot activity are now being made by RCA Communications, Inc. via solar photographs taken in Sweden and transmitted to this country by radiophoto. Calculation of the effect of sunspot activity on shortwave transmission provides advance warning of magnetic storms and permits rerouting of telegraph traffic to circuits outside affected areas.

Until recently forecasts of radio conditions have depended upon success in observing the sun through a refracting telescope installed atop the RCA Central Radio Office at 66 Broad St., New York. Need for a supplementary source of data during cloudy periods led to the present cooperative arrangement with the Royal Board of Swedish Telegraphs in Stockholm Observatory in Saltsjobogen, Sweden.

Thermocouple Wire Code

A four-page pamphlet dealing with coding of thermocouple and extension wire has been released by the Instrument Society of America as part of its program for achieving greater uniformity in the field of instrumentation. Designated as Tentative Recommended Practice RP1.1, the pamphlet includes tables giving recommended symbols for the following thermocouple combinations and extension wire:

- Iron-Constantan (types J and Y); chromel-alumel; platinum, ten percent rhodium-platinum; platinum, 13 percent rhodium-platinum; and copper-Constantan.

The four-page standard, free to members and $1 for non-members, (continued on p 215)

NEW BRITISH RADAR NAVIGATIONAL AID

A view of the 325-ft steel lattice transmitting tower at the master station of the Lane Identification system, Puckridge, Herts., England. Transmissions go out automatically at one-minute intervals 24 hours a day, seven days a week, so ocean-going ships approaching Britain can fix their position and set their receivers for the subsequent voyage up channel

April, 1949 — ELECTRONICS
NOW . . . a comprehensive line of 24 microwave gas switching tubes TR, ANTI-TR, PRE-TR types!

If you need gas switching tubes—for radar or other microwave applications—this extensive Sylvania line will meet all your requirements.

The Sylvania line is the outgrowth of Sylvania's wartime experience as the world's largest producer of gas switching tubes—and of an intensive program of continuing research since the war.

The Sylvania line comprises 24 tubes: 11 TR's, 11 Anti-TR's and 2 Pre-TR's. Many of the newly introduced types offer the advantages of longer life, shorter recovery time and suitability for broad band applications.

Sylvania Electric Products Inc.
Electronics Division, Dept. E-2904
500 Fifth Avenue, New York 18, N. Y.

Gentlemen:
Please send me your new bulletin on TR, Anti-TR and Pre-TR tubes. I am also interested in receiving literature covering applications of your other products in the fields of:

- Communications, Television and Industrial Electronics
- Radioactivity
- Radar and Microwaves

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

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

www.americanradiohistory.com
Continental makes them all and thousands more

Of all the 400,000 varieties of fastenings that literally hold our industries together, Continental makes a large proportion marketed under the famous HOLTITE trade name. Most of them are standard — screws, nuts, and bolts for every use in every industry. Others like the well-known HOLTITE-Sems and HOLTITE-Phillips screws are patented specialties and the famous HOLTITE-Thredlock, Lockite and Tap screws were first designed and produced by Continental. Sometimes a fastening engineered by one industry finds an unexpected use in another. Often a HOLTITE-Engineered fastening will replace several parts that a manufacturer is using. Why not discuss your fastening requirements with a Continental Sales-Engineer. He will focus on your requirements all the broad industrial-fastening experience and ingenuity of Continental. Remember Continental is constantly improving HOLTITE products, lowering their cost and broadening service.

Engineered Fastenings for Product Engineers

A. A typical flat head HOLTITE steel woodscrew. Continental makes a complete range of sizes with either slotted or Phillips heads.

B. Special Phillips "HOLTITE-Thredlock" door hinge screw eliminates lock washers and other locking devices giving improved performance when subjected to vibration.

C. Dial adjusting screw specially designed for bathroom scales. Screw inserted in frame is swaged against square shoulder under head. Completed part engages scale leveling mechanism to allow screw driver adjustment.

D. Beater drive shaft for a home electric mixer. Continental engineered this unusual part and produced it economically by cold heading process. Head end is welded to the beater unit. Knurled section provides grip for motor chuck.

This Trademark
HOLTITE
T.M. REG. U.S. PAT. OFF.
means made by —

Continental Screw Company

New Bedford, Mass., U.S.A.

April, 1949 — Electronics
Cut your Costs 4 ways...

with General Electric’s
“Inch-Cube” Selenium Rectifiers

Cut Initial Costs—Selenium rectifiers cost less than the sockets and tubes they eliminate.

Cut Installation Costs—Only one part to handle—only two connections to make—and this miniature power plant is installed—ready to operate.

Cut Chassis Costs—Use a smaller chassis. Selenium rectifiers can be mounted where a rectifier tube and socket won’t fit.

Cut Inspection Costs—With no multiple-pin socket, no filament circuit, the inspector has only two simple soldered joints to check.

High-voltage selenium rectifiers can be used in place of rectifier tubes in many radio and electronic circuits.
Model 6R55GH1 is recommended for general use while the smaller model, 6R55GH2, should be used when space is extremely limited.
Each rectifier is composed of 5 one-inch-square selenium rectifier cells specially assembled to give constant and uniform spring contact pressure on the cells regardless of temperature variations. Each unit is coated with a moisture-resistant varnish to provide protection against humidity and condensation. These units have ample current capacity to safely withstand the inverse peak voltage obtained when rectifying 110-125 volts, rms, while feeding a capacitor—as required in many radio circuits. Ambient temperatures of 50°C to 60°C are readily withstood. Tests have proved that these rectifiers will outlast the conventional type of rectifier tubes. The forward voltage drop through the rectifier is extremely low—approximately five volts at rated capacity.

For complete details contact your local G-E representative, or write for a new free bulletin on Selenium Rectifiers.

Application Data

<table>
<thead>
<tr>
<th>Model</th>
<th>Height (Inches)</th>
<th>Width (Inches)</th>
<th>Length (Inches)</th>
<th>Normal RMS Volts</th>
<th>Max. RMS Volts</th>
<th>Max. Inverse Peak Volts</th>
<th>Temp.</th>
<th>Max. Peak Current (Ma)</th>
<th>Max. RMS Current (Ma)</th>
<th>Max. D.C. Current (Ma)</th>
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</thead>
<tbody>
<tr>
<td>6R55GH1</td>
<td>1</td>
<td>1</td>
<td>15/16</td>
<td>117</td>
<td>130</td>
<td>380</td>
<td>50</td>
<td>1000</td>
<td>250</td>
<td>100</td>
</tr>
<tr>
<td>6R55GH2</td>
<td>1</td>
<td>1</td>
<td>11/16</td>
<td>117</td>
<td>120</td>
<td>380</td>
<td>50</td>
<td>800</td>
<td>200</td>
<td>80</td>
</tr>
</tbody>
</table>

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For complete details contact your local G-E representative, or write for a new free bulletin on Selenium Rectifiers.

APPARATUS DEPARTMENT, GENERAL ELECTRIC COMPANY, SCHENECTADY 5, N.Y.
SHALLCROSS
DECAYE RESISTANCE BOXES

1 TO 7 DIAL TYPES FOR LABORATORY STANDARDS
A-C and D-C Bridges
Ratio Arms
Voltage Dividers
... and other uses

Widest assortment on the market.
Available from stock from 0.01 ohm to 11,111,110 ohms

Shallcross Decade Resistance Boxes are sturdily made to high quality standards and with accuracy adjustment of resistors as follows: 0.1 ohm ... 1%; 1. ohm ... 0.25% and all others 0.1%.

OVER FORTY TYPES AVAILABLE...
Following are a few of the most popular types normally in stock.

<table>
<thead>
<tr>
<th>Type</th>
<th>Dials</th>
<th>Steps: Ohms</th>
<th>Total Resistance: Ohms</th>
<th>Dimensions: Inches</th>
<th>Weight lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>820</td>
<td>3</td>
<td>1</td>
<td>1,110</td>
<td>10 x 6 x 5</td>
<td>3.5</td>
</tr>
<tr>
<td>822</td>
<td>3</td>
<td>100</td>
<td>111,000</td>
<td>10 x 6 x 5</td>
<td>3.5</td>
</tr>
<tr>
<td>817</td>
<td>4</td>
<td>0.01</td>
<td>111.1</td>
<td>10 x 8 x 6</td>
<td>4</td>
</tr>
<tr>
<td>819</td>
<td>4</td>
<td>0.1</td>
<td>1,111</td>
<td>10 x 8 x 6</td>
<td>4</td>
</tr>
<tr>
<td>825</td>
<td>4</td>
<td>1</td>
<td>11,110</td>
<td>10 x 8 x 6</td>
<td>4</td>
</tr>
<tr>
<td>828</td>
<td>4</td>
<td>1.000</td>
<td>11,110,000</td>
<td>10 x 7 x 6</td>
<td>4</td>
</tr>
<tr>
<td>817-B</td>
<td>4</td>
<td>0.01</td>
<td>111.11</td>
<td>10 x 7 x 6</td>
<td>4</td>
</tr>
<tr>
<td>829</td>
<td>5</td>
<td>1</td>
<td>1,111,100</td>
<td>10 x 7 x 6</td>
<td>4.5</td>
</tr>
<tr>
<td>832</td>
<td>6</td>
<td>1</td>
<td>1,111,110</td>
<td>10 x 7 x 6</td>
<td>4.5</td>
</tr>
<tr>
<td>833</td>
<td>6</td>
<td>10</td>
<td>11,111,100</td>
<td>10 x 7 x 6</td>
<td>4.5</td>
</tr>
</tbody>
</table>

SPECIALS... to your specifications

As a leading maker of close tolerance resistors and precision instruments, Shallcross is well fitted to design and produce special resistance boxes for practically any application.

SHALLCROSS MFG. COMPANY
Department E-49, Collingdale, Penna.
ENGINEERING • DESIGNING • MANUFACTURING

April, 1949 — ELECTRONICS
What makes BENDIX* dynamotors SO MUCH BETTER?
For the answers look inside!

END BRACKETS
Die-cast aluminum for strength and light weight.

SHAFT
Precision machined for accurate bearing fit.

BEARINGS
New Departure, SKF, or Fafnir ball bearings, lubricated with government approved lubricants.

BRUSHES
Specially selected for each type of dynamotor to insure greatest brush life and good commutation.

POLE SHOES
Special electric-grade steel with flared tips to smooth out flux changes. Pole assemblies are easily removable.

COMMUTATORS
Finest grade, hand-drawn, mica insulated copper, precision machined and undercut for good commutation, long brush and commutator life, and low ripple.

ARMATURE
Hand-wound by skilled armature winder's with primary winding in bottom of slot to insure guaranteed ripple value of less than 1% per cent. Balanced to .0002 inch.

FIELD COILS
Pre-formed, impregnated, and baked for long life.

ARMATURE LAMINATIONS
Special electric-grade steel, random stacked to obtain maximum magnetic characteristics. Slots are skewed to smooth abrupt flux changes.

It Pays to buy Quality... and no finer Quality Dynamotor is available than a BENDIX DYNAMOTOR

Dynamotors • Inverters • Converters • D.C. Motors • Carbon Pile Voltage Regulators

RED BANK DIVISION of

RED BANK, N. J.

ELECTRONICS — April, 1949
For Television and all other applications where specifications are precise and the emphasis is on quality and performance, famous FERRANTI transformers offer superior value.

Into each unit goes long years of specialized experience, plus up-to-the-minute knowledge of today’s improved practices and latest materials. Our large and varied stock of patterns, tools, and dies often permits us to supply “custom” requirements from standard parts, effecting worthwhile savings. We invite your inquiries.

OPEN FRAME TYPE for mass production, minimum cost and weight for enclosed equipment.

FERRANTI ELECTRIC, INC.
30 ROCKEFELLER PLAZA
New York 20, N.Y.

FIG. 2—Curves showing usefulness of match-test bridge circuit

Turning this argument around, if opening and closing the switch S does not cause any change in the currents through the bridge arms (through $R_a$), then the bridge must be in balance and $R_a = R$.

If, however, $R_a$ is not properly matched, then closing of switch S will permit flow of current through the null arm and the currents flowing through the other bridge arms will be altered accordingly.

To determine the error $\rho$ it is enough to observe the change in the current through the load impedance $R_L$ from the value $i_L$ when the switch S is open to $i_L'$ when S is closed. The ratio of these two current values can be computed from the parameters of Fig. 1 and is found to be:

$$\frac{i_L'}{i_L} = 1 - \frac{1}{4R + \frac{2\alpha + 3}{\rho + \alpha + 1}}$$

This ratio is equal to unity for $\rho = 0$; no change in current.

In general, the ratio depends somewhat on the mismatch of the source impedance $R_s$; its values are plotted in Fig. 2 for $R_s$ ranging from $0.5R$ to $2R$; the three curves shown are computed for different source impedances, one curve assuming that the source is matched, $\alpha = 1$, one curve for negligible source impedance, $\alpha = 0$, and one curve, $\alpha = 2$, assuming a source impedance of $2R$. It can be seen that the effect of the source impedance on the bridge measurement is negligible for all practical purposes.

The only detail of the diagram that matters in practice is the

April, 1949 — ELECTRONICS
Here's a magnet that's simple in design yet is the heart of Penn room thermostats... thermostats which anticipate heat requirements before temperature changes. The Sintered Alnico 2 permanent magnet snap-acting contact mechanism responds almost instantly to temperature variations.

This application is an excellent example of cost-saving by using stocked G-E permanent magnets. Since the magnet is stocked there are no special tool charges. And orders for stocked magnets are filled quickly, eliminating costly production slow-downs to you.

Perhaps a standard listed magnet can be used in your applications. And if a standard G-E permanent magnet will not meet your requirements, our engineers will be glad to design one specially for you. Remember, too, that General Electric manufactures all grades of cast and sintered Alnico as well as special magnet alloys.

CHEMICAL DEPARTMENT, SECTION 144
GENERAL ELECTRIC COMPANY
PITTSFIELD, MASS.

Please send me: ( ) Bulletin, CDM-2A, "G-E PERMANENT MAGNET CAT-ALOG"
( ) Bulletin, CDM-16, "G-E PERMANENT MAGNET SUB-ASSEMBLIES"

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

G-E Permanent Magnet
SUB-ASSEMBLIES

Here's a new product which may lower your permanent magnet costs. Permanent magnet component assemblies are specially designed to your specifications—ready for immediate installation in your final product. All permanent magnets are mounted for maximum efficiency. And, assembly and calibration operations are completely eliminated at your plant. For your free copy of General Electric's new bulletin on G-E Permanent Magnet Sub-assemblies mail the coupon shown below.

YOU GET QUALITY PLUS ENGINEERING SERVICE
with
PERMANENT MAGNETS

THE MAGNET THAT
Heats Your Home

www.americanradiohistory.com
because Ward Leonard has that many types of resistors in stock

You can get immediate delivery on Ward Leonard Vitrohm wire-wound resistors—both adjustable and fixed—in watt ratings from 5 to 200 and resistance values from 1 to 150,000 ohms.

Resistive element embedded in Ward Leonard's exclusive crazeless vitreous enamel, gives these resistors consistent accuracy and stability even under the most prolonged adverse operating conditions.

HURRICANE!

How violent? Where heading? How fast?

Hurricane warnings that save so many lives on land and sea—where do they come from? From seismograph recorders, perhaps better known for their earthquake-locating power. These sensitive instruments, stationed all over the country and on Atlantic and Pacific island outposts, locate and plot the minute-by-minute movement of violent atmospheric disturbances . . . and pen the vital data on tape.

The heart of each of these life-savers is a Telechron Timing Motor . . . instantly, constantly synchronous. No other motor could be trusted with the tremendous responsibility of feeding facts to the scientists who dedicate their time and talent to this most important work.

Have you a timing problem?

What variable factors do you want to control or record with split-second accuracy? The chances are that the correct application of a standard Telechron Motor is the answer to your problem. A Telechron Application Engineer can quickly tell you. Consult him early in your planning and save time and trouble. In the meanwhile, fill in and mail the coupon below today for up-to-the-minute facts about Telechron Synchronous Motors.

ALL TELECHRON TIMING MOTORS ARE

INSTANTLY . . . CONSTANTLY SYNCHRONOUS

Telechron Inc. A General Electric Affiliate
40 Union Street
Ashland, Massachusetts

Please send me information on Telechron Synchronous Motors (maximum torque: 2 pound inches at 1 rpm). My possible application is:

☐ Instruments
☐ Timers
☐ Electric Appliances
☐ Cost Recorders
☐ Advertising, display items
☐ Juke Boxes
☐ Air Cond. & Heat's Controls
☐ Communications Equipment
☐ Other (please fill in)

NAME ________________________
COMPANY ____________________
ADDRESS _____________________
CITY __________________ ZONE ___ STATE ____________

ELECTRONICS — April, 1949

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TUBES AT WORK (continued)

depends on $R$, and on whether the switch $S$ is open or closed: for $R_1 = R$, it is $0.6R$ in the former case and $1.66R$ in the latter.

Tester for VR Tubes

BY STEPHEN S. PESCHEL
Mount Vernon, N. Y.

VOLTAGE-REGULATOR tubes frequently light up or glow when they are not functioning properly—not stabilizing the voltage at the load terminals. When used to stabilize an oscillator circuit for instance, they may flash on keying without going out, and give all outward appearances of working properly, but in reality they may be loafing on the job. Where voltage-regulation of the order of 1 percent may be needed, tests may disclose an actual regulation of 5 percent. Where such tubes are used in the series-type of electronically-regulated power supply for voltage reference, it is also important to use VR tubes that work properly.

With very rare exceptions new VR tubes, when operated properly, do stabilize voltages within the limits stated in tube handbooks. However, accidental current overloads will impair their operation, and frequently make them entirely useless as regulators. Unless the gaseous discharge or glow changes to an arc discharge and actually burns the tube completely, the tube may appear to glow normally. Some sort of a checker is needed to test these tubes.

Reviewing theory briefly, VR tubes are specially constructed gaseous glow tubes which maintain a rather constant voltage drop when current through them is varied over quite a range. A fundamental voltage-stabilizing circuit using a VR150 is shown in Fig. 1. The limiting resistor is

---

CRISTAL
CRAFTSMANSHIP
in miniature

No need to sacrifice quality when space is limited. BLILEY Type BH6 crystal units pack small size and high precision into a hermetically sealed capsule. Supplied in the frequency range 1 mc to 100 mc with tolerances to meet all commercial or military specifications.

When you need extra stability specify BH6 units in TCO-1 or TCO-2 (single or dual) temperature controlled ovens. This combination will hold frequency within ±.0001% between -55°C and +70°C.

Both BH6 and TCO series units assure top performance with a minimum of weight and space. Both are built to BLILEY standards of craftsmanship, based on nineteen years of leadership in frequency control applications.

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POLARAD
TELEVISION Equipment
for studio • laboratory • manufacturer

SYNCHRONIZING GENERATOR
Model PT 101—Television

FEATURES
• Built-in 6" oscilloscope with synchronized ranges for checking Timing and Video output wave forms.
• External Hi-Q video oscillator for checking output width and rise time.
• Extreme stability, insured by checking all pulses from feed-in of master oscillator pulses.
• Meas for checking synchronizing pulses in odd and even fields.

SPECIFICATIONS
525 line, 30 frames, B/W Synchronizing pulses held to tolerance specified in the NTJPT report of 1945. Output Pulsed: Synchronizing, Video blanking, Camera Blankings, Horizontal Driving Pulses. 2 volts across 100 ohm termination. Dual output jacks. 115 volts 50/60 cps. Complete with tubes.

---

TELEVISION MONOSCOPE
SIGNAL SOURCE
Model PT 102
• Composite Video Signal
• Wide Band Video Amell. 5 volts 50/60 cps
• Dual outputs for feeding 1 or 2, 150 lines
• Black positive or Black negative output
• Resolution greater than 600 lines

INPUT: Vertical and Horizontal Driving pulses. Camera and Kinescope Blankings Pulses.

OUTPUT: Composite Video Signal, 5 volts 100 ohm line 115 volts 50/60 cps. Complete with tubes and including hi and low voltage power units.

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Pilot boat Captain sending written message of arrival of the big ship through Link unit equipped with Sylvania tubes, and in short order...

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Radio-Telefax, a new type of telegraph communication, reports ship arrivals as part of Western Union's Marine Reporting Service.

Out at sea, the captain of the New York Pilot Boat spots incoming liners, writes a message such as "SS QUEEN ELIZABETH INCOMING AT 1644" on a telegraph blank and inserts it in an automatic Telefax transmitter. The unit then transmits it to Western Union over a VHF radio channel. It arrives as a facsimile of the sent message!

And inside this Link equipment, rugged Sylvania tubes, operating smoothly, do their part in this important marine reporting service. Find out more about the complete Sylvania line of Radio Tubes... see your Sylvania Distributor or write Radio Tube Division, Emporium, Pa.

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A tough, horn-like material with high dielectric and mechanical strength. Excellent machinability and forming qualities, great resistance to wear and abrasion, long life, light weight. Sheets, Rods, Tubes, Special Shapes.

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The first fish paper developed for electrical insulation. Strong, smooth, flexible, with excellent forming qualities. High dielectric strength. Sheets, Rolls, Coils.

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---

**TUBES AT WORK (continued)**

Fig. 2—Experimental setup for demonstrating filtering action of VR tube

necessary to limit tube current to a safe value. The resistance is generally selected to permit maximum permissible current thru the VR, say 30 ma, with load disconnected. Its value is calculated by dividing tube current into the voltage difference (supply voltage less tube drop). In the above example, $R = (300 - 150/30 \text{ ma}) = 5,000 \text{ ohms}$.

The supply voltage should be higher than the starting voltage, which is generally about 30 percent higher than the operating voltage. A high supply voltage calls for a high limiting resistor, which aids regulation.

Referring to Fig. 1, with no load (switch open) and $R$ adjusted for maximum permissible current thru the VR150, say 30 ma, obviously both milliammeters, $M_1$ and $M_2$ will indicate the same current of 30 ma. With load rheostat set at full 20,000 ohms and the switch closed, $M_2$ will indicate the load current of 7.5 ma, $M_1$ will decrease from 30 to 22.5 ma, and $M_2$ will read the sum of $M_1$ and $M_4$ or 30 ma. As the rheostat is slowly cut out, $M_4$ will increase at the same rate as $M_4$ decreases, until the VR tube goes out. Then $M_4$ and $M_4$ will read the same, and $M_4$ will be zero.

The more commonly used VR tubes will regulate to within 1 to 3 volts out of 105 or 150 volts, when tube current is varied between 5 and 30 ma. At smaller current variations, voltage regulation will naturally be better.

Since VR tubes will regulate against very rapid current fluctuations, they will also regulate against a-c ripple voltage, which may be likened to a periodic current variation. The use of VR tubes on a poorly filtered power supply frequently produces results ordinarily obtained through the use of an additional section of filter. The
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- Electronic Computers
- Differential Analysers
- Frequency Determining Circuits
- Bridge Standards, etc.

**Characteristics**

- LOW DIELECTRIC ABSORPTION: -.01-.02% residual
- LOW DISSIPATION FACTOR: -.0002-.0003 at 1 Mc
- CONSTANT Q and CAPACITANCE
- HIGH INSULATION RESISTANCE: $10^4$ ohms/mfd. average
- NEGATIVE TEMPERATURE COEFFICIENT: minus 400-500 ppm/°C.

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>LAG101</td>
<td>.0001</td>
<td>19/32x1 3/16&quot;</td>
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<tr>
<td>LAG201</td>
<td>.0009</td>
<td>19/32x1 3/16&quot;</td>
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<td>.0005</td>
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</tr>
<tr>
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<td>.001</td>
<td>19/32x1 3/16&quot;</td>
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<td>.005</td>
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<td>LAG103</td>
<td>.01</td>
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<tr>
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</tr>
<tr>
<td>LAC505</td>
<td>5</td>
<td>6x3 3/4x4 9/16&quot;</td>
</tr>
</tbody>
</table>

**Type** LAG—Glassmike style. Type LAC—Rectangular metal can.

Specify Tolerance—Std.—2%, 5%; 1% to order.

RATED VOLTAGE—500VDC. Resistance and absorption readings taken at 200 VDC.
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filtering action of VR tubes may be easily demonstrated by a simple experiment, Fig. 2.

With all load resistance in the circuit, and the VR tube glowing, a faint hum may be heard in the phones. As the 10,000 to 15,000-ohm rheostat is decreased, a point will be reached where the glow will disappear, at which time the hum in the phones will increase considerably. Measurements with any a-c vtvm capable of reading a few millivolts will show approximately a hundred-fold reduction in ripple, when measured across the power supply and then across the VR tube.

One method of checking VR tubes amounts to an examination of the voltage-current characteristic by varying tube current while noting the change in voltage drop across the tube, Fig. 3A. While the current is varied between 5 and 30 ma, tube drop may change from 153 to 150 volts. Unless a large, open-scale voltmeter is used it may be difficult to see this small change. Greater accuracy may be obtained by inserting a fresh B battery of 135 volts in series with the voltmeter and in opposition to normal current flow, to buck out all but some 15 volts. A low-range vtvm may then be used, when a differential of 2 or 3 volts will be more readily noticeable.

The second method of checking VR tubes takes advantage of the fact that the filtering action of the tube goes hand in hand with regulating ability. An average VR105, for instance, regulates better than the average VR90; it also attenuates ripple better. A simple circuit,
British fabricated up to stringent British standards, BRIMAR Radio Valves bring the highest degree of uniformity and reliability to a receiver specification and into the replacement field.

---

**BRIMAR**

Tubes for Radio Receivers

---

**MINIATURE RANGE**

<table>
<thead>
<tr>
<th>1R5</th>
<th>15A</th>
<th>15S</th>
<th>1T4</th>
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<th>3S4</th>
<th>3Q4</th>
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<td>6C4</td>
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<td>12AT7</td>
<td>12AU7</td>
<td>12BA6</td>
<td>12BE6</td>
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**LOCK-IN RANGE**

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<th>7Z4</th>
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**OCTAL RANGE**

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<th>5U4G</th>
<th>5V4G</th>
<th>5Y3GT</th>
<th>5Z4G</th>
<th>6A8G/GT</th>
<th>6B4G</th>
<th>6B8G/GT</th>
<th>6C5G</th>
<th>6F4G</th>
<th>615G GT</th>
<th>617G GT</th>
<th>6K7G GT</th>
<th>6K8G/GT</th>
<th>6L6G</th>
<th>6AG6G</th>
<th>6N7GT</th>
<th>6Q7G/GT</th>
<th>6R7G</th>
<th>6SL7GT</th>
<th>6SN7GT</th>
<th>6USG</th>
<th>6U7G</th>
<th>6V6G GT</th>
</tr>
</thead>
</table>

**U.X. RANGE**

<table>
<thead>
<tr>
<th>2A3</th>
<th>6A3</th>
<th>6A7</th>
<th>6B7</th>
<th>6C6</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>42</td>
<td>43</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
If you have a fabricating or processing problem involving paper... if you require definite technical characteristics and, above all, *dependable uniformity*, it may be worthwhile for you and MOSINEE technicians to get together. MOSINEE is not interested so much in terms of volume production as in our ability to render helpful service to manufacturers in the field of electronics and in the electrical goods industry. Our "paperologists" are at your service for consultation. Please write Dept. E.

**FIG. 4**—Circuit diagram of simple VR tube checker. Use is made of internal jumpers to complete circuits.

Fig. 3B, illustrates this type of VR tube checker.

A VR tube checker with a small self-contained power supply was constructed, and more than 100 various VR tubes were checked to demonstrate its usefulness. As shown in the schematic of Fig. 4, a separate socket for each type was installed. Advantage was taken of the built-in jumper within the tubes to complete both the power circuit and the metering circuit. Limiting resistors were adjusted to pass exactly 15 ma thru any type of VR tube during test.

Only one tube was tested at one time, by plugging it into the appropriate socket, and reading the hum in millivolts on a Ballantine a-c vtv. The double-throw pushbutton enabled reading the power supply hum voltage ahead of the VR circuit. Since the power supply hum voltage remained constant at 2.25 volts, the push button was not often used.

The results of these comparative checks which are listed in Table I, show that good tubes had low ripple and were constant in the value of ripple. Defective tubes showed a high ripple and in addition some of these had wide fluctuations in ripple output, in one case 30 to 80 mv. This last group was seen to flicker, due to periodic changes in the areas where the glow took place.

Some of the tubes tested, particularly the OA 2 series, were defi-
ANOTHER NEW TYPE IE HAS BEEN ADDED TO THE FAMILY OF STABILINE VOLTAGE REGULATORS

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TYPE IE51005

A new 500 VA voltage regulator, delivering a constant output voltage regardless of variations in input voltage or load current. “Type IE” indicates this STABILINE is Instantaneous Electronic. This means completely electronic operation — no moving parts to get out of order and it gives the fast speed of correction available only when no moving parts are involved. STABILINE Type IE51005 is available as a cabinet model or for rack mounting. It has the same superior characteristics as other STABILINES well-known in the electrical industry for their quality of workmanship and performance.

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Input Voltage Range: 95 to 135 volts. Output Voltage Range: Adjustable between 110 and 120 volts. Rated Output: 0-500 volt-amperes. Frequency in Cycles: 60 ± 10%. Load Power Factor Range: 0.5 lagging to 0.9 leading. Waveform Distortion: never exceeds 3%. Stabilization: ± 0.1 of 1% of the preset value. Regulation: ± 0.15 of 1% of the preset value. Recovery Time: 3 to 6 cycles.

REAR VIEW

Here’s compact, well-organized construction of IE51005, built to give long, trouble-free service.

CIRCUIT DIAGRAM

Operating circuit and components of the new 500VA STABILINE.
Designers, engineers and manufacturers of equipment calling for automatic timing find Haydon experience and practical knowledge of great value in solving timing problems. Many reset or repeat cycle timing obstacles which seem complex can be solved by application of one of the above units without variation. Sufficient volume will warrant development of tailor-made devices. Custom-built Haydon units feature simple design and low cost standard components.

Write to Haydon at Torrington, leader in the field of electric timing devices. Send full details including cycle chart, duty requirement, space limitations, voltage, frequency and unusual operating conditions. Engineering catalog available on request.

WRITE 2416 ELM STREET, TORRINGTON, CONNECTICUT

TUBES AT WORK (continued)

Table I—Results of Tests on 100 VR Tubes

<table>
<thead>
<tr>
<th>Tube Type</th>
<th>Good Tubes (as low as)</th>
<th>Bad Tubes (as high as)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OA2</td>
<td>25 mv</td>
<td>18 mv 80 mv</td>
</tr>
<tr>
<td>VR150</td>
<td>19 mv</td>
<td>12 mv 45 mv</td>
</tr>
<tr>
<td>OB2</td>
<td>11 mv</td>
<td>7 mv 25 mv</td>
</tr>
<tr>
<td>VR105</td>
<td>13 mv</td>
<td>10 mv 23 mv</td>
</tr>
<tr>
<td>VR90</td>
<td>36 mv</td>
<td>28 mv 60 mv</td>
</tr>
<tr>
<td>VR75</td>
<td>17 mv</td>
<td>15 mv 24 mv</td>
</tr>
</tbody>
</table>

Closely spaced small objects are accurately counted by this new narrow-beam count detector in conjunction with standard electronic counter.

New Count Detectors

Electronic counter circuits have been discussed at length in the literature (ELECTRONICS, June 1944, March 1947). These circuits, because of their simplicity and dependability, are finding more and more applications, a few of which are described below.

Basically, there are two general classifications of count detectors for electronic counters, namely, photelectric and electromagnetic. Hitherto, the counting of extremely small objects with photovoltaic detectors required the pieces being

nitely known to be defective, as they were removed from equipment for that reason. Most of these had been overloaded considerably, which accounts for the high average ripple in the OA2 series.

The rest of the averages bear out tube handbook data, particularly that the VR105, and its miniature counterpart, the OB2, appear to be most efficient.
The number of sheets in a pile of paper is rapidly and accurately determined by brushing this sapphire stylus over serrated surface formed by riffling pile counted to be spaced widely, and this was not always practical and sometimes impossible.

A new high-resolution photoelectric count detector has been developed by the Potter Instrument Company of Flushing, New York. It has a beam width of only \( \frac{1}{16} \) inch, and a change in light intensity of 20 percent will actuate the circuit. In the accompanying photograph the device may be seen counting closely-packed paper cups. The light source is placed immediately beside the detector and so positioned that the reflection from the edges of the cups falls on the detector.

This system is applicable wherever closely-spaced objects are to be counted. The surface need only be rough enough to cause a 20-percent reflected light change in the \( \frac{1}{16} \)-inch beam.

The Machlett Dynamox "25" unit for diagnostic work represents the highest development of the rotating anode principle whereby the loading capacity of an X-ray tube is greatly increased.

The control equipment incorporates a special Haydon time delay relay using a 1600 series motor with magnetically operated gear shift; which is employed in connection with the Dynamax motor control circuit. This timer insures an accurate time delay between energizing the motor and exposure, while preventing exposure if connections to motor are broken or reversed.

This Haydon application story is but one of many in diversified industry ... each playing an important part in assuring accurate and dependable timing for greater operating efficiency. If it's about time ... consult Haydon engineers. Free catalog available on request.

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in designing new equipment?

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LINDE synthetic sapphire is characterized by a low coefficient of friction, high melting point and hardness, and unusual chemical resistance. Applied in many diverse problems, it has paved the way for a longer trouble-free life, for both small and large parts.

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The term "Linde" is a trade-mark of The Linde Air Products Company.

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TUBES AT WORK (continued)

inch detector beam area.

The disadvantage of having to feed objects past a counting point one at a time has also been removed. A device which is capable of resolving and totalizing as many as ten simultaneous counts is shown counting screws. Counting rates as high as 6,000 per minute are made possible by dropping the screws through holes which are viewed by 10 parallel phototubes.

An extremely handy method of counting stacked sheets of paper is illustrated in the accompanying drawing. To find out how many sheets a particular pile of papers contains, the pile is riffled, and a sapphire-tipped stylus is brushed across the serrated surface thus formed. This stylus is mechanically linked to an iron armature which varies the reluctance of a magnetic circuit each time the stylus bumps from one sheet to the next.

Flush-Mounted Aircraft Antennas

To REDUCE AERODYNAMIC DRAG due to radio antennas on aircraft flying at very high speeds, the Air Materiel Command has found it necessary to mount antennas inside the airplane structures. The first result from experiments with this
problem was the development of the “pick-ax” antenna which is flush mounted in a plastic cap on the airplane's vertical stabilizer. Similar installations for command communications are now being specified for many types of aircraft.

Instrument-approach and radio-compass antennas for high-speed bomber and fighter aircraft are also being moved inside the airplane. Several different types of internal installations are shown in the accompanying drawing.

For larger planes, where as many as nine antennas are required, practically all fuselage, wing and empennage extremities may be used to house antennas. Flight tests have proved that such installations perform as well or better than exterior antennas.

Infrared Checks
Capacitor Leakage

A NEW application of infrared radiation is that of detecting leakage in metal-cased capacitors, as practiced at the Coventry works of the British Thomson-Houston Co. Ltd.

The capacitors are first placed in a degreasing bath to ensure that the outer casings are completely free from any traces of the petroleum jelly with which they are filled. A wire-mesh conveyor belt then carries them in two rows, at a speed of 18 inches per minute, into the infrared oven where they

The outstanding characteristic of the Model 305 Electronic Voltmeter is its ability to provide absolute indication of transient or pulse voltages of short duration. Reliable indication of pulses a few microseconds wide repeated only 10 times per second is readily obtained with this instrument. The Voltmeter is pre-calibrated, compact, easy to operate and observe. Positive and negative peaks are registered over the range of .001 volt to 1000 volts, peak to peak. Decade ranges and a logarithmic scale output meter are characteristic features, along with a separately available high gain, wide-band amplifier.

Send for Bulletin No. 12

BALLANTINE LABORATORIES, INC.

BOONTON, NEW JERSEY, U. S. A.
In this vacuum furnace, engineered and built by National Research Corporation, Cambridge, Mass., ultra-high quality brazing of large electronic tube components is accomplished in a vacuum of less than one micron — 1/760,000th normal atmospheric pressure! Kinney Vacuum Pumps, working with diffusion pumps, have made possible this outstanding achievement in industry — brazing without oxidation under extremely low absolute pressures.

The high volumetric efficiency of Kinney Vacuum Pumps assures extremely fast pump down and very low absolute pressures. Kinney Vacuum Pumps are ideal for exhausting lamps or tubes, sintering metals, dehydrating oil or food products, and coating lenses. They are entirely dependable on all types of vacuum processing systems and require minimum attention and maintenance. Perhaps low pressure processing with Kinney High Vacuum Pumps can improve your product and reduce its production cost. Kinney Single Stage Vacuum Pumps test to low absolute pressures of 10 microns ... Compound Pumps to 0.5 micron. Bulletin V45 gives complete information.

THREE-SPEED PLAYER

Two pickup arms and a speed-adjustable motor permit this record player to handle conventional records, as well as those of Columbia and RCA Victor. The large diameter hole of the latter is accommodated by a brass collar that slips over the normal spindle. Developed by Scott Radio Laboratories, Inc., of Chicago, the player is automatic on 78-rpm disks and manual on long-playing types.
New York City. The following is an abstract of the information presented in that paper.

**Introduction**

A good picture should appear to the eye to have a contrast range of approximately 30 to 1. This means that the highlights of such a picture, when viewed with surrounding illumination, should be about 30 times brighter than the darkest shade obtainable at the same time.

Paintings, drawings and photographs usually display deep satisfactory shades of blacks since the dyes, paints or printing inks employed for black are extremely light absorbent, thus ensuring adequate contrast range. Regardless of the amount of light directed onto a photograph or painting, the contrast range remains the same.

Motion pictures and television derive their blacks from an absence of light and hence cannot present darker shades than those determined by the surrounding light. In order to approximate the contrast range of the original scene, the highlights of these images have to be many times brighter than the ambient room illumination. Motion picture projectors are unable to furnish this extra brightness and, therefore, the pictures must be viewed in the dark. Television pictures, however, are generally viewed in normally lighted rooms. Let us examine what happens to television images under such conditions.

The light reflected from the walls of the average artificially-lighted room is seldom in excess of 5 foot lamberts. Allowing for reflection loss, this also represents the maximum highlight brightness of the pictures and photographs on the walls of such a room. During the day, with natural illumination, the brightness values are higher. It is safe to assume that television would rarely be viewed in rooms where the illumination of the area surrounding the receiver would be more than 20 foot lamberts.

The majority of the current black-and-white direct-viewing television receivers, when located in rooms where the ambient illumination is 20 foot lamberts, reflect approximately 15 foot lamberts from

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**5,348 RELAY TYPES**

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<table>
<thead>
<tr>
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<th>Large Power Types</th>
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<tr>
<td>&quot;Memory&quot; types</td>
<td>Industrial motor reversing</td>
</tr>
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<td>(mechanical latch, electrical reset)</td>
<td>Time delay (inertia, motor-operated and thermal)</td>
</tr>
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<td>Sensitive low power</td>
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<td>Instrument controlled</td>
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<tr>
<td>Polarized</td>
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<tr>
<td>Vibration resistant</td>
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</table>

Sequence (ratchet and multipole)
Close differential
Overload
Telephone auxiliary signaling combinations
DB timers for continuous processes
their screens. In order to obtain a contrast range of 30 to 1 in pictures produced by these receivers, the necessary highlight brightness would have to be 15 x 30, or 450 foot lamberts.

It is quite conceivable that commercial direct-view type receivers some day will be capable of furnishing a highlight brightness of 450 foot lamberts. It is doubtful, however, that this would be a satisfactory solution, since viewing such a bright image without a correspondingly bright surrounding would be uncomfortable. Assuming that the presently used field repetition rate of 60 per second were employed, such a picture would, in addition, display objectionable flicker.

Actually, many receivers do not furnish more than 30 foot lamberts measured on a blank raster. Thus, with an ambient illumination of 20 foot lamberts, the maximum contrast range will not be in excess of 3 to 1 (the ratio of the maximum highlight brightness of 30 plus 15 foot lamberts to the reflected ambient light of 15 foot lamberts). If one wished to obtain a contrast range of 30 to 1 with these receivers, the reflected illumination from the screens would have to be not more than one-thirtieth of the maximum highlight brightness, or 1 foot lambert.

For adequate image recognition, contrast range is thus more important than mere brilliance. This is substantiated by the curves shown in Fig. 1 and 2, which show that increasing image brightness beyond about 2 foot lamberts has little effect on contrast discrimination and visual acuity.

Figure 1 illustrates how visual acuity varies with brightness. A visual acuity of 1.0 represents the capacity of the eye just barely to resolve detail which occupies one minute of the visual angle, which corresponds to a resolving power of 20/20. The test object used in

---

**MEMO**

For more than 50,000 hours since 1941 when these two C65 tubes were installed at the S. E. Woodrich Company's Akron, Ohio plant, they have operated without attention to control the speed of a 30 HP motor. Well over half of this time has been under load.

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---

**FIG. 1**—Curves showing effect of increasing brightness on visual acuity
plotting this curve was a gratifying exercise as applied to three different brightnesses as applied to three different sizes of test areas. The relative position of the three different curves shows the inverse ratio between object size and required contrast for perception.

Experimental Set-Up

To determine experimentally the validity of the above theories, the simple test set-up shown in Fig. 3 was used at the CBS laboratories to determine the effect of trading higher brightness and low contrast range for lower brightness and high contrast range, by the use of a 5 percent-transmission neutral density filter placed in front of a 15 x 20-inch screen on which colored picture slides were projected.

Without the neutral density filter, the projected color picture had a highlight brightness of 60 foot lamberts and contrast range was about 13 to 1. With the filter in front of the screen, the highlight

---

FIG. 3—Simple test setup used at CBS laboratories to determine effect of neutral density filters for typical observers.

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brightness was reduced to one-tenth of its original value, or roughly, 1 foot lambert. As a result the contrast range was trebled and became 40 to 1.

In each test, picture highlight brightness was adjusted to measure 60 foot lamberts without the filter. Of a total of 49 observations, 43 resulted in preference for the picture with the filter, while the remaining 6 indicated no preference. Not one observer reported preference for the picture with greater brightness but less contrast.

Experiments with visual acuity and with contrast recognition have shown that both reach their optimum for a given brightness when the surrounding illumination is about the same as the locally illuminated area. A surrounding which is too bright or too dim tends to decrease the effectiveness of the visual functions.

In the CBS color television system, color filters in front of the cathode-ray tube reduce highlight brightness from 200 foot lamberts (at the screen) to 20 or 25 foot lamberts. This loss of light is, however, compensated for to a large extent by greatly improved contrast range in the presence of ambient illumination.

From the aforesaid, it is evident that in the presence of surrounding illumination, improved picture rendition can be provided in direct-viewing black-and-white receivers through the use of neutral density filters. These filters may be thin layers of cellophane, or any other suitable light-absorbing material. This process of improving rendition through reduction of picture brightness appears to be paradoxical, and for that reason is misunderstood frequently.

Copper in Electronic Tubes

By R. Carson Dalzell
Chief Technical Advisor, Revere Copper and Brass, Inc.
New York, N. Y.

COPPER plays an important role in electronic tubes, hence a knowledge of its general properties assists one in understanding the electrical and mechanical characteristics of tubes. Furthermore, although only the few engineers who are directly con-
concerned with tube design need be familiar with tube materials in detail, equipment designers can make fuller use of tubes and appreciate better what special features can and cannot be built into them with the present state of the art if they know more about the materials of which tubes are made.

Properties of Copper for Tubes

Because electronic tubes are evacuated either permanently or prior to being filled with special gases, they must be made of materials that are as free from deleterious gas as possible.

Oxygen-free high-conductivity (OFHC) copper is uniformly dense and relatively free from porosity so that it neither permits air to enter a tube made from it nor complicates exhaustion. The high purity and uniformly small grain size of this copper minimize the likelihood of faults at copper-glass seals and give high electrical and thermal conductivity. It may be drawn, spun, formed, rolled, cold extruded, turned, milled and shaped. All of these techniques are used in tube fabrication to obtain the wide variety of shapes needed.

Because this copper forms an adherent and uniform oxide that the glass of a seal can wet, it produces vacuum-tight seals. It is sufficiently ductile so that, in forming seals by the Housekeeper or modified Housekeeper methods, it is unnecessary to match the coefficient of thermal expansion of the glass and the copper. This copper also brazes well so that vacuum-tight soldered
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**THE ELECTRON ART**

(continued)

Two types of pipe seals: (above) coaxial press seals and (below) feather edge seals for magnetron filament leads.

Joints can be made between the copper of a glass seal and other metal parts of a tube. The copper can be cleaned by standard methods and also has low vapor pressure at high temperatures and under vacuum as it does not contain impurities that would boil off during pumping and poison the cathode. Other grades of copper are apt to become embrittled by exposure to the gas flame used in making the copper-to-glass seal or during brazing.

**Common Types of Seals**

There are three common basic types of seals, each of which has its particular applications: (1) pipe or lead seals, (2) disc or ribbon seals and (3) seals to external anodes.

The filament connections to magnetrons illustrate the pipe-type seal. For these seals the leads are made of OFHC copper rod, to which flexible leads can be attached if needed. The rod is oxidized and the softened glass pressed about it in a glass lathe. Another form of pipe seal is made by first drilling an accurately centered hole in the rod, through which the lead will pass. The end that is to fit into the magnetron anode block is threaded and the outside diameter turned down. Then a cone is fastened at the other end by turning, rolling or spinning on a mandrel. This produces a feather edge that is only 0.0015 to 0.0025 inch thick, to which the glass is
Disc seals such as in this T.R tube are possible because of the thinness and ductility of the copper sealed. Tubing might be used in place of rod, but its use would limit the latitude of design. However, by turning the parts from appropriately sized tubes and brazing them together, machining and scrap costs can occasionally be reduced.

At ultrahigh frequencies, seals that permit direct passage of the electric fields are used. A typical example is the disc or ribbon seal in klystrons and T-R tubes. They are made of OFHC copper with a deep-drawing temper by first stamping wrinkles in the disc to permit expansion and contraction under heating and cooling and then by finish-drawing to final shape. To retain the small grain size and prevent excessive work hardening during drawing, it is necessary to anneal the copper between drawings. Small grain size in this application is important because it gives a smooth (low-resistance) surface. The copper part of the seal is very thin, about 0.001 inch, and so can be buttscaled effectively to the glass.

In high-power transmitting tubes the anode forms a part of the external tube envelope so that it can be cooled. Copper that is nonpor-

Tube parts can be machined from solid copper or built up and brazed together from smaller pieces.
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Once the copper part has been shaped for the seal, it is chucked on one spindle and the glass tubing on the other of a glass lathe. As both parts revolve, multiple jets of utility gas, air and oxygen are played on the main body of the copper part. The tapered feather edge, which is very thin and susceptible to oxidation, heats by conduction from the main body. The glass part is next heated until it becomes plastic. The two parts are moved together until they fuse to form the seal.

The oxidizing flame that heats the parts forms a uniform layer of oxides on the copper, the cuprous oxide acting as wetting agent for the glass and at the same time adhering strongly to the base metal. A carbon spatula and air pressure can be used to shape the glass for the seal. To clear the copper before beginning the seal or if excess oxide is formed, a solution of acetic acid and sodium chloride is used.

Disc seals can be formed in several ways. The disc and glass can be jigged inside a glass cylinder containing an inert gas (CO, or N₂) and induction heated, the glass adjacent the copper heating sympathetically. In this method either a borated or a preoxidized copper disc is used. This technique avoids the need for removing excess oxides from the disc after the seal is formed. Another technique is to pass a preoxidized disc, on which

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End seal being made in glass lathe illustrates technique whereby pipe and external anode seals are made.

powdered glass has been placed, through an oven to form a glass nub to which the glass of the tube can later be joined in a glass-glass seal.

Press leads at the outer end of filament pipe tubulations are made with borate wire. External anode seals are made in a glass lathe with gas heating or on a jig with induction heating.

Whereas large anode blocks for magnetrons and the like were initially machined from solid copper blocks, it is simpler and quicker in production to build them up by brazing stamped parts together. Alternate stampings are made of different outside diameters to provide radiating fins. To braze the parts they are placed in fixtures interspersed with silver solder wire or gaskets and passed through reducing-atmosphere furnaces. Capillary action makes the solder flow between the copper parts. For this method of fabrication eutectic silver, a silver-copper alloy, is usually used.

Metal-Wall Picture Tube
Registration of the new 16-inch metal-wall television picture tube as type 16AP4 has been announced by the RMA Data Bureau simultaneously with release of defining data as set forth here and in the accompanying diagram.

The tube has a white P4 screen of medium persistence, and uses magnetic focusing and deflection along with a magnetic ion trap. Heater requirements are 6.3 volts...
Dimensional specifications and basing diagram of type 16AP4 tube.

NOTE 1: Reference line is determined by position where hinged gauge 1.500" + 0.003" - 0.000" I.D. and 2" long will rest on cone.

NOTE 3: Distance to internal pole pieces. Line through pin No. 6 and tube axis passes through line joining centers of pole pieces. Direction of principal field of ion-trap magnet should be such that North Pole is adjacent to pin No. 6 and South Pole to pin No. 12.

NOTE 4: Location of deflecting yoke and focusing coil must be within this space.

NOTE 5: Keep this space clear for ion-trap magnet at 0.6 amp. Maximum ratings are: $E_v = 14$ kv; $E_{et} = 410$ v; $E_{et} = -125$ v. Typical operating values are: $E_v = 12$ kv; $E_{et} = 300$ v; $E_{et} = -33$ to $-77$ v.

New Microwave Triode

ALTHOUGH the present New York to Boston microwave radio relay system using velocity-variation tubes can be extended to somewhat longer distances without appreciable distortion, it is fairly certain that severe amplitude and phase distortion would occur if a coast-
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For descriptive literature write 115-1

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April, 1949 — ELECTRONICS
to-coast linkage were attempted. Moreover, the required equalizer networks would be difficult and costly to apply. This situation is due to a fundamental limitation on the amount of bandwidth and gain obtainable with klystrons. Realization of this led to the development of a new close-spaced planar triode for 4,000-mc operation. Technical details presented here are based on papers presented by J. A. Morton and R. M. Ryder of Bell Labs at a New York City IRE Section Meeting and at the AIEE Winter General Meeting.

**Triode Design Limits**

In a triode the upper transconductance limit of approximately 11,000 micromhos per ma is reached when cathode and grid are so close that the electron velocity produced by the grid voltage is small compared to the average Maxwellian velocity of the cathode emission. Ordinary microwave triodes are still a factor of 20 to 25 below this limit.

By translating the known requirements on gain, bandwidth and power output into specifications on the actual triode dimensions, it was found that the input spacings of existing commercial planar triodes had to be reduced by a factor of about five times and cathode emission densities had to be increased by about 3 to 4 times. A tube design was then evolved in which the required close spacings could be produced to close tolerances by methods that do not require specialized laboratory skills.

**Tube Construction Details**

For comparison, Fig. 1 illustrates the electrode spacing of the new BTL 1553 tube and a commercially available microwave triode. The cathode oxide coating of the new tube is 1 mil thick, grid-cathode spacing is 6/10 mil, grid wires are 3 mil in diameter wound at 1,000 turns per inch and the grid-anode spacing is 10 mils.

The cathode subassembly is illustrated in Fig. 2A. The nickel cathode core is mounted in a ring of low-loss ceramic in such a manner that the nickel and ceramic surfaces may be precision ground flat and coplanar. A four-legged molyb-

---

**ADC Quality Wins Again**

An important part of Western Union's nationwide plant mechanization program is the new Type 20 FM Carrier Channel Terminal equipment. Designed to provide telegraph message channels for the interconnection of telegraph offices, this new equipment was ordered in large quantities from the Radio Corporation of America in the fall of 1946. ADC was chosen to provide the transformers and inductors—over 85,000 coil assemblies were produced by ADC under rigid specifications and on individual test inspection only 14 were rejected.

**Series 550-50 Transceiver**

When Western Union recently ordered additional quantities of this equipment, Radio Corporation of America again won the contract award and ADC was again chosen for the transformers—inductors.

**Series 550-50 Tuner**

The accompanying photographs show three of the principal components of Western Union's Type 20 FM Carrier Channel Terminal equipment.

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from the cathode to the shell of the bulb.

The final assembly is shown in Fig. 3. The grid-cathode by-pass assembly is inserted into the preformed Kovar-7052 glass bulb and the press carrying the heater is welded to the cathode can. The grid-anode spacing of 10 mils is easily obtained by means of the adjustable anode plug.

**Electrical Performance**

Characteristics for the type 1553 triode are given in the accompanying table. At a plate current of 25 ma, the transconductance per milliampere is about 2,000, or one fifth

**Characteristics of 1553 Microwave Triode**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-Frequency Characteristics (10-percent tolerance)</td>
<td></td>
</tr>
<tr>
<td>$V_g$</td>
<td>250 V</td>
</tr>
<tr>
<td>$I_p$</td>
<td>25 ma</td>
</tr>
<tr>
<td>$g_m$</td>
<td>10,000 μmhos</td>
</tr>
<tr>
<td>$r_p$</td>
<td>10,000 ohms</td>
</tr>
<tr>
<td>$C_{pg}$</td>
<td>0.005 μf</td>
</tr>
<tr>
<td>Amplifier at 4,000 mc (bandwidth 80 to 100 mc)</td>
<td>70 watts</td>
</tr>
<tr>
<td>Class A Gain</td>
<td>10 db</td>
</tr>
<tr>
<td>Class B Gain</td>
<td>6 db</td>
</tr>
<tr>
<td>Modulator (65 to 4,000 mc)</td>
<td>70 watts</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>60 to 80 mc</td>
</tr>
<tr>
<td>Gain</td>
<td>20 db</td>
</tr>
<tr>
<td>Power output</td>
<td>70 watts</td>
</tr>
<tr>
<td>Local oscillator power</td>
<td>150 milliwatts</td>
</tr>
</tbody>
</table>

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of the theoretical upper limit. At lower currents this figure is higher; at 10 ma it is 3,000.

One stage of class-A amplification using simple resonant cavities and coupling windows will provide 7 to 10-db gain at 4,000 mc over a 3-db-down bandwidth of 80 to 100 mc.

A new amplifier circuit has recently been developed which provides considerably greater gain-band products with the 1553 triode in the 4,000-mc range. For example, gains of 8 db at bandwidths of 200 mc for a gain-band product of 1,250 mc have been obtained.

The tube also works well as a harmonic generator. It has produced enough power for use as a 4,000-mc transmitting oscillator from a chain of multipliers beginning with a piezoelectric crystal oscillator at 40 mc. The last stage of this array is a 1553 doubler going from 2,000 to 4,000 mc with a gain of from 0 to 3 db at an output level of 300 milliwatts.

SURVEY OF NEW TECHNIQUES

An automatic message accounting system that will be extended to other central offices has been installed in the Philadelphia area of the Bell Telephone System. In operation, the equipment first determines the type of message rate for the call. A tape perforator records the numbers of the calling and called parties and the time the call begins and ends. The tape is

Tape punching equipment records a coded pattern for calling and called numbers, month, day and time to tenths of minutes at which each conversation begins and ends.

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Your apparatus can have higher electrical stamina . . . longer operating life . . . if insulated with Westinghouse "Tuffernell" Insulating Varnishes.

Outstanding among these new varnishes are Tuffernell B-161, B-163, and B-165. All are thermosetting; and each has specific properties of high resistance to heat . . . moisture . . . centrifugal force . . . and to other enemies that break down ordinary varnishes.

It is because of these properties that Baker-Raulang, of Cleveland, chose Tuffernell B-163 for their well-known line of industrial trucks, tractors, and cranes. They like B-163's deep penetration of windings, giving better heat transfer and cooler-running motors. They have found, too, that B-163 is economical and faster to use, and stands up in rugged service.

The complete Tuffernell line includes Insulating Varnishes and Compounds for your application. All are described in Bulletin 65-120, available on request.

Investigate Tuffernell today for your needs. Call your nearby Westinghouse office, or write Westinghouse Electric Corporation, Dept. 34, P.O. Box 868, Pittsburgh 30, Pennsylvania.

J-06418

Westinghouse

TUFFERNELL INSULATING VARNISHES

—for every electrical need

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then transferred to the accounting office where another machine tabulates the stored data ready for billing. Like the dial system, this equipment is a stride in reducing telephony to an entirely automatic basic.

Rural radio receivers in Russia are being powered by wind-driven generators. The present sets that are in production at a Moscow factory, each of which operates hundreds of loudspeakers and has provision for a record player and microphone for reproducing speeches at collective farm meetings, are too powerful for average collective farm communities. Accordingly, factory engineers have designed a compact set the 6-8 volt generator of which is driven by wind vanes of 7-feet diameter. Storage batteries float on the line to operate the receiver, which has a 3-watt output for operating 30 to 40 loudspeakers, and lighting. This receiver is undergoing laboratory testing prior to organization for mass production.

Magnetic recording techniques are used to simplify operation of motion picture equipment on location in a new RCA recorder (Model PM-61). The unit is a modification of a photographic recorder. Although it employs standard size 35-mm film, one side of the film is coated with iron oxide powder. Immediate playback is thus possible; the life of the record is virtually limitless.

Magnetic recording makes possible this portable film sound recorder for use on location, which has reduced size and weight over comparable optical equipment. Unit at lower center houses both recording and playback heads.
NEW PRODUCTS
(continued from p 134)
comprises a mount casting and attaching bracket supporting a motor and magnetic clutch for the magazine take-up drive. For users who desire continuous viewing of the c.r. tube screen during recording, there is now available a binocular split-beam viewer equipped with a special color-selective filter that obviates the danger of fogging film when a P11 screen is used.

Graphic Sound Recorder
Sound Apparatus Co., Stirling, N. J. Model FRA direct ink-recording instrument plots a curve of any changing measurable quantity that can be converted into a d-c or a-c voltage. Ranges can be recorded on either a linear or logarithmic scale. The unit illustrated is available in

Electronic Gas Filter
TRION, INC., 1000 Island Ave., Mckees Rocks, Pa. Unit 11594 is a new electronic gas filter to enable steel mills to clean the coke oven gas that accures as a by-product in

NEW!... R. F. AND VIDEO COMPONENTS FOR PRECISE CONTROL

R. F. FIXED ATTENUATORS
TYPE RF-155
CIRCUIT: 1 network.
IMPEDEANCE: 50 ohms.
LOSS: 5 to 20 DB.
ACCURACY: ± 4% at D.C.
IMPEDEANCE ACCURACY: Same as series RF-540

R. F. VARIABLE ATTENUATORS
SERIES RF-540
CIRCUIT: 1 network.
IMPEDEANCE: 50 ohms.
NO. OF STEPS: 4 (push-buttons.)
RESISTOR ACCURACY: ± 2% of D.C.
IMPEDEANCE ACCURACY: Terminal impedance of loss network essentially flat from 0-225 MC.
LOSS:
Type RF-540—1, 2, 3, 4 DB (10 DB total.)
Type RF-541—10, 20, 20, 20 DB (70 DB total.)
Type RF-542—2, 4, 6, 8, DB (20 DB total.)
Type RF-543—20, 20, 20, 20 DB (80 DB total.)

SUGGESTED APPLICATIONS
- In signal generators.
- In field strength measuring equipment.
- Nuclear and atomic research.
- Television receiver testing.
- Wide-band amplifiers.
- Pulse amplifiers.
- Any application where attenuation of UHF is required.


THE DAVEN CO.
191 CENTRAL AVENUE
NEWARK 4, NEW JERSEY

ELECTRONICS — April, 1949

www.americanradiohistory.com
The Model 53 Breaker-type D.C. Amplifier was developed for the measurement of d.c. and low frequency a.c. voltage in the microvolt and fractional microvolt region. It is compact, portable, and makes an excellent replacement for the suspension galvanometer. The output of the amplifier is sufficient to operate standard meters and recording devices directly.

Among the advantages of this amplifier are the following:
1. Noise level that approaches the theoretical limit imposed by Johnson noise.
2. Extremely low zero drift (less than .005 µV after warmup).
3. Freedom from the effects of vibration such as found in moving vehicles.
4. Response characteristics permitting overall amplification flat from 0 to 10 cycles per second.
5. Reliability, as demonstrated by units which have been in continuous operation for several years.

THE PERKIN-ELMER CORPORATION
Dept. 53, GLENBROOK - CONNECTICUT

TOROIDS — Cased and Uncased

Closetolerance toroids from 3/4 in. o-d up. Wound to the rigid requirements of Lenkurt Carrier Systems, they can be made accurate within 0.1 per cent. Available to specifications with emphasis on magnetic and temperature stability.

Made with two balanced windings, tapped or untapped, impregnated or not, as required. Also available with close-coupled secondaries for impedance-matching applications. Write for further data:

LENKURT ELECTRIC CO.
SAN CARLOS • CALIFORNIA

Lenkurt knows how

EASTERN AIR DEVICES, INC.
585 DEAN ST., BROOKLYN 17, N.Y.
DESIGNERS AND BUILDERS OF STANDARD AND SPECIAL ROTATING EQUIPMENT

April, 1949 — ELECTRONICS
NEW PRODUCTS (continued)

the manufacture of coke. Power requirements are 11 kw, either 110 or 220-volt, single-phase, 60-cycle a-c.

Pickup Arm

PROCTOR SOUNDEX CORP., 133 North 6th Ave., Mount Vernon, N. Y. The new pickup arm features a carrier which slides the cartridge in and out of the unit offering instant substitution with all standard and l-p microgroove cartridges; a stylus pressure scale inscribed in grams and a zero setting pointer; and a stylus pressure selector knob.

Dynamic Noise Suppressor

HERMON HOSMER SCOTT, INC., 385 Putnam Ave., Cambridge 39, Mass. The new oversize output transformer of the 210-A laboratory amplifier with dynamic noise sup-

pressor reduces hum level to 86 db below maximum power output under normal operating conditions. Actual hum power level is 0.05 microwatt.

Accelerometer Tube

MULLARD ELECTRONIC PRODUCTS LTD., Century House, Shaftesbury Ave., London WC2, England. Type DDR100 accelerometer tube is an all-glass loctal type that may be mounted in any attitude, for the measurement and recording of vibration on aircraft in flight. It is a double diode with anode elastic-

Radiation Components
New—unique—superfine

5801/VX-41A
The 5801/41-A sub-miniature electrometer tube is designed especially for the needs of exacting instrument performance and its characteristics are ideal for many types of radiation measuring instruments. Features a 10 milliamper filament current and grid resistance of 1015 ohms minimum.

5803/VX-34
A new sub-miniature triode for exacting requirements of extremely low plate voltage and high transconductance. Essential characteristics are: E1 1.25 volts, I1 10 ma., E2 7.5 volts, I2 10-14, Gm 150, Mu2. Now available.

VXR-130
The VXR 130 sub-miniature gaseous voltage regulator tube provides a tube of unusual stable voltage regulation where such regulation must be maintained over a long period of time. Regulation is at 130 volts over an operating range of 1.0 to 2.5 ma.

Hi-Meg resistors
Hi-megohm resistors, vacuum sealed, are used in all ion chamber radiation measuring instruments and electrometer circuits where accuracy and stability are required. Available in a range of 108 to 1013 ohms.

1B87
The new 1B87 sub-miniature Thyrode is designed to operate at 900 volts with a plateau greater than 100 volts and a nominal background counting rate of 12 counts per minute.

1B85
The 1B85 Thyrode, actual size introduces a new advancement in counter tube construction. It is a rib reinforced aluminum, self quenched, beta, gamma, counter tube operating at 900 volts. Wall thickness 30 mg./cm2.
A DOUBLE-NEEDLE PICKUP CARTRIDGE
with Top Quality Performance Characteristics
plus the most convenient needle replacement
arrangement that has been devised.

The Astatic
LQD TURNOVER TYPE
CRYSTAL CARTRIDGE

A GENTLE PRY with penknife or screwdriver, and ONE needle
comes out of the Astatic LQD Double-Needle Cartridge when replace-
ment is necessary . . . without disturbing the other needle, without
removing cartridge from tone arm, without so much as the turn of a
screw or use of other tools. Gentle pressure with the tip of a knife
blade snaps the new needle into place. This simple arrangement has
 debunked a resounding welcome by large users for Astatic's new
LQD Cartridge. Astatic type "Q" Needle, with three mil tip-radius, and
"Q-33," with one mil tip-radius, are employed . . . established types
which have been on the market for some time and are readily available.
The relatively high vertical and lateral compliance of this needle design
affords appreciable reduction in needle talk, contributing greatly to
the new cartridge's high standard of reproduction.

Listening tests by prospective users have prompted such comments as:
"Unquestionably the best we've heard." You are urged to make your
own comparisons, note the excellent frequency response particularly
at low frequencies, judge for yourself the performance qualities and
convenient utility of the Astatic LQD Double-Needle Cartridge. Avail-
able with or without needle guards.

SPECIFICATIONS
1. Stamped aluminum housing.
2. Frequency response—50 to 7,000 c.p.s.
3. Output—1.2 volts (Audio-Tone Record, 78 RPM);
   .75 volts (Columbia 281 Record, 33-1/3 RPM).
4. Recommended needle pressures—15 grams for 78 RPM and 6 to 8
   grams for 33-1/3 RPM.

NEW PRODUCTS (continued)
ally supported so that the anode
impedance is varied when the tube
is subjected to acceleration. In
practice, the tube is rigidly clamped
to the structure under test and the
measurement is expressed in terms
of a current change in a Wheat-
stone bridge circuit of which the
anode-cathode impedance of the
accelerometer tube forms adjacent
arms. The frequency range over
which the response to a sinusoidal
acceleration can be considered inde-
pendent of frequency is 0 to 250
cycles. The resonant frequency of
the tube is 1 kc and the maximum
acceleration range is 100g.

Time Delay Relay
AGASTAT DIVISION, AMERICAN GAS
ACCUMULATOR CO., 1029 Newark
Ave., Elizabeth 3, N. J. The new
time-delay relay for radio and tele-
vision transmitters provides an

initial time delay of one minute.
Time delay starts when the coil is
energized. Once the timing cycle is
complete the unit switches off. Rest-
oration of power within 1 to 15
seconds instantaneously re-estab-
ishes the circuit. After 16 seconds,
time delay is proportional to the
length of time of the power failure.

Piezoelectric Gages
CAMBRIDGE THERMIONIC CORP., 437
Concord Ave., Cambridge 38, Mass.,
now has available piezoelectric
gages for measuring pressures of instantaneous nature from a few pounds to 30,000 psi. Their usefulness lies in their ability to measure shocks of high magnitude when transmitted through liquids, gases, and, at times, through solids.

**Ruggedized 6AK5**
RAYTHEON MFG. CO., Newton, Mass.
Type CK5654 is a ruggedized version of the type 6AK5 tube that incorporates several additional features. The heater is designed to withstand at least 5,000 on and off cycles at 7.5 volts. The type was developed especially for applications such as in aircraft equipment in which the standard tube sometimes failed.

**C-R Tube Printer**
MARKEM MACHINE CO., Box 480, Keene, N. H. Model 13A cathode-ray tube printer is used to imprint upon the base of television tubes the manufacturer's trade mark and type number. The operator places the end of the tube into the fixture, depresses a foot treadle and the machine places the imprint on the tube.

**Sweep Signal Generator**
TRANSVISION, INC., New Rochelle, N. Y. Model SG sweep signal generator for television and f-m covers the range from 0 to 227 mc with no band switching. Sweep width is...
### Standardized Read-To-Use Metal Equipment

**Adaptable for Every Requirement**

Par-Metal Equipment offers many features, including functional streamlined design, rugged construction, beautiful finish... plus ADAPTABILITY. Eliminate need for special made-to-order units on many jobs.

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*Very Low Capacitance cable*

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### Silicone News

**Increased Volume Cuts Cost of Silastic**

Design engineers weigh the properties and service life of a material against its price per pound. Sometimes there is only one material that will serve the purpose and price becomes relatively unimportant. That has been true of Silastic, the Dow Corning Silicone Rubber. But this initial market for Silastic has now become large enough to permit more efficient production and the opening of new markets through a price reduction of 20 to 43 cents a pound.

In the aircraft industry Silastic found a good initial market because it is the only resilient material that withstands hot oil and both high and low temperatures. Typical uses are: sealing thermal anti-icing systems, gasketing engine rocker boxes; and flexible heating ducts.

Silastic tubing reinforced with glass cloth is used to seal heating and ventilating ducts operating at 350-450° F. in Consolidated's Vulper Convector, in jet type phopnes of temperates of 350-450° F. and under pressures up to 150 p.s.i.

In the automotive industry gaskets are one of many applications for Silastic now under test.

---

### Par-Metal Electronic Housing

Engineers and manufacturers will effect economies with Par-Metal Products, which are available for every type of job from a small receiver to a deluxe broadcast transmitter.

Professional techniques and years of specialization are reflected in the high quality of Par-Metal...

**Cabinets • Chassis • Panels • Racks**

Write for Catalog

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**Par-Metal Products Corporation**

32-62-49th Street
Long Island City 3, New York

Export Dept., Nortico International Corp.

13 East 40 Street, New York 16

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**April, 1949 — ELECTRONICS**

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variable from 0 to 12 mc, and a marker generator is built in. Output impedance is 5-125 ohms. There are directly calibrated markers, 20 to 30 mc for trap, sound and video i-f alignment.

**Selenium Rectifiers**
International Rectifier Corp., 6809 S. Victoria Ave., Los Angeles 43, Calif. The selenium rectifier stack illustrated features a special moistureproof finish capable of withstanding salt spray for periods up to 200 hours. Plates are made in six different sizes. Power requirements from 2 volts and 150 ma up to 5,000 volts and 10,000 amperes can be handled with efficiencies varying from 65 to 85 percent. Each plate is rated at 26 volts r.m.s. inverse voltage.

**Television Leadin**
Federal Telephone and Radio Corp., 100 Kingsland Road, Clifton, N. J. Intelin L-111 is a new 300-ohm shielded, balanced line de-

- Investigate Brush measuring devices before you buy... they offer more for your money... Why not have a Brush field engineer call? At no obligation, of course. Just call or write... today... you will find it worth a few seconds' time!
THE CENCO-MEGAVAC PUMP

is an excellent mechanical unit for high speed evacuating in cathode-ray and television tube production. This pump is proved for fast initial evacuation and dependable and trouble-free service. Makes an ideal unit for backing glass or metal diffusion pumps. Speed at 1 micron, 375 ml; vacuum, 0.1 micron or better. No. 92015A Cenco-Megavac Pump mounted with base and motor for 115 volt, 60 cycle operation. $198.00

Also available with motors for other voltages and frequencies.

Write Dept. B, I. for engineering Bulletin 10 "High Vacuum Equipment".
NEW PRODUCTS (continued)
types. The latter units are immune to extreme climatic and artificial heat and the operable humidity range is extremely wide.

Breakdown Tester
ELECTRICOIL TRANSFORMER CO., 417-421 Canal St., New York 13, N.Y. A portable insulation breakdown tester now in production has an output up to 11,000 volts rms in 100-volt steps. Breakdown actuates a buzzer and pilot lamp. A high reactance circuit limits output current to a low value to prevent destruction of the material under test and to lessen operator hazard.

Input Transformer
UNITED TRANSFORMER CORP., 150 Varick St., New York 13, N.Y. The MA-1 Adaptor is an input transformer designed for matching low-impedance microphones and pickups to high-impedance circuits. The unit matches any source from 50 to 500 ohms impedance to grid. Response is essentially flat from 50 to 10,000 cycles.

Antistatic Welding
MID-STATES EQUIPMENT CORP., Chicago, Ill. A remote-control device for welding machines with automatic arc stabilizer shuts off the high-frequency unit whenever the

MICROSEN PRESSURE TRANSMITTER
Means "ONE-POINT" Pressure Indications

An economical, efficient and accurate method of transmitting pressure indications to a central control point, through simple electrical wiring, is provided by the new Microsen Pressure Transmitter.

Such transmission avoids the dangers and difficulties present with long pressure lines that must pass through areas where leakage or fracture of those lines may cause serious damage.

The complete installation is simple and easy. The transmitter is connected to the pressure source in exactly the same manner as a Duragauge.

Since the power supply can be any of the normally used circuits commonly available in industry, the electrical connections are equally simple. All models are available in standard Duragauge pressure ranges.

Write for specific information.

MICROSEN PRESSURE TRANSMITTER
A Product of
MANNING, MAXWELL & MOORE, INC.
BRIDGEPORT 2, CONNECTICUT

SYNCHRON
TIMING MOTORS
AND
TIME MACHINES

Never Need Oiling... Operate Efficiently In Any Position...

Motor is equipped with oil storage reservoir and patented oil feed to bearings. Rotor shaft, reduction train, and output shaft, all have double bearings to reduce vibration and assure quiet, efficient operation when mounted in any position.

Brass Gears Operate Against Steel Pinions—Steel Shafts Operate In Babbitt Bearings

There is no compromise for quality in the design and construction of SYNCHRON Timing Motors and Time Machines! If you have any timing design problems, SYNCHRON offers the benefit of long experience and capable design assistance.

Write for catalog and engineering data.

HANSEN MANUFACTURING CO., INC.
Princeton 10, INDIANA

Established 1907 - a Pioneer in Synchronous Motors

MILWAUKEE WROUGHT WASHERS

Since 1887

The SYMBOL of QUALITY for 62 YEARS

WASHERS... Standard and Special, Every Type, Material, Purpose, Finish... STAMPINGS of every Description... Blanking, Forming, Drawing, Extruding.

Your most dependable source of supply — the world's largest manufacturer of Washers, serving Industry since 1887. Over 22,000 sets of Dies.

Submit your blueprints and quantity requirements for estimates.

WROUGHT WASHER MANUFACTURING CO.
The World's Largest Producer of Washers
2118 S. BAY ST., MILWAUKEE 7, WIS

SYNCHRON TIMING MOTORS
AND TIME MACHINES

SYNCHRON TRADE MARK

Never Need Oiling... Operate Efficiently In Any Position...

Motor is equipped with oil storage reservoir and patented oil feed to bearings. Rotor shaft, reduction train, and output shaft, all have double bearings to reduce vibration and assure quiet, efficient operation when mounted in any position.

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WROUGHT WASHER MANUFACTURING CO.
The World's Largest Producer of Washers
2118 S. BAY ST., MILWAUKEE 7, WIS

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welding electrode is not actually in contact with (grounded by) the workpiece. In this way, the high-frequency emanations that otherwise cause severe interference to broadcast radio and television can be eliminated.

**Industrial VTVM**

*General Electric Co., Schenectady, N.Y.*

Type AA-1 vacuum-tube voltmeter has a calibrated range from 0.001 to 300 volts at all frequencies from 10 cycles to 1.5 megacycles. In addition, the meter scale is graduated in decibels covering a range from minus 52 to plus 52 db from a reference level of 1 milliwatt at 600 ohms. A ten-position push button switch selects the desired working range.

**Diode Probe**

*Radio Corp. of America, Camden, N.J.*

Type WG-275 twin-diode probe has recently been made available for use with Voltohyst meter type WV-95A. The probe has a substantially flat response from 30 cycles to 250 megacycles and reads sine-wave voltages directly in rms values. Peak-to-peak voltages of both sine and complex waveform can be obtained by multiplying the meter-scale reading by a factor of

---

**HARDWICK, HINDLE, INC.**

**Rheostats and Resistors**

Subsidiary of

*The National Lock Washer Company*

Newark 5, N.J. Established 1886 U.S.A.
Twenty-seven years ago Radio Receptor's engineers launched an intensive campaign for better air traffic control and navigation through radio.

As a pioneer in this field many new developments of a radical nature followed, resulting in greatly improved transmitting and receiving units.

At the beginning of World War II the experience gained during those early years was effectively applied in the solution of the more complex problems created by war conditions, including combat flying. Our contributions to the Armed Forces throughout the war have written a brilliant page in the history of air communication—a background of outstanding achievement that we point to with justifiable pride.

Today Radio Receptor is actively engaged in the development of new equipment to meet the requirements of RTCA and ICAO. Constantly alert to the rapid advancement in air navigation practice, we are always able to offer precision equipment engineered to the user's specific needs.

Radio Receptor Equipment will now be found in practically every major airport, furnishing a daily demonstration of high efficiency and dependability in air traffic control and navigation under the exacting requirements of modern flying.

Write us for Catalog

NEW PRODUCTS (continued)

2.83. In measuring unsymmetrical voltage waves, the full-wave circuit of the diode probe eliminates errors inherent in half-wave probes.

**Gamma Survey Meter**

Bay Instruments and Development, 2200 Woolsey St., Berkeley 5, Calif. Type II300A gamma-ray survey instrument has been designed for uranium prospecting. A resistor-quenched Geiger tube (available separately) permits small size and circuit simplicity. The tube, operating at 300 volts from a single battery actuates headphones without amplification. The probe can be used on cords up to 250 feet for sounding test holes.

**Television Transformers**

Chicago Transformer Division, 3501 W. Addison St., Chicago 18, Ill. Now available from stock is a complete line of television transformers designed to fit the circuits of leading television receiver manu-

April, 1949 — ELECTRONICS
NEW PRODUCTS (continued)
facturers. Included are power, vertical blocking oscillator, vertical scanning output, and horizontal scanning output transformers. A four-page illustrated catalog with complete descriptions and dimensions is available.

Wire Breakage Detector
UNIVERSAL WINDING Co., Providence 1, R. I. A new type of wire breakage detector is now available for application to either overend or unrolling tension used on No. 102 Universal coil-winding machines. The device operates through a lever activated by the tension compensators. This lever is equipped with a splash type mercury switch that is connected to the counter solenoid. When the mercury switch is agitated, it operates the solenoid which in turn disengages the clutch in the winding head and stops the arbor.

Low-Current Chopper
STEVE\NS-ARNOLD INC., 22 Elkins St., South Boston 27, Mass. Type 240 d-e or a-c chopper is a single-pole, double-throw electromechanical chopper, rectifier (demodulator) or square-wave generator.

MAKE TUNING AS EASY AS VIEWING with S.S.WHITE FLEXIBLE SHAFTS

Here's a simple way to do it. Just use S.S.White flexible shafts to connect the tuning knobs to their respective circuit elements. Doing this enables you to mount the knobs where the set can be tuned from a comfortable standing position regardless of where the tuning elements themselves are located.

S.S.White remote control flexible shafts are ideal for this purpose, having been used for many years in all types of radio equipment. Their special construction assures minimum angular deflection under load and practically equal deflection in either direction of rotation. When properly applied, they are as smooth and sensitive as a direct connection.

WRITE FOR THIS FLEXIBLE SHAFT HANDBOOK

260 pages of technical data on how to select and apply flexible shafts. Copy sent free if you write for it on your business letterhead and mention your position.

S.S.WHITE INDUSTRIAL DIVISION
THE S. S. WHITE DENTAL MFG. CO. DEPT. H 10 EAST 40th ST., NEW YORK 16, N. Y.
FLEXIBLE SHAFTS AND ACCESSORIES
MOLDED PLASTICS PRODUCTS—MOLDED RESISTORS
One of America's AAAA Industrial Enterprises
NEW PRODUCTS
(continued)

that will operate at any frequency in the range from 10 to 500 cycles. Contacts will handle up to 0.05 ampere. Further details of coil ratings and mechanical arrangements are given in catalog 232A. New ratings have been assigned the type 222 so that it can be used up to 0.5 ampere.

Two-Pole Motors
RUSSELL ELECTRIC CO., 340 W. Huron St., Chicago 10, Ill., announces the type 350 line of shaded pole skeleton motors based on a 31-in. square frame lamination. De-

signed for efficiencies up to 35 percent and starting torques up to 60 percent, the units are available in capacities from 0.04 to 0.1 h-p, 3,000 rpm.

Industrial Tube Analyzer
GENERAL ELECTRIC CO., Syracuse, N. Y. Type YTW-3 industrial electronic tube analyzer supersedes the earlier type T7-1 and was developed specifically for use with thyatron and planotron tubes used in welding and control operations. The device measures the peak arc drop voltage of these tubes under maxi-

specifications

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<td>Hiatus. Amplifier:</td>
<td>10%</td>
<td>0.5 peak-to-peak volt/inch</td>
</tr>
<tr>
<td>Deflection Factor:</td>
<td>0.5 volt/cm</td>
<td></td>
</tr>
<tr>
<td>Sweep Frequency Range:</td>
<td>...</td>
<td>(cont.)</td>
</tr>
<tr>
<td>Triggered-sweep Repetition Rate:</td>
<td>up to 50 kHz</td>
<td></td>
</tr>
<tr>
<td>Blanking:</td>
<td>Return trace blanked on triggered deflection</td>
<td></td>
</tr>
<tr>
<td>Power Supply:</td>
<td>105/125 volts, 50/60 cycles</td>
<td></td>
</tr>
<tr>
<td>Power Consumption:</td>
<td>200 watts</td>
<td></td>
</tr>
<tr>
<td>Dimensions:</td>
<td>14 1/2&quot; high, 8 1/4&quot; wide, 18 1/4&quot; deep</td>
<td></td>
</tr>
<tr>
<td>Weight:</td>
<td>42 lbs.</td>
<td></td>
</tr>
<tr>
<td>For Sine Waves:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RCA WO-79A

- Truly a laboratory instrument, the WO-79A 3-inch oscilloscope is outstanding for a wide range of research and industrial applications. It is particularly useful for the observation and measurement of phenomena such as TV synchronizing and deflecting voltages, ignition waveforms, pulses, and radar signals. The WO-79A will accurately display 1-µs pulses and other waveforms which have extremely steep leading edges, such as are encountered in photo-flash devices and electro-mechanical relays.

The WO-79A features a triggered sawtooth sweep with a delay network, two-to-one trace expansion, frequency response from 10 cps to 5 Mc, calibrating meter for voltage measurements, high voltage for photography of transients, wide-range centering controls, and retractable light shield. It is shipped complete with compensated attenuating cable, and with a direct probe cable.

Ask your local RCA Test and Measuring Equipment Distributor for further details, or write RCA, Commercial Engineering, Section 42DY, Harrison, N. J.

Available from your RCA Test and Measuring Equipment Distributor

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TEST AND MEASURING EQUIPMENT
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April, 1949 — ELECTRONICS
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Primary—115 volts 60 cycles
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Sec. No. 2—6.3 volts, 8 amps.
Sec. No. 3—6.3 volts, 6 amps.
Sec. No. 4—5 volts, 3 amps.
Sec. No. 5—5 volts, 2 amps.
Size: 4" x 5½" x 4½"—Weight: 11 lbs.
PRICE—quantities of 500—$5.72 ea.

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Sec. No. 1—800 volts CT, 225 ma. DC.
Sec. No. 2—6.3 volts, 8 amps.
Sec. No. 3—6.3 volts, 6 amps.
Sec. No. 4—5 volts, 3 amps.
Sec. No. 5—5 volts, 2 amps.
Size: 4" x 5½" x 4½"—Weight: 11 lbs.
PRICE—quantities of 500—$5.72 ea.

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Electronics — April, 1949

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NEW PRODUCTS (continued)

mum load, or if desired, under a specific application load. Readings are taken directly from a large dial that controls a slide-back type voltmeter.

Four-Channel Oscilloscope

Electronic Tube Corp., 1200 E. Mermaid Lane, Philadelphia 18, Pa. Model H-4GRT four-channel oscilloscope is a laboratory indicator for registering phenomena from d-c to 500,000 cps. Inputs as low as 0.03 volt rms to the a-c amplifiers will trigger the sweeps while inputs of 0.5 volt rms to the d-c amplifier or external sync terminals will also initiate the sweeps.

Metallized Paper

Smith Paper Inc., Lee, Mass. A new metallized paper developed particularly for the manufacture of capacitors consists of a kraft base upon which is spread a very thin uniform layer of lacquer that greatly increases insulation resistance and dielectric strength. The final operation is the deposition of a layer of zinc on one side of the paper. This metallized face obviates the need for foil, thereby reducing the space factor. A further feature of the technique is the improved self-healing quality of capacitors manufactured with the new materials, so that such capacitors can be subjected to repeated breakdowns without impairing continued satisfactory use.

Power Triode

Radio Corp. of America, Harrison, N. J. Type 5770 power triode is water and forced-air cooled for grounded-grid service. In unmodulated class-C service it has a maxi-
mum plate dissipation of 50 kilowatts. It can be operated at full ratings to 20 megacycles and at reduced ratings to 35 mc. Full tentative data have been published.

New Tube
MULTI-TRON LABORATORIES, 5512 West Harrison St., Chicago 44, Ill.
A new tube using a principle of secondary emission so far unexploited is now available for d-c amplification, nuclear studies, and ultrahigh frequency applications.

Time Calibrator
OWEN LABORATORIES, 9130 Orion St., San Fernando, Calif.
Type 160 time calibrator is used to measure elapsed time between any two points on an oscilloscope trace. The unit requires a single connection to the oscilloscope sweep sawtooth voltage, but no a-c or d-c power is necessary. Marker intervals are 1 millisecond, 100, 10, or 1 microsecond. Error is dependent upon the oscilloscope input characteristics but will generally not exceed plus or minus 5 percent. Approximately 20 micromicrofarads is

NEW PRODUCTS
(continued)
THE Carter Multi-Output Super Dynamotor simultaneously delivers 2 or 3 separate DC insulated, ungrounded output voltages or 1 AC and 1 DC output. Used on Pan American Clipper ships radio equipment.

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- Output volts, 3 DC or 1 AC, 1 DC up to 1200 volts with series commutators.

Output current, up to 500 MA.
Ripple content, 1% or less.
Efficiency, 60-70%.

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**NEW PRODUCTS**

(continued)

added to the normal input capacitance of the scope. Input impedance at the sweep terminal of the unit is equivalent to 470,000 ohms paralleled with 6 microfarads.

---

**Inverters for Television**

ELECTRONIC LABORATORIES, Inc., Indianapolis, Ind. New inverters for changing d-c to a-c operate with an automatic remote starting system. They have been particularly designed for television use. Model 110R15 is for table model sets and model 110R30 is suitable for console models.

---

**Dual Changers**

WEBSTER-CHICAGO, Chicago, Ill. Two new automatic record changers, models 246 and 256 provide automatic or manual play of standard or long-playing microgroove records at 78 or 33.3 rpm. Equipped with a tandem-tip needle, the changers are now available to manufacturers.

---

**Pointer Galvanometers**

G-M LABORATORIES, INC., 4300 North Knox Ave., Chicago, Ill. A new line of pointer galvanometers suitable for building into testing equipment is now available. Typical characteristics of type 570-603: movement resistance, 100 ohms; sensitivity, 0.2 microampere per millimeter; external critical damping resistance, 400 ohms.

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**R-F Test Set**

MACONI INSTRUMENTS LTD., St. Albans, Herts., England. The r-f test set type TF 890 has been designed for checking over complete
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NEW PRODUCTS (continued)

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carrying a thermistor power bridge,
cavity wavemeter, crystal detector-
mixer, and a frequency-swept kly-
tron oscillator with associated time
base, i-f amplifier and cathode-ray
monitor.

Miniature Pentode
RAYTHEON MFG. Co., Newton, Mass.
Type 6AN5 miniature pentode can
be used in many of the applications
for which the metal type 6AG7 has
been previously employed. In addi-
tion, the new type is useful at vhf
as a frequency multiplier, wide-
bend r-f and i-f amplifier, class C
r-f amplifier, and switching tube
for computers. It has a normal plate
current rating of 35 ma and a
transconductance of 8,000 microm-
hos.

Video Interconnector
REEVES SOUNDRAFT CORP., 10 East
52nd St., New York 22, N. Y. The
Multivideo Connector is a device
for connecting a number of tele-
vision sets to one antenna. Each
receiver requires one of the units
that will retail for $12.85.

Television Tester
RADIO CORP. OF AMERICA, Camden,
N. J. The attenuator coupler illus-
trated was designed for aligning,
tuning and testing a microwave re-

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pounding of noisy ma-
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Provides a comprehensive survey of theory and design techniques for microwave antennas, and a full description of antenna measurement methods. It surveys those parts of electromagnetics and optical theory which are basic to the subject. Series of chapters discuss various types of antenna feeds and the complete antenna systems used for producing all principal types of microwave beams.

MICROWAVE DUPLEREKS
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Presents the theory, properties, and use of the silicon and germanium point-contact rectifiers which have been developed for use in microwave converters and for other circuit applications. Treatment of the theory of semiconductors, of the semiconductor-metal contact, of frequency-dependent behavior of rectifiers and of some operation by crystals is followed by engineering information on the production and use of practical crystal types.

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Describes the microwave portions of receivers for very high frequency waves. Treats various types of receiving systems and their relative merit and the conversion frequency problem. Practical mixers are described and their design problems are discussed. Schemes are described for maintaining a constant absolute frequency of the local oscillator as well as those for stabilizing a constant frequency difference between the transmitter and local oscillator.

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NEW PRODUCTS

(continued)

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NEW PRODUCTS (continued)

adapted for use in television testing, nuclear instrumentation, oscillography and general laboratory measurements.

Flame-Failure Control
COMBUSTION CONTROL CORP., 77 Broadway, Cambridge 42, Mass. A new flame-failure control for supervising both pilot gas flame and main oil flame comprises type 45JP1 electronic flame rod, type 45PH5 photoelectric scanner, and type 24PJ8 programming control. Relay contacts will directly handle a 1-h-p motor. Further details are given in bulletin CH4753.

Kilovoltmeter
BRADSHAW INSTRUMENTS CO., 348 Livingston St., Brooklyn 17, N. Y. Model 4000 Kilovoltmeter has been designed for x-ray and television use in measuring voltages up to 50,000 v d-c. It is based upon a 20 microampere meter with an input impedance of 1,250 megohms. The

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NEW PRODUCTS (continued)

sensitivity of the instrument is 50,000 ohms per volt at 25 kv. Shielded probes and test leads are provided as well as a normal-reverse switch so that the probes become essentially independent of polarity. The large-scale meter makes it possible to read accurately voltages as low as 3,000 v. Price is $67.50.

Regulated Power Supply

CHATHAM ELECTRONICS, 475 Washington St., Newark, N. J., has announced a series of laboratory-type regulated power supplies. Model E-48 has an input of 105 to 125 volts, 60 cycles, 750 watts. Output is variable from 160 to 1,500 volts, 125 ma d-c. Ripple is less than 0.05 volt peak-to-peak.

Multiplier Photometer

FARRAND OPTICAL CO., INC., 4401 Bronx Blvd., New York 66, N. Y., offers an electron multiplier photometer for general purpose measurement of very low light intensities. It is comprised of three units: detector, power supply and controls, and galvanometer. Detailed description is contained in bulletin 804.

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An S.S. White 100 Megohm Resistor is used as the plate load resistor for the first tube in the D.C. amplifier in this instrument which measures very small d.c. currents and voltages over an extreme range of values. The manufacturer, Beckman Instruments Division of National Technical Laboratories, says of the S.S. White Resistor "it has been very satisfactory"—which checks with the experience of many other electronic equipment manufacturers who use S.S. White Resistors.

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It gives essential data about S.S. White Resistors including construction, characteristics, dimensions, etc. Copy with price list on request.

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5/16" maximum inside diameter.

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5/32" wall thickness.
30° tolerance, 10° ± 10° tolerance.

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STANDARD RANGE
1000 OHMS to 9 MEGOMMS

S. S. WHITE RESISTORS

are of particular interest to all who need resistors with inherent low noise level and good stability in all climates.

HIGH VALUE RANGE
10 to 10,000,000 MEGOMMS

STANDARD RANGE
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5 REASONS

WHY THIS

Model MCM
Master Midget Lever

SWITCH

Aids Electronic Designs

1 ▶ It's adaptable
It gangs enough contact arrangements to handle nearly every circuit change you can conceive.

2 ▶ It's compact
Small enough to fit in the tightest spots, it extends only 2 3/4 inches behind the panel and weighs but 3 1/2 ounces complete with 12 springs.

3 ▶ It's positive
Each detent action is fixed by patented stainless steel inserts; full throw in non-lock as well as in locking action.

4 ▶ It's dependable
Contacts handle 5 to 10 amperes at 115 volts a-c, depending on load characteristics; tested at 2500 volts a-c to ground.

5 ▶ It's convenient
Single-hold mounting; contact assemblies are detachable for easy wiring. Alternate actuating means suit varied installation requirements—waterproof handle (A) for marine use, rotary actuator (B) and lever arm (C) permit switch mounting parallel to panel.

WRITE TODAY FOR DETAILS
of this and other General Control apparatus for manual and automatic control of electronic and electrical apparatus.

New Sub-midget Model MCT Switch provides convenience, adaptability, and dependability in minimum space. Ask for bulletin.

NEW PRODUCTS

(continued)

instrument cabinets have further reduced motor-winding temperature rise and improved resilient mounting incorporated in the unit. They can be mounted directly over dust filters in either push or pull operation.

Universal Power Supplies

ELECTRONICRAFT, INC., 5 Waverly Place, Tuckahoe, N. Y. Model 101 universal power supply provides 5 a-c voltages, 3 d-c channels, 3 d-c unfiltered, and a filament supply. Other units provide other voltage ranges suitable for laboratory and industrial applications. A brochure is available.

Regulated D-C Supply

BETA ELECTRONICS Co., 1762 Third Ave., New York 29, N. Y., announces the model 252 regulated d-c power supply for applications re-

On the assembly line and in the laboratory, CTC ALL-SET Boards are valuable time-savers.

With Type 1558 Turret Lugs, a new board now offers mounting for miniature components. 1 1/16" wide, 3/32" thick, only. (Type X1401E.)


With the addition of the new miniature board, CTC ALL-SET Boards now cover the entire range of components.

All boards are of laminated phenolic, in five-section units, scribed for easy separation. Each section drilled for 14 lugs. Lugs solidly swaged into precise position...whole board ready for your assembly line.

SPECIAL PROBLEMS

Custom-built boards are a specialty with CTC. We're equipped to handle many types of materials including the latest types of glass laminates...many types of jobs requiring special tools...and all types of work to government specifications. Why not drop us a line about your problem? No obligation, of course.

CAMBRIDGE THERMIONIC CORPORATION
437 Concord Avenue, Cambridge 38, Mass.

April, 1949 — ELECTRONICS
For Proof Beyond Compare

Try

RUBYFLUID
Soldering Flux
Send for Ruby's $1 Offer

For $1 Ruby will send you 1 pint of liquid, one half pound of paste soldering flux and a new booklet on "How to Solder."

Take advantage of this offer now!

Send your $1 today to—

RUBY CHEMICAL CO.
59 McDOWELL ST.
COLUMBUS, OHIO

Specifications

Glass Jewel Bearings by Bird are highly accurate and surprisingly inexpensive. They're ideal for use in ammeters, voltmeters, timing instruments, compasses and other instruments where large volume production and low cost must be maintained.

Of special interest to instrument manufacturers is Bird's method of mounting jewels. There's a minimum of stress and strain on the bearing itself as a result of Bird's special mounting technique. It is this special mounting feature which adds so materially to the useful life of Bird Jewel Bearings.

Whenever there's a need for jewel bearings — whether in glass or in sapphire — Bird can supply the right bearing to your specifications. Write today for more information and a quotation.

Sapphire Bearings available in all jewel styles and mountings

Richard H. Bird & Co., Inc.
1 Spruce Street
Waltham 54, Mass.

"Serving Industry with Fine Jewels Since 1913"

ELECTRONICS — April, 1949

MAKE YOUR PRODUCT FULLY NON-CORROSIVE!

STAINLESS STEEL SCREWS

IMMEDIATE DELIVERY

Machine, Self-tapping
Socket, Sets, Wood
Screws. Also Nuts,
Bolts, Washers, Rivets,
Caps—all types and
sizes—delivered
immediately from
America's largest
stock.

PROMPT SHIPMENT
ON SPECIALS

M A N U F A C T U R E R S SINCE 1929

ALLMETAL
Screw Products Co.
33 GREENE STREET, NEW YORK 13, N.Y.

A COMPLETE LINE OF T-V TEST EQUIPMENT

RCA WR-59-A. Television Sweep Generator—An extremely fine and well known sweep signal generator covering 12 TV ranges and 3 IF ranges. Any channel immediately available by rotation of selector. Phasing control and attenuation control makes for ease of operation. Especially recommended for production lines, service and laboratories.

DUMONT 208B-5" Oscilloscope—A modern and excellent unit for practically all requirements. Uses a 5" intensifier tube with exceptional trace brilliance. Freq. Range from 2 to 100,000 cycles both X and Y axes. Hi def. reception sensitivity. Excellent for TV work.

DUMONT 208B-8" Oscilloscope—A modern and excellent unit for practically all requirements. Uses an 8" intensifier tube with exceptional trace brilliance. Freq. Range from 2 to 400,000 cycles both X and Y axes. Hi def. reception sensitivity. Excellent for TV work.

SUPREME 650-Deluxe 5" Oscilloscope—The answer to the needs of the TV industry for a scope for alignment work. Has wide band amplifiers. Vertical sweep, response to 7 MC. Horiz. to 20 MC. Has voltage regulator, probe, 2 axis amplifiers. Uses SCP5 tube.

PRECISION E-409—Sweep Signal Generator—A tremendous value and smash engineering success is this new Precision Range. Frequencies range from 2 to 480 MC in narrow and wide band sweeps. 5 to 50 MC and 50 to 500 MC sweep control. Multiple crystal marker and calibrator built in. 10.7 MC and 2 MC crystals furnished. Complete with cables, crystal's, one manual.

PRECISION E-202C—The favorite and famous signal generator for all-round shop, lab and field work. 59 KC to 120 MC coverage. 400 ohm audio, dual RF attenuation. Each unit is individually calibrated. An excellent means of providing "marker pips" for a TV sweep generator.

For Catalog No. 49C, write today, on your letterhead.

ARROW ELECTRONICS
INCORPORATED
82 CORTLANDT STREET, NEW YORK 7, N.Y.
Duplicates Precision Notches WITHOUT DIES!
The new precision Di-Acro Notcher eliminates the need for punch press and dies on many production notching operations. It is also ideal for experimental work as it can be quickly adjusted for any size or shape notch. Many straight shearing operations can also be performed with this flexible unit.

CUTS CLEAN—NO BURRS OR ROUGH EDGES

The powerful Di-Acro Notcher has an exclusive roller bearing cam design which provides a tremendous pressure with a small amount of effort. The precision-ground Vee-shaped ram and blades of alloy tool steel assure clean cuts and permanent accuracy.

LARGE CAPACITY. The Di-Acro Notcher cuts 90° notches up to 6" by 6" in 16 gauge steel in one operation. Larger notches, and wider or narrower angles, can also be obtained.

SEND FOR 40-PAGE CATALOG. Gives full information on all six "DUPLICATING" production boosters—Di-Acro Benders, Brakes, Shears, Rod Cutters, Punches, Notchers—with many examples of accurately duplicated parts.

Di-Acro is pronounced "DIE-A-KRO."

NEW PRODUCTS
quiring very good regulation and stability. Input is 115 volts, 60 cycles, 400 watts; and output is adjustable from 260 to 300 volts d-c, negative grounded. With load changes from 400 to 600 ma the output voltage change at any setting is less than 0.05 percent.

Multitester
BRADSHAW INSTRUMENTS Co., 348 Livingston St., Brooklyn 17, N. Y.
A new test meter model 30 covers

21 ranges; up to 1,250 v a-c, 1,000 v d-c, 100 ma d-c, 1 megohm, and from minus 10 to plus 57 db in five ranges. Sensitivity is 1,000 ohms per volt.

Field Strength Meter
TRANSVISION, INC., New Rochelle, N.Y. Model FSM-1 is a compact portable television service instrument complete with self-contained power supply for operation from

120 volts, 60 cycles. The unit is capable of measuring field strength from 50 to 50,000 microvolts at the 300-ohm input terminals.

Hermetic Solder
CERRO DE PASCO COPPER CORP., 40 Wall St., New York 5, N. Y. Cerroseal-50 is an Indium solder that
Economical Hot Water ELECTRICALLY
with this new VULCAN Immersion Heater

THERMOSTAT can be set for any desired temperature. No danger
of overheating.

EASILY INSTALLED by simply inserting in tank or boiler and
connecting to the nearest convenient outlet. * The one-inch tapped
pipe thread fits standard domestic type hot water boilers.

FLEXIBLE Permits placing small tanks where hot water is to be
used.

PRACTICAL for wash rooms . . . or anywhere in factories, stores,
ofices or institutions where hot water is needed.

CAN BE USED with present hot water systems without disturbing
existing piping.

* Or 1/4" if desired.

VULCAN ELECTRIC COMPANY
DANVERS, 10, MASS.

Makers of Vulcan Electric Soldering Tools, Solder Pots, Glue Pots,
Branding Irons and a wide variety of Heating Elements for assembly
into manufacturers' own products.

Over 1000 Sizes

PARAMOUNT SPIRAL WOUND PAPER TUBES

Square • Rectangular • Triangular
Round and Half-Round

With a wide range of stock arbor ... plus the
specialized ability to engineer special tubes ... PARAMOUNT can produce the exact shape and size
you need for coil forms or other uses. Hi-Dielectric,
Hi-Strength. Kraft, Fish Paper, Red Rope, or any
combination, wound on automatic machines. Tol-
erances plus or minus .002". Made to your speci-
fications or engineered for YOU.

Inside Perimeters from .592" to 19.0"

PARAMOUNT PAPER TUBE CORP.
616 LAFAYETTE ST., FORT WAYNE 2, IND.
Manufacturers of Paper Tubing for the Electrical Industry

NO OBSOLESCENCE
ONE AMPLIFIER for ALL RECORDS
... plus *Dynamic Noise Suppression

New developments in recording, regardless
of turntable speed or pick-up point, will not
obsolesce the H. H. Scott type 210A amplifier
because it already includes every feature
necessary for faithful reproduction of re-
corded or broadcast music.
And in addition, the built-in *Dynamic Noise
Suppressor assures freedom from rumble, hiss,
and the scratch that inevitably increases with
each playing of any record.
Brilliant, realistic reproduction of every record,
33, 45, or 78 RPM . . . and of FM and AM broadcasts as well . . . is certain now
and for many years to come with the H. H.
Scott 210A amplifier.

Hear it TODAY and you'll agree that it
satisfies tomorrow's requirements. For com-
plete technical data, write Dept. 904E2

GUARANTEED FOR A FULL YEAR

*Licensed under U.S. and foreign patents
pending and issued.

Lavite STEATITE CERAMIC

Design engineers and manufactures in the
radio, electrical and electronic fields are
finding in LAVITE the precise qualities
called for in their specifications . . . high
compressive and dielectric strength, low
moisture absorption and resistance to ro-
ture, acids, and high heat. The exceed-
ingly low loss-factor of LAVITE plus its
excellent workability makes it ideal for all
high frequency applications.

Complete details on request

D. M. STEWARD MFG. COMPANY
Main Office & Works: Chattanooga, Tenn.
Nashville, Mass., Chicago * Los Angeles
New York * Philadelphia

ELECTRONICS—April, 1949
HAVE YOU EVER SEEN PERFORMANCE LIKE THIS?

Revolutionary D. C. TIMING MOTORS with CHRONOMETRIC GOVERNORS by A. W. HAYDON

A PRIMARY TIME-Power SOURCE OF EXTREME ACCURACY, PRACTICALLY UNAFFECTED BY VARYING VOLTAGE, LOAD OR TEMPERATURE.

SPECIAL FEATURES
- EXTREME ACCURACY
- REVERSIBLE
- COMPACT
- LIGHT WEIGHT
- WIDE RANGE OF VOLTAGE, TEMPERATURE, LOAD

At last, an accurately controlled motor drive is available for Direct Current in a wide range of output speeds for use in computers, recorders, timers and controls. Precision timing is obtained by the use of a temperature-compensated clock escapement which pulses the motor circuit. This synchronizes the motor electrically with the speed of the escapement.

Send for Catalog sheet on D. C. Timing Motor with Chronometric Governor... Our staff is at your service.

Use ICA TELEVISION, RADIO AND ELECTRONIC PARTS FOR PEAK EFFICIENCY

OVER 2000 TESTED STOCK ITEMS RANGING FROM CHASSIS, CABINETS AND ANTENNAS To Television Accessories

ICA produces the nation's greatest variety of top quality television, radio and electronic parts. Pioneer and developer of countless standard equipment, ICA's wide range of precision instruments meet almost all needs.

Thousands of industrial manufacturers have found ICA the right answer to their problems. They know that for dependability, quality, price and all-around performance, you can't beat ICA.

If it's a special item, ICA's vast manufacturing facilities are available. Send your specifications for quick estimate. Catalog available on request.

NEW PRODUCTS (continued)

adheres directly to clean smooth glass, mica, and some ceramics. It also bonds to the same metals as ordinary solders. Working temperature is approximately 260°F on glass. The substance can be applied with a cotton swab and has several advantages over the litharge and glycerine seal.

Indoor Antenna

JERROLD ELECTRONICS Corp., 121 N. Broad St., Philadelphia, Pa. The new In-tenna combines an adjustable dipole with a wide-band high-gain television preamplifier. Designed to eliminate all kinds of interference, this compact indoor antenna retails for $42.50.

Ball Bearings

MINIATURE PRECISION BEARINGS, Inc., Keene, N. H. A new miniature bearing accepts a ¼-in. shaft and requires only a ⅛-in. housing. The bearing is a full-race radial type with fifteen 1-millimeter balls. Either chrome-alloy steel or stainless steel are available.

Mobile Radio

RADIO CORP. OF AMERICA, Camden, N. J. The Carfone two-way mobile radio equipment is designed to
operate in the 152 to 174-mc band. Highly selective circuits make possible operation in channels between stations now on the air without spillover into adjacent channel. The equipment is available for commercial or government use.

**Literature**

**Miniature Tubes.** Raytheon Mfg. Co., 55 Chapel St., Newton 58, Mass. A four-page folder contains characteristic data for 77 miniature tube types. Basing diagrams and tube outlines are included.

**Components Reference.** American Phenolic Corp., 1830 South 54th Ave., Chicago 50, Ill. Catalog 73 provides a quick reference to a line of radio-electronic products. It features a complete index, grouping of parts by their uses, proximity of related items, graphic illustrations and mounting diagrams.

**Tubular Rheostats.** James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa. Bulletin 41 describes various styles of standard, screw-drive, double, graded, switch-board, metal-caged and noninductive rheostats. Charts are shown and examples given as assistance in proper selection of the instruments.

**Circuit Controller.** Electric Regulator Corp., 79 E. 130 St., New York 35, N. Y. Bulletin 502 gives pertinent facts on the applications and general construction of the Regohm rheostatic regulator. The unit is applicable to electronic tubes, saturable reactors and close differential relays.

**Speed Measurement.** James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa., has released bulletin 35-14 presenting the description, operation and selection of chronometric, centrifugal and resonant reed tachometers. A price list for over 60 speed measuring instruments is also available.
Now! TRYLON Prefabricated Guys...

...with PRES-TITE Connectors

Now available...TRYLON's prefabricated guys for use on any guyed tower...completely made up prior to factory shipment with the exclusive, high strength aluminum alloy PRES-TITE Connectors on each end of insulators and at the tower connections. This is real "guys insurance" with permanent, rust-proof fittings! Overall cost? No more than guys with standard guy clamps! If you are considering guys replacements, write now describing tower and anchor positions, insulator spacings and guy size.

TRYLON LADDER TOWERS

No taper. Compleely uniform design assures plus coverage; minimum upkeep. Guys protected with PRES-TITE Connectors. TRYLON Vertical Radiators are easy to climb for relamping and inspection and are inexpensive to maintain. Write for catalog.

Tower and Antenna Division
WIND TURBINE COMPANY
West Chester, Pa.

NEW PRODUCTS (continued)

Land, 2, Ohio. Catalog 300 is designed as a reference for a line of ammeters, voltmeters, milliammeters, battery cell testers and hearing aid testers. A variety of precision measuring instruments for the automotive and electronic fields is treated.


Thermocouple Meters. Rawson Electrical Instrument Co., 111 Potter St., Cambridge 42, Mass. Bulletin 502 covers portable thermal meters and multimeters with vacuum thermocouples for the measurement of a-c or d-c. Units described were designed for true rms readings, nonsinusoidal waveform and low power.

Magnetic Contactors. Ward Leonard Electric Co., 31 South St., Mount Vernon, N. Y., has announced development of the bulletin 4454 size 4 and bulletin 4455 size 5 a-c magnetic contactors for motor, heater and lamp control purposes. The units are 150 and 300 amperes respectively, and are completely described and illustrated in a recent 4-page folder.


Resistance Box. Technology Instrument Corp., 1058 Main St., Waltham 54, Mass. Chief features of the type 110 slide-wire resistance box with maximum resistance of 11,000 ohms, specifications and prices are given on one side of a sheet recently issued.

Soldering Manual. Kester Solder Co., 4201 Wrightwood Ave., Chicago 39, Ill., has released a 28-page technical manual affording a complete analysis of the properties

MEASUREMENTS CORPORATION

Model 59

2.2 mc. to
400 mc.

MEGACYCLE METER

Radio's newest, multi-purpose instrument consisting of a grid-dip oscillator connected to its power supply by a flexible cord.

Check these applications:
- For determining the resonant frequency of tuned circuits, antennas, transmission lines, by-pass condensers, chokes, coils.
- For measuring capacitance, inductance, Q, mutual inductance.
- For preliminary tracking and alignment of receivers.
- As an auxiliary signal generator; modulated or unmodulated.
- For antenna tuning and transmitter neutralizing, power off.
- For locating parasitic circuits and spurious resonances.
- As a low sensitivity receiver for signal tracing.

SPECIFICATIONS:

- Power Unit: 5 1/4" wide; 6 5/8" high; 7 1/2" deep. Oscillator Unit: 3 1/4" diameter; 2" deep.
- Frequency: 2.2 mc. to 400 mc.; seven plug-in coils.
- Power Supply: 110-120 volts, 50-60 cycles, 20 watts.

MANUFACTURERS OF

Standard Signal Generators
Pulse Generators
FM Signal Generators
Square Wave Generators
Vacuum Tube Voltmeters
UNF Radio Noise & Field Strength Meters
Capacity Bridges
Waveform Meters
Phase Sequence Indicators
Television and FM Test Equipment
Engineers and Designers who insist on dependable components have adapted ADVANCE RELAYS into their control circuits. They are specifying ADVANCE products, and are submitting their relay problems to us. Our expanded engineering and plant facilities, plus the recognized dependability of ADVANCE RELAYS, make it possible for us to offer the most complete line of relays for light, immediate and heavy duty applications. Proved and Improved relay performance through ENGINEERED adaptability.

Follow the Engineers to ADVANCE

ADVANCE ELECTRIC & RELAY CO.
1340 West Second Street • Los Angeles 26, California

ENJOY MAXIMUM LIGHT VISIBILITY!
JOHNSON 147-1127
1 inch - Lucite Cap


JOHNSON 147-1143
11/16 inch Lucite Cap


JOHNSON carries in stock a complete line of standard pilot light assemblies to meet every ordinary need. Special assemblies, to meet your most exacting requirements, can be furnished in production quantities on special order. Your inquiries are invited.

JOHNSON
E. F. JOHNSON CO. • WASECA, MINN.

ELECTRONICS — April, 1949
NEW TV REVENUE from Pattern Time!

with the GRAY

TELOP

(TV Optical Slide Projector)

Dual projection capable of any desired optical dissolve
with exact density control

For advertising, photos, titles, programs, glass slides, transparencies or
small physical objects.

The TELOP is a TELevision Optical Projector for use with TV Film
Cameras. Great flexibility permits instant fading of one object to
another, change by lap resolve or by superimposing with exact density
control of each object for unique effects. The widest latitude is given
the program director for maximum interest and added station income.

Please write for descriptive bulletin T-101

GRAY RESEARCH & DEVELOPMENT CO., Inc.
16 ARBOR STREET, HARTFORD 1, CONNECTICUT

W. E. Ditmars, President

NEW PRODUCTS

(continued)

and application of soft solder
alloys and soldering fluxes.

Speed Control. Reliance Electric
& Engineering Co., 1076 Ivanhoe
Rd., Cleveland 10, Ohio. Bulletin
K-2101 explains how the VSS
short-stroke dancer roll provides
control tension for loops of mate-
rial in process and control of
motor speed in proportion to the
position of some object or mecha-
nism. Among other data presented
are a family of curves of available
range of VSS output and pictorial
and schematic representations of
a typical installation.

F-M Antennas. Andrew Corp., 363
E. 75th St., Chicago 19, Ill. Tech-
nical information on the high-gain
studio-transmitter link parabolic
antennas, (for use in the 920 to
960 mc f-m relay band), is found
in bulletin 902.

Precision Readings. Hewlett-Pack-
ard Co., 1756 Page Mill Rd., Palo
Alto, Calif., has published a four-
page folder giving detailed specifica-
tions on the type 400C vtvm and
two battery-operated instruments:
the 204A audio oscillator and 404A
vtvm. Prices of the instruments
are included.

Electromagnetic Unit. Meta-Mag-
net Associates, P. O. Box 3664,
Orlando, Florida. A recent folder
describes the Meta-Magnet, a new
form of electromagnet for demon-
stration purposes which attracts
nonferrous metals as well as iron.
On 60 cycles 115 volts the unit
described picks up and holds silver
coins and pieces of aluminum.

Logarithmic Attenuator. Kalbfell
Laboratories, Inc., 1076 Morena
Blvd., San Diego 10, Calif. A small
folder gives description, applica-
tions and specifications for the
Logaten, a wide-range logarithmic
attenuator whose output is pro-
portional to the logarithm of its
input for a range of 50 db.

Transformer Catalog. General
Radio Co., Cambridge 39, Mass. An
8-page catalog covers a line of new
Variac continuously adjustable
transformers. Essential dimen-
sions, illustrations and data to aid
in selection are included.
Tektronix Type S11-AD Oscilloscope $845 f.0.b. Portland

Wide Band, Fast Sweeps

The Type S11-AD, with its 10 mc. amplifier, 0.25 microsecond video delay line and sweeps as fast as .1 microsec./cm. enables the S11-AD to perform superlatively as a conventional oscilloscope.

Tektronix Type S12 Oscilloscope $930 f.o.b. Portland

Direct Coupled, Slow Sweeps

The Type S12 with a sensitivity of 5 mv./cm., DC and sweeps as slow as .3 sec./cm. solves many problems confronting workers in the fields where comparatively slow phenomena must be observed. Vertical amplifier bandwidth of 1 mc. and sweeps as fast as 3 microsec./cm. make it an excellent general purpose oscilloscope as well.

Both Instruments Feature:

- Direct reading sweep speed dials.
- Single, triggered or recurrent sweeps.
- Amplitude calibration facilities.
- All DC voltages electronically regulated.
- Any 20% of normal sweep may be expanded 5 times.

Phone 6197 Tektronix
Cables 712 S. E. Hawthorne Blvd.
Portland 14, Oregon

NEWS OF THE INDUSTRY (continued)

is available from the National Office of the Instrument Society of America, 1117 Woldendale St., Pittsburgh 12, Pa.

Tube Conference Program

TECHNICAL program for the AIEE conference on the industrial use of electron tubes being held April 11 and 12 at the Statler Hotel, Buffalo, N. Y., is as follows:

Monday, April 11

9:30 A. M. Session I—Industrial Electronic Control Applications—W. C. White of GE presiding:
- Electronic Control of D-C Motors, by Ben Cooper of GE.
- Electronic Regulators and Regulating Systems, by W. C. Roman of Westinghouse.
- Electronic Control of A-C Power, by E. W. Hutton of GE.

8:30 P. M. Dinner—Address on Control Aspects of Atomic Power, by K. H. Kingdon, Assistant Director of the GE Research Lab in charge of the Knolls Atomic Power Lab.

8:30 P. M. Session II—Problems of Electronic Equipment Users—J. A. Glenger of Eastman Kodak presiding:
- Effects and Need of Primary Voltage Control, by Frank J. Hosticka of Visiting Corp., Chicago.

Additional papers pertaining to the problems of the users of electronic control equipment are being organized with speakers from representative industries.

Tuesday, April 12

9:00 A. M. Session III—Problems of Electronic Equipment Design—H. L. Palmer of GE presiding:
- Tube Ratings as applied to Industrial Control Equipment, by O. W. Livingston of GE.
- Desirable Improvements in Tube Characteristics & Ratings, by P. H. Yelder of Westinghouse.
- Problems Related to Components Used in Industrial Electronic Equipment Design, by Roland Russel, of Clark Controller, Cleveland.
- Selection and Use of Capacitors in Electronic Control Equipment, by W. J. Thacker of GE.

1:30 P. M. Session IV—Problems of the Tube Deleter—O. H. Willis of Princetone, presiding:
- Ratings of Ignitrons for Rectification, by H. C. Stelner of GE.
- Ratings of Mercury Thyratrons, by L. L. Thoman of GE.
- Ratings of Radio Receiving Type Tubes, by George Van Bent of RCA.
- Phototube Characteristics, by A. M. Glover of RCA.

Loran Aids Cable Ships

Tests have recently proven the value of loran to the efficient operation of cable ships. Based upon experience aboard the C. S. Lord Kelvin, Western Union Telegraph Co. has reported the importance of the technique in maintaining the flow of communications through

Pull the trigger switch, make contact, and you solder. Then release the trigger and off goes the heat—automatically. No wasted time. No wasted current. No need to unplug the gun between jobs. The Weller Gun's flexiput heat only when in use—saves hours and dollars. Your Weller Gun will pay for itself in a few months.

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0.5 watts 4-32 mcs.
20 cps per mc for ambient change of 50° C.
5 cps per mc for ± 10% Line voltage.
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20 cps per mc to: Feadi-

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equipped local common oscillator injection voltage to re-
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Frequency section gives stability equivalent to that of
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for operation of receivers on a fixed frequency basis.
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and cathode ray oscilloscopes, which have
inputs of 1 megohm and 10 mmf, onto
signal circuits of 50,000 ohms and higher
—such as a periodic amplifier stage with
its high resistance plate load—without the
loss of voltage and high frequency re-
sponse which would result if the measur-
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Input Impedance: 200 megohms shunted by
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Gains of 1.00, 10.0, and 100. Frequency
Range from 5 cps to 150,000 cps within
2%. Background noise equivalent to 40
to 70 microvolts at the input.

Descriptive Bulletin Sent Upon Request

Keithley Instruments
1507 Warrensville Center Rd., Cleveland 21, Ohio

NEWS OF THE INDUSTRY
(continued)

the more than 30,000 nautical miles of
cable operated by the company.
The captain of the Western
Union Cable ship pointed out that
when certain cables lie close to-
gether loran enables correct chart-
ing of both, with subsequent ease
in returning to either when repairs
are necessary.

Sperry Gyroscope Co., manu-
facturers of loran, have announced
that deliveries of Mark 2 loran will
soon begin to the U. S. Coast Guard
and Army Transportation Service.

Electrical Engineering
Building Dedicated

F O R M A L DEDICATION of the new
$2,000,000 electrical engineering
building of the University of
Illinois at Urbana, Ill., will take
place May 19, 20 and 21. The build-
ing has ample classrooms and lab-
oratories for experimental work
in communications, illumination,
measurements, servomechanisms
and electrical machines.

Featured in the dedication cere-
monies will be a symposium whose
main theme is “Expanding Front-
tiers in Electrical Engineering.”
Topics and speakers are as follows:

Electron and Ion Dynamics, by
Albert W. Hull of GE, W. C. Hahn
of GE, and A. L. Samuel of the
University of Illinois; Semi-Con-
ductors, by Frederick S. Seitz of Carnegie
Tech, W. Shockley of Bell Labs,
and Lloyd P. Smith of Cornell Uni-
versity; Statistical Problems in
Electrical Engineering, by Norbert
Wiener of MIT, D. O. North of RCA
Labs, and K. Norton of National
Bureau of Standards; Application
in fields of Illumination, Machines
and Sound, by Ward Harrison of
Nela Park Labs, Gabriel Kron of
GE and William J. Fry of the Uni-
versity of Illinois.

BUSINESS NEWS

Radio Corp. of America, Camden,
N. J., recently awarded certificates
to sixty-nine engineers enrolled in
its sixth television technical train-
ing program. Since the beginning
of the program nearly 400 engineers
have received training in basic the-
ory, design, operation and mainte-
ELECTRONICS—April, 1949

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**Panoramic Ultrasonic Analyzer for easy, fast Ultrasonic Analysis**

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Yes, this is it—a genuine Brook High Quality Amplifier in the moderate price field. An amplifier of inestimable performance...equaling Brook 30 watt models in all respects.

Use of triode in all stages—together with Brook-designed transformers, permits electron amplification ever achieved. Distortion is reduced to the vanishing point.

No matter how discriminating you are, this new Brook All-Triode Amplifier will surpass your most exacting expectations. Hear this latest of amplifiers at your dealer's NOW!

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217

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Luxtron* photo cells convert light into electrical energy. No external voltage is required to operate meters and meter relays directly from Bradley photo cells, improving control over your processes, reducing your costs. House model shown. Many different sizes and shapes, mounted and un-mounted.

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82 Meadow St. New Haven 10, Conn.

NEWS OF THE INDUSTRY (continued)

nance of television broadcast equipment.

CORNING GLASS WORKS, Corning, N.Y., has begun mechanized production of 15 and 16-inch all-glass television bulbs by means of new types of glass-working machine. The process will permit price reductions of 24 percent.

WESTERN ELECTRIC Co., has installed over 500 specially designed air diffusers in its Allentown, Pa., plant to create the ideal environment for the manufacture of vacuum tubes, varistors and other precision electronic equipment.

TUNG-SOL LAMP WORKS INC., tube manufacturers, have expanded facilities by moving their Chicago plant to 351 E. Grand Ave., Chicago 11, Ill.

GENERAL ELECTRIC X-RAY CORP., Ltd. is the new name of Victor X-Ray Corp. of Canada, Ltd., manufacturers of medical and industrial x-ray apparatus and supplies.

STANDARD-THOMSON CORP., Dayton, O., will establish an electronics and aircraft equipment division as part of the company's increasing production for the aircraft industry. James P. Malstrom has been appointed head of the new division.

ACRO ELECTRIC Co., Cleveland, Ohio, manufacturer of snap-action switches, has changed its name to the Acro Switch Co.

BRANSON INSTRUMENTS, Inc., manufacturers of ultrasonic thickness gages and testers, have moved from Danbury, Conn., to larger
quarters at 436 Fairfield Ave., Stamford, Conn.

COIL CO. OF AMERICA, New York, N. Y., is the new name of Nigberg Electrical Labs., manufacturers of coils and special windings for television.

PERSONNEL

JAMES F. KOEHLER, engaged in airborne radar development during the war, is now chief engineer in charge of the design of specialized government and industrial electronic equipment at Philco Corp.

KENNETH H. KINGDON, for the past two years in charge of the Knolls Atomic Power Laboratory, has been made assistant director of the GE research laboratory, Schenectady, N. Y.

WILLIAM E. SHOUPP, manager of electronic and nuclear physics research at Westinghouse Research Laboratories since 1943, was recently named director of research of the company's new atomic power division.

WILLIAM BROWN, formerly with the RCA Laboratories industry service division, has joined the Television Equipment Corp. as secretary and chief engineer.

CAMERON PIERCE, ABC television operations supervisor in Hollywood, Calif., has been elected president of the Society of Television Engineers of Los Angeles.

SIDNEY L. CHERTOK, formerly associated with Solar Mfg. Corp., has been appointed to the application engineering staff of Sprague Electric Co., North Adams, Mass.

HENRY P. KALMUS, formerly with the research laboratory of Zenith Radio Corp., has been appointed to the staff of the National Bureau of Standards and will conduct investigations in advanced electronic techniques in the Bureau's Ordnance Research Laboratory.

RAYMOND F. FOSTER, a development engineer on television receivers at General Electric Co., Syracuse, received one of the 1948 Charles A. Coffin awards for his work on...
Z-ANGLE METER'S
Accuracy — Speed — Simplicity
PLEAS ES LANGEVIN ENGINEERS

AUDIO ENGINEERS:
Note This Report From Langevin

"The Langevin Manufacturing Corporation Development Laboratories finds the Z-Angle Meter extremely useful in the determination of transformer impedances. In the manufacture of amplifiers it is often necessary to determine the impedance existing within amplifier stages. Heretofore, these determinations have involved a long drawn out test procedure. The Z-Angle Meter, however, allows readings to be made accurately and quickly."

Their engineers say, "... the plate impedance of a resistance coupled triode tube can be determined by taking a reading with the Z-Angle Meter at the output terminals and then extracting the unknown from the mathematical formula for the impedance in parallel. This is only one of the many uses we have found for this instrument."

THE Z-ANGLE METER is a modern, self-contained instrument for making quick, accurate measurements of IMPEDANCE and PHASE ANGLE at audio frequencies.


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To those familiar with the history of Altec Lansing, its reputation in the top-level quality field is easily understood. Altec Lansing is best known as the designer and manufacturer of massive motion picture theatre speaker systems where highest obtainable quality out-weighs every other consideration. In the design and manufacture of a balanced line of speakers fulfilling every need for highest quality reproduction of sound—yet adaptable to more confined space, no compromise was made with quality. For the professional audio world and for the electronics industry generally, the history of Altec Lansing is the clue to its reputation.

Write for Descriptive Brochure — Altec Lansing Corporation, 1116 North Vine St., Hollywood 38, Calif., 163 Sixth Ave., New York 16, N. Y.

NEW THE INDUSTRY (continued)

the improvement of television receiver circuits.

FRANK H. ROCKETT, JR., formerly associate editor of ELECTRONICS, has joined the staff of Airborne Instruments Laboratory, Mineola, N. Y., to assist in editing and providing technical review for research reports published by the Laboratory. He worked on the proximity fuze project at the Applied Physics Laboratory of Johns Hopkins University and taught in the laboratories at Lehigh and Columbia Universities before joining ELECTRONICS in 1945.

JAMES W. MCRAE, formerly director of electronic and television research, has been placed in charge of development of transmission, switching and electronic apparatus at Bell Telephone Laboratories.


E. D. McARTHUR, holder of 39 patents in the field of electronics, has been promoted to head of the GE Research Laboratory's High-Frequency Electronics Division. He was formerly in charge of the uhf vacuum-tube section.

PHILIP N. ROSS, previously associated with Westinghouse as a central station engineer, and since 1946 assistant to the director of the power pile division at the Oak Ridge National Laboratories, has been appointed assistant director of research in the new atomic power division of the Westinghouse Electric Corp.

HAROLD M. HELMARK, former consulting radio communication engineer, was recently appointed chief
AIRBORNE RADIO
FOR ALL CLASSES OF AIRCRAFT
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HI-VOLTAGE REGULATED RF POWER SUPPLY

25 to 30 KV at 1 Ma. Maximum

Regulation within 1% from no load to full load at any output voltage within rating.

Within 1% for any voltage variations from 95 to 125 volts at any output voltage or load within ratings.

Ripple voltage within 1% at any output voltage.

No. of Tubes: 11

Dimensions: Length — 19", Height — 17¼", Depth — 15".

Also available in voltage ranges of 15 to 20 KV, 20 to 25 KV

Focus voltage tap available upon request for use with STP4 Projection Kinescope.

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...measures and records time intervals with a resolution of 1/1,600,000 seconds

This instrument determines and indicates directly the elapsed time between electrical "Start" and "Stop" signals derived from the beginning and ending of a time interval to be measured. A 1,600,000 c.p.s. crystal oscillator is used as the time base. The instrument, which is completely self contained, counts the number of cycles from this time base which occurs during the time interval measured. Price $925.00

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An Electronic Stop-Watch
for the measurement of time
10 microseconds to 1 second

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DESIGNED for universal application. Four ranges
-1, 10, 100 and 1000 milliseconds full scale. Accuracy is better than one scale division (1%) on any range.

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NEWS OF THE INDUSTRY (continued)

engineer for Doolittle Radio, Inc. of Chicago, Builders of precision radio communication equipment.

ROGER M. WISE, president of the tube consulting and engineering firm bearing his name, has joined Philco Corp. along with his staff of tube engineers. The Wise organization will occupy new laboratories in the Lansdale Tube Co. plant.

A. V. ASTIN, engaged in the development of proximity fuzes during the war, has been advanced from assistant chief to chief of the Electronics Division, National Bureau of Standards, succeeding the late Harry Diamond.

JOHN W. COLTMAN, former head of the x-ray section of the Westinghouse Research Laboratories, has been named manager of the Electronics and Nuclear Physics Department at the Laboratories.

J. W. NELSON, JR., formerly development engineer and sales engineer in GE's Government Division in Syracuse, N. Y., has been named head of the Air Force Sales Section in the division.

F. E. BAKER, formerly section engineering manager of Westinghouse Electric's Specialty Transformer Department, was recently appointed manager of the department.

D. F. J. SHEA, associated with the electronics division of the Bureau of Ships during the war, was recently elected a director and vice-president of Hazeltine Research, Inc.

HENRY A. STRAUS, previously with the Atomic Energy Commission and engaged in Navy radar development during the war, was recently appointed principal research engineer at Bendix Radio Division, Baltimore, Md.
NEW BOOKS

Vacuum Tube Amplifiers


Volume 18 of the MIT Radiation Laboratory Series.

The ten authors of Vacuum Tube Amplifiers have put a great deal of useful material into its fourteen chapters, and the two editors have kept it pretty much to the point. People doing work in the fields covered will want to refer to the book.

Most of the chapters deal with very practical matters, such as stagger-tuned and double-tuned interstages, feedback, pulse response, stabilized computer amplifiers, low-noise amplifiers and various gain and noise measuring techniques. Some matters which did not come within the scope of the work at the Radiation Laboratory are not dealt with, as for instance broad band amplifiers with much feedback such as Bode discusses, high-efficiency transmitter amplifiers, and phase equalization.

The approach is usually that of analyzing practical circuits and cases, citing experimental results and making an evaluation. The mathematics is chiefly algebraic manipulation.

Chapter 18 on Minimal Noise Circuits gives an especially good account of an important matter which is skimmed in most books.

Some chapters are different. Chapter 1 tells in 64 pages how to understand and use Laplace transforms in obtaining the transient response of networks. The 108 pages of Chapter 12 give a mathematical treatment of shot and thermal noise which will leave some who are able to understand a good deal of the book groggy. Most of the results given are worth having; however, equation 500, dealing with secondary emission noise, is wrong although equation 496 is correct.

This book isn’t like a handbook; many handbook-like results are presented, but they are derived as well as presented. The general results are often inferred after an analysis of many particular cases. Thus, grounded-cathode, grounded-grid and grounded-plate circuits are considered independently rather than as amplifiers with varying
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GET A PROCTOR SOUNDEX

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The Proctor Soundex Pickup System is designed to simplify and integrate the use of the many new types of pickup cartridges required with standard and microgroove records

NEW EXCHANGE CARTRIDGE CARRIERS...  
load your own cartridges in Proctor Soundex Carriers... have your whole selection ready for instant use... quick and easy removal of carrier permits frequent inspection, simple maintenance, speedy substitution of cartridges

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Be instantly ready to supply any length open fuse-mounting panel; also simplify your parts inventory. Stock all five available styles of this new Littelfuse 12-pole unit. Saw them to 1, 2, 3, 4 or more pole-lengths in your own plant as needed; or order them cut to your specifications.

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NEW BOOKS  
(continued)

amounts of feedback, and general remarks about the effect of feedback on noise figure are made later. Too, there is much emphasis on valuable particular information. The book should be accepted as what it is, an organized group of technical papers, mostly very good, fitting together well to cover a large segment of the very large field of vacuum-tube amplifiers. — J. R. PIERCE, Bell Laboratories.

Radar Primer


Since its declassification, many books and articles have been written about radar. For the most part, these treatments have been of a highly technical nature, far beyond the comprehension of the average citizen, or over-simplified discussions without any real meat. This book, however, gives a comprehensive treatment of this technical subject at the level of the student of elementary physics, the radio operator, the electronic technician and the teacher of general science.

The fundamentals of radar, the determination of distance, direction, and altitude, and the various methods of presenting this data are clearly described. The similarities, differences and limitations of marine and aeronautical radar sets, plus such special applications as the radar altimeter, beacons, air traffic control and ground-controlled approach (GCA) landing systems and long range navigation (Loran), are presented in considerable detail.

In addition, there are sections on point-to-point microwave systems, pulse-time and pulse-position modulation systems, sonar, the history of radar, and television, the latter section being more extensive than the others.

The book is well illustrated with photographs of actual radar sets, installations and indicator displays supplementing appropriate drawings and diagrams. The test questions at the end of each chapter and the selected bibliography at the close of the book will be of special interest to the serious students and
Radio Engineering


The jacket of this new volume for practicing radio engineers states that the book is "a storehouse of fundamental radio techniques, stressing practical methods and applications, designed for novice or expert."

There can be little quarrel with this bookmaker's blurb—the book has a great deal of fundamentals and a great deal of practical useful material much beyond the mere matter of calculating impedances and working with complex numbers. The fact that the book is by an Englishman and had its origin in instructions for BBC engineers means only that some of the terms are English and that it is a book of practice, not theory.

The first 250-odd pages deal with circuit components; then follow tubes, amplifiers, modulators, oscillators, transmitters and antenna systems. Although these are chapter headings which occur in many radio books, the treatment here is unusual in that one is taught the design of the circuit involved and the theory is treated only insofar as is necessary. How to line up class C amplifiers or line up long, medium or short-wave antenna systems, a great deal on amplifier load lines and how to use them, much about class B and C amplifiers, the causes of parasitics in r-f amplifiers, frequency multipliers and dividers are but a few of the topics covered.

In the chapter on oscillators will be found a clear analysis of the modified Colpitts circuit in which the tuning inductance and capacitance are in series, thus bringing much-needed light to a subject which has been written up rather extensively lately but without much clearness.

Such matters as receivers, meas-
Volume users of Special Fasteners and allied devices turn first to UNITED-CARR for cost-cutting design engineering service

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Separate voltage supplies eliminated

CHECK THESE FEATURES
Two continuously variable B supplies, from 0 to 300 volts at currents up to 120 ma.
One continuously variable C supply, from minus 50 to plus 50 volts at 5 ma.
One heater supply, 6.3 volts A. C. at 5 amperes.
Power requirements: 105 to 125 volts, 50 to 60 cycles.
Two 5Y3 rectifiers two 6Y6 control tubes.
Length 16", height 8", depth 83/4".
Wgt. 28 lbs.

The Kepco Multiple Power Supply is now widely used in schools and industrial laboratories.

Kepco ELECTRONIC INSTRUMENTS

NEW BOOKS (continued)
uring equipment, filter design, interference and noise, level compression and expansion are to be covered in a second volume not yet ready. The practical man or one who must learn while he plies his trade will find this a useful book.—K. H.

Industrial Electronics and Controls


This easily understandable survey of the theory and applications of electronics in industry was written primarily for college engineering students. Those who have had basic electron tube theory can omit the first five chapters. On the other hand, the first eight chapters can be used very nicely as an introductory course in tubes. Simple basic circuits receive emphasis, and operating explanations are based on the direction of electron flow throughout.

Industrial electronics is very properly introduced with a comprehensive chapter presenting twenty components and circuits for control. These include amplifiers, oscillators, saturable-core reactors, phase-shift circuits, free-wheeling circuits, time-control circuits, non-linear resistors, long-tailed pairs, light control devices, temperature-control devices, position-control devices, rotary amplifiers and anti-hunt circuits.

A chapter on servomechanisms and one on rectification and inversion complete the student’s preparation for the final ten chapters dealing each with a specific industrial electronic application, as follows: High-Frequency Heating; Resistance Welding; Electrostatic Precipitation; Electronic Operation of D-C Motors; Photoelectric Control Devices; Electronic Regulators; Electronic Power Controls; Amplidyne Servomechanisms; X-Ray Applications; Special Photo Applications.

Problems and questions appear after approximately half the chapters, and references are cited after most of the chapters. In general, the writing style is clear, concise
The Trend Toward Economy—

The service of the consulting engineer is a real economy. With his knowledge of organization and production problems and his wide and varied experience, he can usually reveal the points of waste and inefficiency that are costing you money and suggest inexpensive means for their elimination.
and to the point, with no attempt on the part of the author to show off how much he really does know. As a result, the treatment is well-rounded and ideally suited for engineering student use. Illustrations are well chosen and executed to teach as well as stimulate the interest of the reader.—J.M.

Books Received for Review

PRACTICAL ANALYSIS: GRAPHICAL AND NUMERICAL METHODS. By F. A. Wilpers, Professor at Freeburg Mining Academy; translated by R. T. Beyer, Dover Publications, Inc., New York, 1948, 462 pages, $5.00. Presentation, evaluation and comparison of the various numerical, graphical and instrumental methods available for analysis, over the entire range from simple slide-rule calculations through interpolation, integration, differentiation and empirical functions to mechanical integrators.

INSTALLATION AND SERVICING OF LOW POWER PUBLIC ADDRESS TUBES. By John P. Rider, John F. Rider Publisher, Inc., New York, 1948, 204 pages, $1.89. Fundamentals of sound theory, theory of microphones and pickups, impedance matching, amplifier and loudspeaker characteristics, suggestions for installing low-power sound systems (under 50 watts), and servicing.

PRINCIPLES OF RADAR. By Dennis Taylor and C. H. Westcott, The Macmillan Co., New York, 1948, 141 pages, $5.00. For engineers, physicists and advanced students who know radio and desire the over-all principles of radar. Future books in this British-authored series will cover radar techniques and radio navigation.

SCIENTIFIC AND INDUSTRIAL GLASS BLOWING AND LABORATORY TECHNIQUES. By W. E. Harr and Victor J. Anhorn. Instruments Pub. Co., Pittsburgh, 1948, 389 pages, $6.00. Practical instructions for experimenters in small laboratories who often have occasion to make simple glass seals themselves, and advanced information intended to help laboratory workers design complex glass equipment more intelligently. Considerable data on construction of samples of new vacuum tubes and similar devices, including glass-to-metal seals.


THÉORIE ET APPLICATIONS DES TUBES ÉLECTRONIQUES. By D. G. Field, Durand, 52, Rue Bonaparte (VI), Paris, 1948, 226 pages (paper cover), 1,560 francs (approx. $5.60). French translation of the author's book "Électricité Electronique", containing all the major sections of the programs but with all notations changed to equivalent French terminology.


BIBLIOGRAPHY ON X-RAY STRESS ANALYSIS. By H. R. Isenburger, St. John X-Ray Laboratory, California, N. J., 17 pages looseleaf, unbound, $3.50, 240 references and subject index.

April, 1949 — ELECTRONICS
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to efficient and economical produc-
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Classified Advertising Division
ELECTRONICS
Backtalk

This department is operated as an open forum in which our readers may discuss problems of the electronics industry or comment upon articles that ELECTRONICS has published.

TV Synchronization

Dear Sirs:

I was very much interested in your short note in "Cross Talk" on the possibility of splitting the video signal under certain conditions into a high-speed component and a low-speed component.

The history of the development of the composite video signal is quite obscure to me, possibly because I am one of the relatively late comers to the field of television. However, for a long time, we have felt that the present approach to transmitting all the needed information describing a video picture has led to many complications. The solution to these complications has often, in turn, produced others, most often costwise.

Pending an article in your magazine tracing the development and reasons for the composite video signal, I would like to offer for consideration the following modification of the signal.

Since the transmission of the picture information is, in itself, a major problem in camera design, the following proposal might lend itself to much simplification both at the transmitter and the receiver.

It is proposed that in any locality where television stations exist that a master station be set up, operating on a relatively long wavelength. This station would transmit only the synchronizing pulses. Each transmitting station could be linked to this master station by cable and have remote pickups by a radio link. All receivers in the area would have a section tuned to this master station.

With this station operating, the synchronizing and sweep systems of the cameras would be very similar to that used in receivers. Since all stations would be locked together by this master synch transmitter and all receivers are also

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linked to the same transmitter, as the receiver was changed from one station to the next, the picture would always be in frame. In addition, the problem of switching from one camera to the next is also simplified.

Often the limitation to receiving a picture is the weakness of the synch pulses. With the master transmitter operating on a longer wavelength, where the horizon effect is not as great, weak signals can probably be received successfully. In addition, since we visualize very strong synch pulses, which could even be of f-m nature, it becomes conceivable that the synch pulses in systems may be used to initiate the sweeps without recourse to intermediary timers.

S. L. REICHES
Leverox Engineering Associates
Cleveland, Ohio

AFC—ARC
Dear Sirs:
Existing nomenclature is frequently somewhat inadequate for use in connection with television circuitry. In specifying AFC in television receivers, a further qualification must be made as to whether reference is to local oscillator control or horizontal sweep oscillator control.

An arbitrary distinction might be made by applying the term automatic frequency control to sinusoidal oscillators, in this case the local receiver oscillator, and using the term automatic rate control, or arc, with reference to a pulse repetition oscillator, of which the horizontal sweep oscillator is a type.

LEO MACKA
Brooklyn, New York

Repeller Storage Tube
Dear Sirs:
It was stated in the original draft (p 106, Aug. 1948) that a signal-to-noise ratio gain of the \( \sqrt{10} \) (author's note: not "10") was theoretically possible, this improvement in signal-to-noise ratio for periodically recurring signals being obtained at a sacrifice in speed of reception. Reference to this reduction of speed was omitted from the published article.

The oscillograms reproduced in the published article were not properly matched and therefore contained misleading captions. The correct oscillograms with proper captions submitted by the authors were unfortunately misplaced by the publishers.

J. T. deBETTENCOURT
Raytheon Manufacturing Company
Walhalla, Massachusetts

H. KLEMPERER
MIT (formerly with Raytheon)
Cambridge, Massachusetts

Good Idea, But...

Dear Sirs:
STEVEN PANTAGES’ conductor-jumper safety suggestion (Backtalk, Feb. 1949) might be O.K. for low-current electronic and radio work, but in the case of high-power transmission lines, it’s a question as to whether it is better to get electrocuted by the juice or to get massacred by a blast of molten metal.

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Engineering Dept.
Hazelton Electronics Corp.
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1. At least 3 years practical experience in installation and maintenance.
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(COMPLETED FROM PAGE 251)

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GRADUATE ENGINEER seven years experience in aircraft and radar. Warranted by one year assignment under competent supervisor who can verify my knowledge and practical experience in electronic engineering or responsible technical position. PW 8215, Electronics.

TECHNICAL SECRETARY—Experienced in types of radion, television, and navigation. Can read schematics, technical rewriting. PW 8216, Electronics.

ELECTRONIC ENGINEER BSEE, 8 years excellent experience, electronics, microwaves, radar, electronics and some sales experience. PW 8224, Electronics.

ELECTRONIC ENGINEER, having both B.S. and M.S. degrees in electrical engineering, desires change. Background in television and electronics, desires part-time position N.Y.C. or vicinity. PW 8158.

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April, 1949 — ELECTRONICS

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**Step Down Transformer:**
- Pf: 440/220, 115/30, 750 volt isolation, 500va 750va.
- Price: $20.00

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  - DC: 400 ma
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- Measures frequency from 60 to 200 mc, by heterodyne method. Power of XN-9T can be seen on meter.
- Measures all voltages and currents. Meters are so designed that they may be operated on 110 v, 60 c. by conventional hand cranks. Meters are completely self-contained, col. chart, ammeter, voltmeter.

**Teleprinters**

- Original TELETYPE, with standard keyboard. DC meter: 250, type 35Y-Mar. 1,250 ma, 1700 rpm.
- Units are slightly used in excellent condition. As shown $105.00

**Photocell**

- Model 1045, 6000 ma, 12 volt, $9.50

**Vane Switch**

- 100 ma, 12 volt, $4.50

**Condenser**

- 400 mc, 3000 ma, 12 volt, $6.00

**Oil Condensers**

- $12.50

**Combinations**

- $10.00

**Transists**

- $12.50

**Relays**

- $12.50

**Power Supplies**

- Swing: Clock: 4 to 8 hr, 2 to 1 amp.

**Voltage Regulators**

- Pf: 115 v, 200 volt, 15 amp.
- Price: $15.00

**Filter Reactor**

- Pf: 115 v, 200 volt, 15 amp.
- Price: $15.00

**Combinations**

- $10.00

**Communications Equipment Co.**

- 131 “B” Liberty St., New York, N. Y. Dibby 9-4125

---

**BC-929 Scope**

An excellent foundation unit for a Hi-Gain Scope. Gives 100% of CC/TV display. Original (15/30 TV) oper., but simple conversion makes it 100% of CC/TV display on 110V, 60c. New. Complete w/3 tubes: 2N907, 2N697, 1N466. $110.00

**Great Tube Values**

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**Cox Cable**

- $24.95

**Universal Output Transformer**

- American: 1000, 1050, 1040, 1030, 1020, 1010, 1000, 950, 900, 850, 800, 750, 700, 650, 600, 550, 500, 450, 400, 350, 300, 250, 200, 150, 100, 50, 25, 10, 5, 2, 1, 0.5, 0.25, 0.1, 0.05, 0.025, 0.01. $75.00

**Potentiometer**

- 15,000 ohm.

**Ceramic Condensers**

- $7.50 per 100

**Carbon Pipe Voltage Regulators**

**Test Set 159 TPX**

- Measures frequency from 60 to 200 mc, by heterodyne method. Power of XN-9T can be seen on meter.
- Measures all voltages and currents. Meters are so designed that they may be operated on 110 v, 60 c. by conventional hand cranks. Meters are completely self-contained, col. chart, ammeter, voltmeter.

**Teleprinters**

- Original TELETYPE, with standard keyboard. DC meter: 250, type 35Y-Mar. 1,250 ma, 1700 rpm. $110.00
INVERTERS
12117-2, Pioneer. Input 24 volts D. C. Output 26 volts, 400 cycle, 6 V. A.
Price $20.00 each net.

153F, Holtzer Cabot. Input 24 volts D. C. Output 115 volts, 400 cycle
Price $125.00 each net.

Price $75.00 each net.

Price $40.00 each net.

149H, Holtzer Cabot. Input 28 volts at 44 amps. Output 26 volts at 250 V. A.
400 cycle and 115 volts at 500 V. A. 400 cycle.
Price $39.00 each net.

149F, Holtzer Cabot. Input 28 volts at 36 amps. Output 26 volts at 250 V. A.
400 cycle and 115 volts at 500 V. A. 400 cycle.
Price $35.00 each net.

12117, Pioneer. Input 12 volts D. C. Output 26 volts, 400 cycles, 6 V. A.
Price $22.50 each net.

5D21NJA General Electric. Input 24 volts D. C. Output 115 volts 400 cycle at 485 V. A.
Price $14.00 each net.

WESTON FREQUENCY METER
Model 637, 350-450 cycle, 115 volts.
Price $10.00 each net.

WESTON VOLTOMETER
Model 833, 0 to 130 volts. 400 cycle.
Price $4.00 each net.

PIONEER AUTOSYNs
AY1, 26 volts, 400 cycle.
Price $4.00 each net.
AY20, 26 volts, 400 cycle.
Price $5.50 each net.
AY30, 26 volts, 400 cycle.
Price $10.00 each net.
AY31, 26 volts, 400 cycle.
Price $10.00 each net.
AY32, 26 volts, 400 cycle.
Price $10.00 each net.

PIONEER PRECISION AUTOSYNs
AY101D, new with calibration curve.
Price $35.00 each net.

PIONEER TORQUE UNITS
Type 12602-1-A.
Price $30.00 each net.
Type 12606-1-A.
Price $34.00 each net.
Type 12627-1-A.
Price $70.00 each net.

PIONEER TORQUE UNIT AMPLIFIER
Type 12073-1-A.
Price $17.50 each net.

MAGNETIC AMPLIFIER ASSEMBLY
Pioneer Magnetic Amplifier Assembly Saturable Reactor type output transformer. Designed to supply one phase of 400 cycle servo motor.
Price $8.50 each net.

BLOWER ASSEMBLY
MX-215/AG
John Oster, 28 volt D. C. 7000 R. P. M. 1/100HP.
Price $2.90 each net.

RANGE GENERATORS
PM2, Electric Indicator Company, .0175 V. per R. P. M.
Price $7.25 each net.
F16, Electric Indicator Company, two-phase, 22 V. per phase at 1800 R. P. M.
Price $12.00 each net.
J36A, Eastern Air Devices, .02 V. per R. P. M.
Price $9.00 each net.
B-68 Electric Indicator Co., Rotation Indicator, 110 volts, 60 cycle, 1 phase.
Price $14.00 each net.

SINE-COSINE GENERATORS
(Resolvers)
PFE 43-1, Diehl, 115 volts, 400 cycle.
Price $20.00 each net.
FJE 43-9, Diehl, 115 volts, 400 cycle.
Price $20.00 each net.

SYNCHROS
If Special Repeater, 115 volts, 400 cycle. Will operate on 60 cycle at reduced voltage.
Price $15.00 each net.
211M1 Control Transformer 105-63 Volts, 60 cycle.
Price $20.00 each net.
211G1 Control Transformer, 57.5/57.5 volts, 400 cycle.
Price $1.90 each net.
211H1 Selsyn Differential Generator, 57.5/57.5 volts, 400 cycle.
Price $3.25 each net.
5G Generator, 115 volts, 60 cycle.
Price $25.00 each net.
W. E. K5-5950-L2, Size 5 Generator, 115 volts, 400 cycle.
Price $3.50 each net.
5G Special, Generator 115/90 volts, 400 cycle.
Price $15.50 each net.
55F Repeater, 115/90 volts, 400 cycle.
Price $19.00 each net.
221F1 Selsyn Generator, 115 volts, 400 cycle.
Price $3.50 each net.

Write for complete listings
Western Union Address: WUX Flushing, N. Y.

147-57 41st AVENUE FLUSHING, N. Y.
Telephone INdependence 3-1919

April, 1949 — ELECTRONICS
A. C. MOTORS

5071930, Delco, 115 volts, 60 cycle, 7000 R. P. M. Price $4.50 each net.

36228, Hayden Timing Motor, 115 volts, 60 cycle, 1 R. P. M. Price $3.15 each net.

Hayden Timing Motor—110 V. 60 cycle 3.2 Watts, 4 R. P. M., with brake. Price $4.00 each net.

45629R Hayden Timing Motor, 110 volts, 60 cycle, 2.2 watts, 1/240 R. P. M. Price $3.15 each net.

Eastern Air Devices Type 333 Synchronous Motor 115 V., 400 cycle, 3 phase, 8,000 R. P. M. Price $8.50 each net.

Telechron Synchronous Motor, Type 83, 115 volts, 60 cycle, 2 R. P. M., 4 watts. Price $5.00 each net.

SERVO MOTORS

CK1, Pioneer, 2 phase, 400 cycle. Price $10.00 each net.

CK2, Pioneer, 2 phase, 400 cycle. Price $4.50 each net.

FPE-25-11, Diehl, Low-Inertia, 75 to 115 V., 60 cycle, 2 phase. Price $16.00 each net.

FP-25-2, Diehl, Low-Inertia, 20 volts, 60 cycle, 2 phase. Price $9.00 each net.

FP-25-3, Diehl, Low-Inertia, 20 volts, 60 cycle, 2 phase. Price $9.00 each net.

MINNEAPOLIS HONEYWELL TYPE

8 Part No. G300AY, 115 volts, 400 cycle, 2 phase, built-in gear reduction, 50 in lbs. torque. Price $7.50 each net.

GYROS

Schwein Free & Rate Gyro type 45600 Consists of two 28 volt D. C. constant speed gyros. Size 8" x 4.25" x 4.25". Price $10.00 each net.

Schwein Free & Rate Gyro, type 46800. Same as above except later design. Price $11.00 each net.

Sperry A5 Vertical Gyro. Part No. 644841, 115 volts, 400 cycle, 3 phase. Price $20.00 each net.

Sperry A5 Amplifier Rack Part No. 644890. Contains Weston Frequency Meter. 350 to 450 cycle and 400 cycle, 0 to 130 voltmeter. Price $8.00 each net.

Sperry A5 Control Unit Part No. 644836. Price $7.50 each net.

Sperry A5 Azimuth Follow-Up Amplifier Part No. 656039. With tube. Price $5.50 each net.

Pioneer Type 12800-1-D Gyro Servo Unit. 115 volts, 400 cycle, 3 phase. Price $8.00 each net.

Norden Type M7 Vertical Gyro. 26 volts D. C. Price $19.00 each net.

Norden Type M7 Servo Motor. 26 volts D. C. Price $20.00 each net.

General Electric Type 8672162 Azimuth Gyro Assembly Contains Delco Type 5067125 Constant Speed Motor and Signal Assembly. Price $12.75 each net.

D. C. MOTORS

5069625, Delco Constant Speed, 27 volts, 120 R. P. M. Built-in reduction gears and governor. Price $4.25 each net.


58A1018D, General Electric, 27 volts, 0.7 amp., 110 R. P. M. Price $3.50 each net.

5066665, Delco Shunt Motor, 27 volts, 4000 R. P. M. Reversible, flange mounted. Price $4.50 each net.

C-28P-1A, John Oster Shunt Motors, 27 volts, 0.7 amps, 7000 R. P. M., 1/100 H. P. Price $3.75 each net.

D. C. AMACO FIELD MOTORS

5069600, Delco, 27 V., 10,000 R. P. M. Price $4.50 each net.

5069466, Delco, 27 V., 10,000 R. P. M. Price $3.00 each net.

5069611, Delco, 12 V., 10,000 R. P. M. Price $4.00 each net.

5069370, Delco, 27 V., 10,000 R. P. M. Price $4.70 each net.

5067125, Delco, 27 V., 10,000 R. P. M. With Governor. Price $6.50 each net.

S. S. FD6-16, Diehl, 27 V., 10,000 R. P. M. Price $3.75 each net.

S. S. FD6-18, Diehl, 27 V., 10,000 R. P. M. Price $3.75 each net.

S. S. FD-6-21, Diehl, 27 V., 10,000 R. P. M. Price $3.75 each net.

GENERAL ELECTRIC D.C. SELSYNS

8TJ9-PDN Transmitter, 24 volts. Price $3.75 each net.

8DJ11-PCY Indicator, 24 volts. Dial marked 
-10° to +65°. Price $4.00 each net.

8DJ11-PCY Indicator, 24 volts. Dial marked 0 to 360°. Price $7.50 each net.
SEARCHLIGHT SECTION

ELECTRO IMPULSE LABORATORY

TS-155B/UP SIGNAL GENERATOR, pulsed, calibrated output, 110 v. 60 cy. NEW.

TS-125/AP CALIBRATED S BAND POWER METER.

TS-110/AP S BAND ECHO BOX.

MUTUAL INDUCTION OR PISTON TYPE ATTENUATOR, type N connectors, rack and pinion drive, attenuation variable 120 decibels, barrel diameter 3/8", $30.00.

APR-1 RADAR SEARCH RECEIVER, complete with tuning units for range of 80-4000 mc, 30 mc I.F., 2 mc wide.

TUNING UNITS FOR APR-1 or APR-4 RECEIVERS (can be used with any 30 mc amplifier):
TN-17, range 80-300 mc
TN-18, range 300-1000 mc
TN-19, range 1000-2000 mc
TN-54, range 2000-4000 mc

X BAND VSWR TEST SET TS-12/AP, complete with linear amplifier, direct reading VSWR meter, slotted wave guide with gear driven traveling probe, matched termination and various adapters, with carrying case, new.

TS-13/AP X BAND SIGNAL GENERATOR, pulsed, calibrated output, 110 v. 60 cy.

X BAND POWER METER (TS-36/AP, 6700-9500 mc, .1 to 1000 milliwatts.

S BAND PICK-UP HORN AT-48/UP, with coaxial fittings $5.00.

S BAND MIXER, type N signal input, oscillator input, and I.F. output connectors, variable oscillator injection $17.50.

S BAND HIGH PASS FILTER, F-29/SPR-2 $12.00.

MICROWAVE TEST CABLE, RG-9/U cable with UG-21U connectors, 4/5 feet long $3.00.

NOISE FIGURE METER, 10-400 mc, measures N.F. to 14 db, 50 ohm impedance.

COMPLETE APS-4 RADAR, new.

COMPLETE SQ RADAR, 10 cm, 300 yards minimum, max. 3, 15, 45 miles, A, B, or P.P.I. presentation, 90-130 volts, 60 cps.

SD-3 SHIPBOARD RADAR EQUIPMENT, complete with all accessories, operates on 115 volts, 60 cps, new.

SA-1 RADAR TRANSMITTER, Receiver and Indicator, 115 volts, 60 cps, new.

GENERAL RADIO PRECISION WAVEMETER, type 724A, range 16 kc to 50 mc, 0.25% accuracy, V.T.V.M., resonance indicator, complete with accessories and carrying case, new $175.00.

125/APR ANTENNA $5.00.

TS-10/AP FOR APR-1 $40.00.

TS-203/AP CALIBRATED SELSYN $13.00.

TRANSFORMERS, 115 volts, 60 cps primaries:
1. 6250, 3250 and 2000 volts, tapped primary, voltage doubler, 12.5 kv ins. $14.00.
2. 6250 volts 80 ma, ungrounded, G.E., voltage doubler, 12.5 kv ins. $12.00.
3. 2 secondsaries at 500 volts 5 amps each, wt 210 pounds $50.00.

PULSE INPUT TRANSFORMER, permalloy core, 50 to 400 kc impedance ratio 120 to 2350 ohms $3.00.

PULSE TRANSFORMER, UTAH 9280 $1.50.

PULSE TRANSFORMER, GE 68G, 828G-I $5.00.

PULSE TRANSFORMER, Westinghouse 145-EWP $10.00.

HYPER SIL CORE CHOKE, 1 Henry, Westinghouse L-422041 or L-422032 $3.00.

VARISTORS: WE D-171520, D-161827-1 each $0.75.

Clough Bringle Resistance Capacity Bridge, model 230A, new $50.00.

Audio Signal Generator, Hickok 198, RC tuned 20-20,000 cps $45.00.

CONNECTORS:
UG-10/U .80 SG-100/U .72 G-100/U .68
UG-12/U .80 SG-200/U .72 G-200/U .68
UG-21/U .80 SG-250/U .72 G-250/U .68
UG-24/U .80 PL-259 .28
UG-25/U .80 (for small cable)
UG-27/U .50 M-359 .28
UG-29/U 1.00 SG-266 .68
UG-30/U 1.00 SG-259 .68
UG-30/U special 1.00
UG-58/U 1.00 PL 54 .10
UG-59/U 1.00 PL 81 .50
UG-83/U 1.00 AN-3102-145-5P .25
UG-84/U 1.00 AN-3102-145-2P .25
UG-167/U 2.00 RC-10066-20-4P .50.

TUBES:
W.E. 704A MINIATURE DIODE, and 705A H.V. RECTIFIER $2.00 each.

METERS:
0-350 VOLTS, WESTINGHOUSE NX-35 METER, 1000 ohms per volt, 3/4".
0-200 MICROAMPS, MARION 2/3" SEALED METER, scale 0-100 $45.00.
0-8 AMPS R.F. SIMPSON TS-89, 2% to 10 mc $40.00.
0.3 MA TRIPLETT 3" square $4.00.
0.1 AMPERES TRIPLETT 327-3, 3" square $4.00.
1-0.1 MA, MARION SEALED METER HB5, scale 1-0.1 mA, and 1/0.1 mA, new $4.00.
100 AMPERES METER SHUNT, G.E., for 500 meter $1.50.

W.E. NETWORKS:
D-161638, D-161844, D-162627, D-162629, D-162631, D-162632, D-162634, D-162635 $1.00 each.

CAPACITORS:
Feed thru, ceramic, 55 mmd, 1000 VDC, threaded .10 each.
Feed thru, silver mica, disc type, 300 mmd, 500 volt, .20 each.
Ceramic double cap, 55 mmd, 10,000 v, .50 each.
Mica .005, 2500 W.V. DC, .05 each.

TRANSMITTING OIL-FILLED CAPACITORS:
2 mfd 1000 WV 1.00.
1 mfd 2500 WV 1.50.
25 mfd 4000 WV 90.
13 mfd 4000 WV 1.00.
2 mfd 4000 WV 5.00.
1 -- 1 mfd 7000 WV 2.00.
075 -- 075 mfd 10000 WV 5.00.
2 mfd 15000 WV 25.00.

BATH-TUB CAPACITORS:
1 -- 1 mfd 400 WV .08.
1 mfd 600 WV .08.
5 -- 5 mfd 1000 WV .35.
5 -- 5 mfd 300 WV .25.


Leo PN 20 E for MN26, D.F., new $10.00.

Flexible aluminum alloy conduit, with tinned copper braid, I.D. 1/2", 3/4", 88" long, with fittings .50.

Stranded aluminum flexible shield conduit, I.D. 3/8" .05 ft.

ELECTRO IMPULSE LABORATORY

6 Broad St. Red Bank 6-4247 Red Bank, N. J.

April, 1949 — ELECTRONICS
Gasoline Heater—Motorola Model GN-3-24

An internal combustion type heater which will

give 15,000 B.T.U. of heat per hour. Ideally suited
for use with equipment, boats, bungalows, and
residences. W. H. 2" rd for use with equipment,
cabins, trailers, work sheds, livestock, mobile
equipment, transmitter stations, and any place
where a quick heat is required in volume.

Very economical in operation—tank holds one
gallon of gasoline which is sufficient for 6 hours
operation. Does not require maintenance.

This unit is designed primarily for aircraft
installation. However, if used on extrametallic
and can be readily adapted to a 115 or 230 volt 60 cycle power supply
or other types of a similar public service and radiation. Similar car
per unit for installation and an
installation of additional transformers, etc. Power
consumption approximately 110 to 115.5.

Approximately 12" long x 9 ½" high x 6" wide.

Complete with technical manual and parts list.

@ $22.50 F.O.B. N. Y.

COMBINATION OFFER

150 VOLT A.C. METER

Triplet 331-3, 35/2% rd flush case

30 AMP A.C. METER

Triplet 331-3, 35/2% rd flush case

Both meters for $7.95

D. C. MILLIAMMETERS

0-1 Dohr Ammco 24/6 rd Spec. Sc. $2.50
0-1 G.E. 23/6 rd, ac cal. 100-250 $3.50
0-1 SIMP 125 sq 24/6 rd Spec. Sc. $3.50
0-10 G.E. 7/2 sq 24/6 rd Spec. Sc. $3.50
0-100 G.E. 12 sq 24/6 rd Spec. Sc. $3.50
0-1000 G.E. 32 sq 24/6 rd Spec. Sc. $3.50
0-5000 G.E. 70 sq 24/6 rd Spec. Sc. $11.50
0-2500 G.E. 35 sq 24/6 rd Spec. Sc. $11.50
0-10000 G.E. 70 sq 24/6 rd Spec. Sc. $30.00
0-50000 G.E. 70 sq 24/6 rd Spec. Sc. $75.00

D. C. AMMETERS

0-15 G.E. 23/6 rd $2.50
0-2 Simp 25/6 rd, d c, bake case $2.50
0-5 G.E. 23/6 rd, d c, bake case $3.00
0-15 Simp 25/6 rd, d c, bake case $3.00
0-30 G.E. 23/6 rd, d c, bake case $3.50
0-60 G.E. 23/6 rd, d c, bake case $4.50
0-120 G.E. 23/6 rd, d c, bake case $6.00
0-200 G.E. 23/6 rd, d c, bake case $9.00
0-600 G.E. 23/6 rd, d c, bake case $12.50
0-1200 G.E. 23/6 rd, d c, bake case $20.00
0-2500 G.E. 23/6 rd, d c, bake case $40.00
0-6000 G.E. 23/6 rd, d c, bake case $80.00

D. C. VOLTMETERS

0-5 Simp 23/6 rd, d c, bake case $2.00
0-5 G.E. 23/6 rd, d c, bake case $2.50
0-15 G.E. 23/6 rd, d c, bake case $4.00
0-30 G.E. 23/6 rd, d c, bake case $6.00
0-60 G.E. 23/6 rd, d c, bake case $8.50
0-120 G.E. 23/6 rd, d c, bake case $14.00
0-180 G.E. 23/6 rd, d c, bake case $24.00
0-300 G.E. 23/6 rd, d c, bake case $45.00
0-500 G.E. 23/6 rd, d c, bake case $75.00
0-750 G.E. 23/6 rd, d c, bake case $110.00
0-1500 G.E. 23/6 rd, d c, bake case $210.00
0-2500 G.E. 23/6 rd, d c, bake case $430.00
0-5000 G.E. 23/6 rd, d c, bake case $940.00

All items are Surplus—New. Guaranteed. C.O.D.'s not sent unless accompanied by 25% Deposit.

Orders accepted from radio enthusiasts, public institutions, etc., on open account.

The above is only a partial listing of the many items we have in stock. Our catalog is circular.

NOTE—We Supply—all items are Surplus—New Guaranteed. All prices FOB, NY.

MARITIME SWITCHBOARD

336 Canal Street. Worth 4-8217. New York 13, N. Y.

ELECTRONICS — April, 1949

www.americanradiohistory.com
AUTOSYNS

Pioneer Types
AT-1, AT-14, AT-20, AT-30, AT-54D, 2320, and AT-101D.

Price on request

Pioneer Fuel Pressure Transmitter Type C-44A. 0-15 lbs. 25 v. 499 cycles. Stock #SA-131. Price $0.75 each.
Pioneer Oil Pressure Transmitter Type 4150-31B. 0-500 lbs. 25 v. 499 cycles. Stock #SA-28. Price $0.85 each.
Pioneer BZA Dust Oil Pressure Indicator. 0-200 lbs. Use with BS-25, Stock #SA-231. Price $0.60 each.

D. C. MOTORS

Blower Assembly
MX-215/APG

John Oster, C-EP-1L 28 v. DC. 1/100 hp. #2 L-R Blower.
Stocker #SA-202. Price $3.95 each.

Universal Electric DC
W.E. KS-5605-L22, 28 v. DC. 0.6 amps. 1/100 hp. 4 lead shunt. Stock #SA-233.

Delco 5000416 Motor
Alinco PM field. 27.5 v. DC. 1/4" x 1" x 2" ins. Fitting gear on shaft. Stock #SA-65. Price $2.95 each plus 15c p.p.

EMC DC Gearhead Motor

Also

Many other types
Makes and Ratings

DYNAOMOTOR

D-101, 27.5 v. DC 1/5 amp. DC output 285 v. @ .060 amps. Stock #SA-187. Price $1.50 ea.

C-1 Autopilot Servo Unit—25v. DC shunt motor. 2250 rpm. 2 magnetic clutches, reduction gear, differential and 2 magnetic brakes. Output shaft 16 rpm. Torque 255 in/lb. Stock #SA-190 Price $10.50 each.

Open account shipments to rated concerns All prices F.O.B., Paterson, N. J.

April, 1949 — ELECTRONICS
**SEARCHLIGHT SECTION**

**VOLTAGE REGULATOR**
Any unfiltered source of 500-400 volts DC may be converted to this unit to provide damped and regulated current at 116-117 volts. Contains 24 Hz. Former, 6-3/4 in. in position: Bleeder, diode and current limiter resistors, etc. Ideal for the lab for experimental set-ups. Complete, brand new with 3-VH 100 tubes.

Brand New $7.95

**STEPDOWN TRANSFORMER**
115V, 60 cycle output. 48 V, 15 amp. Full waveform for plate light. Ideal for Selenium Rectifier Applications, etc.

Brand New $2.45

**BRIDGE TYPE Selenium Rectifier**

Brand New $2.75

**LINEAR SAWTOOTH POTENTIOMETER**
W.E. No. KS 15158
The d-c potentiometer consists of a dished type die-cast aluminum alloy frame containing a continuous resistance winding in which electric power is 180 degrees out of phase with the brush. Two fixed brushes (180 degrees apart and bearing on the resistance winding) and two take-off brushes are provided for the output source. Varying the position of the brushes varies the output voltage in accordance with a linear sawtooth wave. This potentiometer is equipped with 24-volt direct current, is arranged for panel or bracket mounting, and approximately 1-1/16 inches in diameter, 2 inches deep, 1-1/2 inches high, and has an external diameter of 1-1/8 inches. All terminations are made through a standard A.N. type connector.

Brand New $5.75

**PARABOLOIDS**
Ideal for microwave experimental use, beautifully built and made of fully reinforced 1/4 inch aluminum, with a 1/2 inch horizontal and vertical adjustment. The parabola is 17 inches in diameter, 1/2 inch thick. Center hole 1-1/2 x 1-1/2 inch. For operation at 116V D.C. at 50 cycles per second.

Brand New $125.00

**NAVY MOTOR GENERATORS**
Allis-Chalmers
115V, D.C. to 120 A.C. 60 cy. 1 ph. 1-1/2 HP V.A. 3600 RPM, ball bearings, centrifugal starter, fully enclosed, splashproof.

Brand New $27.50

**Panoramic Adapter**
AN/APA-10
Includes 21 tubes and 3 scope tube. Certified for operation 115 v. 60 cycles. Tested and guaranteed in perfect operating condition.

$195.00

**Western Electric Mercury Contact Relays**
**Type D-168479**
These relays are glass sealed, mercury-wetted contact switches surrounded by operating coils and encased in metal housings, mounted on an octal tube base.

**TYPICAL APPLICATIONS**
- High speed keying
- Tabulating, sorting and computing machines
- Relay Amplifiers
- Vibrator Power Supplies
- Servo-mechanisms

**CHARACTERISTICS**
- High speed of operation
- Constant operating characteristics
- Freedom from chatter
- High current capacity
- Long, trouble-free life

Single Pole, Double Throw Contacts. Two coils of 700 ohms and 3300 ohms. Operating current with coils connected in series 6.6 ma. Release current 5.2 ma.

When operated under specified conditions, this relay has a life expectancy of 1000 hours at 60 operations per second.

Overall length—3-3/8" Overall dia.—1-5/16" Brand new Priced at a fraction of Government cost $4.75

Send for 4 page Technical data.

**Sound Powered Telephones**
**Type TP-3**
For two-way signaling for use with communication No. 9 batteries. May be used on metallic or ground circuits, open wire line, cables or systems using local-battery telephones, switchboards, two-way, ring-down systems circuits of common-battery switchboards, etc. Contained in treated waterproof fabric case with adjustable carrying strap.

Brand New $39.50

**SERVO AMPLIFIER**
G.E. Type SVC1LV1 including dust cover not shown.

**BRAND NEW** $9.50

**10 CM WAVEGUIDE**
Solid bronze, 90° elbow flatwise bend.

Brand New $20

**SO-1 RADAR ANTENNA ROTATORS**
These Radar Antenna Rotating mechanisms are now being used in many television companies and experimental laboratories for rotating microwave and other transmitting and receiving equipment. The SO-1 Radar Rotator is designed for this purpose because of its high torque and smooth, weatherproof construction. These mechanisms consist of a high precision, variable D.C. Motor. On the low-speed end of the worm shaft, there is driven a large spur gear attached to the rotating assembly. The latter is essentially held in position by the gear train where the drive motor is off, preventing drifting of the antenna in high winds.

Brand New $249.50

*Return Direction Indicators equipment specifically designed for use with these Rotators is available on special order. Write for further information.*

**SHOCK MOUNTS**

All Merchandise Guaranteed. Immediate delivery, subject to prior sale.

All Prices Subject to Change Without Notice

**ELECTRONICraft INC.**
5 WAVERLY PLACE TUCKAHOE 7, N. Y.
PHONE: TUCKAHOE 3-0044

April, 1949 — ELECTRONICS
Guaranteed by WELLS

Brand new, standard make tubes by the thousands are ready for immediate delivery at the lowest prices in our history. Check this list for exceptional values in magnetrons, cathode-ray tubes, voltage regulators, transmitting tubes and also neon, pilot and flashlight bulbs. Be sure to order enough for future needs directly from this ad or through your local parts jobber.

<table>
<thead>
<tr>
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<td>R7/92A</td>
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Stock Manda No. Valves Watts Bulb Base Price
350-50 64 6-8 E3 CP G-6 DC Bay 0.60
350-50 1520 23 1 amp. T-3 Min. Bay .12
350-31 57 12-15 1.5 CF G-1 Min. Bay .08
350-22 Spec. 12 2.5 Watts G-3 Min. Ser. .08
350-50 1446 12 2.5 watts G-3 Min. Bay .14
350-14 49 2 2 amp. T-4 Min. Flang .06
350-15 396 120 3 watts H-4 Min. Ser. .06
348-22 P6-10 8 5 watts T-3 Min. Ser. .12
350-15 1477 24 17 amp. T-2 DC Bay .22
350-55 293 3 (AIRCRAFT) T-2 Min. Ser. .22
LB-103 44 (Ruby) 6-8 25 amp. T-3 Min. Bay .14
LB-102 1150 12-16 10 CP T-11 DC Bay .14
LB-104 313 28 17 amp. T-3 Min. Ser. .11
350-24 134 12 .09 amper. 11 T-3 Tel Base .18
LB-107 24-A2 W E 24 75 amp. 105 T-2 Tel Base .18
LB-109 TELEPHONE TYPE NEON T-2 .17
350-41 945 6-8 100 CP 80-13 S. C. Pref. .17
350-43 11A/T4C 11 .11 amp. T-4 Cond. Ser. .14

Pilot and Flashlight Bulbs

Manufacturers: We carry thousands of electronic parts in stock.

Send us your requests for quotations.

Distributors: Our standard jobber arrangement applies. Order directly from this ad.

320 N. LA SALLE ST., DEPT. SL, CHICAGO 10, ILL.

April, 1949 — ELECTRONICS
**NOTE THE NEW ADDRESS!**

**JONES BARRIER STRIPS**

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**DIFFERENTIAL**

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<td>1</td>
<td>$2.25</td>
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</table>

**HC-100V, 60 Cyc.**

Used between No. 56084 as damper. Can be converted to a HC-6084M core in 10 minutes. Conversion sheet supplied.

**HARDWARE**

**SHAVE WIZZER**

- Screw, note, washers, socket lug 3 lbs. $1.00
- Allen Sets Screws, 4-40 x 3/4, 6-40 x 2 1/2, 8-40 x 5/8, 10-40 x 3/4, 11-40 x 1/2 24.00

**PILOT LIGHTS**

- No. 41, 50 V., 60 Cyc.
- $19.50

**BUCKY FEET**

- 3 1/2" white .25
- 3 1/2" black .25

**STEEL JUNCTION BOX**

Water-tight, 14 ga. steel, 17"x35"x6 1/2". Screw type with brass lagging on back. Approx. 40 lbs. $17.50

**CHROMALOX STRIP HEATER**

115 V. A. C. 60 Cyc. 12" x 1/2" strip 6,000 W. 2/3 x 24" strip 5,000 W. 5/3 x 30" strip 4,000 W. $25.00

**SILVER MILLS**

- 12" x 1/2" strip 6,000 W. $25.00
- 5/3 x 30" strip 4,000 W. $20.00

**NEEDLE BEARINGS**

- 1 1/2" white .25
- 1 1/2" black .25

**RELIANCE MERCHANDIZING CO.**

12th St. Cor. Buttonwood
Telephone Stevenson 7-3035

**SEARCHLIGHT SECTION**

**PULSE TRANSFORMERS**

<table>
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<tr>
<th>No.</th>
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<td>115 V.</td>
<td>.45</td>
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</table>

Any order for 10 pieces—10% off; for 1,000 pieces—20% off.

**NEW CATALOGUE**

Send 5 cents for new catalogue. It is complete and illustrated.

MINIMUM ORDER $5 All orders f.o.b. PHILA., PA.
BUFFALO RADIO SUPPLY, one of America's largest electronic distributors, is in position to supply most of the requirements of radio repairmen that are directly or indirectly connected with the government. Importers are solicited both from export houses and from foreign government purchasing commissions here and abroad. EXPENSE CAN BE REDUCED AND REQUIREMENTS FILLED WITH A MINIMUM OF DELAY BY CONTACTING BUFFALO RADIO SUPPLY.

SEARS SEARCHLIGHT SECTION

BUFFALO RADIO SUPPLY, 219-221 Genesee St., Dept E

APRIL, 1949 - ELECTRONICS

1. SENSATIONAL, FASCINATING, EXCITING

RT-1248 15-TUBE TRANSMITTER-RECEIVER
TERRIFIC POWER - (50) watts on any two of the 15 tubes, which means this receiver will do the work of 50 receivers. Ideal for general broadcasting on any frequency from 435 to 580 meters. Designed by Stromberg-Carlson and made in the U.S.A.

Sensational Value in AC-DC Pocket Tester
This instrument is manufactured by the Tube Laboratory and is designed for those who make use of an AC-DC pocket tester. It is a highly portable instrument that will be found in every radio shop.

General Electric RT-1248 15-Tube Transmitter-Receiver

VACUUM TUBE VOLT-Ohm-CAPACITY METER
The instrument designed and built by the Tube Laboratory is a fully automatic instrument for testing the performance of any vacuum tube. It is designed to give a direct reading of the voltage, ohms, and capacity of any vacuum tube. The instrument is easy to use and is ideal for engineering work.

PE-109 POWER PLANT

REMOTE CONTROL UNIT

Bike Radio

BIKE RADIO

BUFFALO RADIO SUPPLY, 219-221 Genesee St., Dept E

April, 1949 - ELECTRONICS
ELECTRONICS Tremendous stocks issue 3/3

250 Ohms

1500

20

3.50

.0001 mfd

.01

.002 Watt

.002

3.00

1500

20

1.5

.0005 mfd

Types

Deduct 25%

2500

1.50

.0001 mfd

1.25

.0001 mfd

.0005 mfd

W. W. POWER Rheostats

25 Ohms

300 Ohms

50 Ohms

40, 80, 80, 15, 50

.008

.01

.002

.0003 mfd

200 Ohms

25 Watt

.003

25 Watt

50 Watt

WIRE WOUND RESISTORS

5 Watt Air Wnd: 20, 50-200-500-2500

4000 ohms

10 watt type AB, 25-40-84-40-760-1325

1900-2000 ohms

21 watt type BD, 25-50-100-250-500-1000

2000-5000 ohms

1000-10000 ohms-2000-20000-50000-100000

ADJUSTABLE RESISTORS

20 Watt: 1, 5, 50 Ohms

50 Watt: 80, 100, 150 Ohms

75 Watt: 150, 200, 250, 300 Ohms

100 Watt: 250, 300, 500, 750, 1000 Ohms

1500, 2500 Ohms, 100 Watt Female Resistors.

220 Vac. 50/60 c.p. 1/10 Watt

Any Taps from 2 to 254

DUNC RELAY DPDT 6 Volt 60 cycle coil. A.C.

$1.69

OIL CONDENSERS

As above P.T.D. $1.95 each.

As above but 4000 ohms DC Coil.

1.75

MEGOMETER

Variety of Instruments model L-25A 110 volt, 3000 ohms. Input: Direct reading from 0-10000 ohms. Range selector can be extended to 80000 for external use. Storing by hardwire... 

10,000 60 cycle Brockway Coils.

$7.95

**FINES OF SURPLUS**

**PEAK ELECTRONICS CO.**

**FAVORITE CERAMICOS**

1.5 to 7 Megs.....24 4 to 30 Megs......24 2 to 10 Megs.....24 7 to 40 Megs.....24

**FIXED CERAMICS**


$5.95 each

**PHASE SHIFT CIRCUIT**

4 Stage Single Rotor, 0.300 Degree Rotation......Only $2.95 each
MOBILE H.F. ROTARY ANTENNA ARRAY

Operating from 12 volts DC, this equipment (known as RC-163 Radio Beacon Eqpt.) will serve most of the antenna needs of mobile installations. Also ideal for mobile stations, the equipment is designed for 20 to 40 mc operation without any other changes than that of a small plug-in inductor. Four coils are supplied for this frequency coverage, but other coils can be easily made for higher or lower frequencies.

Design is direct coupled for horizontal polarization. Code keyer easily removed for straight transmission. Power consumed approximately 54 watts (4.5 amps.), when rotating motor is "ON." Rotation is clockwise, and 7 1/2 rpm. Supplied with antenna array, antenna mount with rotating motor, two discs, radio oscillator, phase shifter, detector, tuning indicator-receiver which checks field strength as well as frequency, valuable compass and tripod, control panel, all necessary cables and complete technical manuals for installation, theory and service. Equipment is NEW and export packed, two cases per complete set.

$169.50

RADIO TRANSMITTERS, MODULATORS, AND POWER SUPPLIES

Immediate Delivery from Stock

2.5 KW Press Wireless. Model 2A consisting of 2 sections—one, the 2.5 KW power supply, second section containing exciter-driver stages with crystal-controlled oscillator (with over load protection). Excluding control. Operation from 10 mc to 25 mc. Operates from 220V. 50/60 cycles A.C., condition. WRITE FOR PRICE.

2 KW Power Amplifiers, as described above power amplifier section and power supply only. Will be built only with COMPLETE power pack. Also, ideal as an spare PA and power supply for above. WRITE FOR PRICE.

T.E.—Radiomarine Transmitter, 125 watts Continuous Wave (Mobilite A1, A52), complete, new. Each 24.00

5.5 KW Transmitter, as described above. Each 28.50

30 KW Transmitter, as described above. Each 32.00

30 KW Transmitter, as described above. Each 32.00

40 KW Transmitter, as described above. Each 35.00

60 KW Transmitter, as described above. Each 38.00

80 KW Transmitter, as described above. Each 40.00

100 KW Transmitter, as described above. Each 42.00

150 KW Transmitter, as described above. Each 45.00

200 KW Transmitter, as described above. Each 48.00

300 KW Transmitter, as described above. Each 50.00

500 KW Transmitter, as described above. Each 52.50

1000 KW Transmitter, as described above. Each 55.00

Prices F.O.B. N.Y.C. All Material Offered Subject to Prior Sale

TELEMARINE COMMUNICATIONS COMPANY

280 Ninth Ave., N. Y., N. Y.
Famous SCR 274-N
A Complete Radio Station

**TRANSMITTERS & RECEIVERS FOR 10-20-40-60 METERS**

**$39.50**

This sensation of all surplus is a complete amateur radio station! Other ways to use it: Xmr. VFO driver stage gives your BC-275-E RF output up to 150 watts. Make swell standby receivers with the RC-368 on round-table "true chews." You get all this: 3 receivers—195-550 kc. "Lazy Q Fiver," 8-6 and 6-9.1 mc; 2 xmrts, 4-6-3 mc, 5-7 mc; 4 dynamos—25 v DC input; 1 modulator with carbon mike input; 2 control boxes; 1 coupling box with r-f ammeter, act. relay and 5000 v. 55 mmfd. WE vacuum condenser (ant. relays can be used with most rigs); and a complete set of 25 popular tubes. CAN BE SHIPPED F.O.B. ARIZONA, OKLA., OR VIRGINIA.

We still have a few BC-313 transmitters available at $20 each for Arizona complete with 6 tuning units. Transmitter and 1 tuning unit, dynamotor, antenna loading unit—F.O.B. Oklahoma, only $15.00.

---

**APN-4 RCVR—SCOPE POWER SUPPLY**

4 switch-selected screw-driver tuned RF channels; IF freq. 1060 kc, band-width 45-60 kc; RF freq. 16 2000 kc. Tubes: (2) 2Y2, (3) 6814, (4) 6SK7, (1) 6AQ5, 11AT, 11AX7, 12AT7, 12AX7, 6HC5. Makes fixed tuner for mod. freq. police calls or PA systems. Also single cylinder, 2-cycle gasoline engine generator that is rated at 2000 watts direct current, 79 amps. Ideal for job around the farm; useful as field day power supply. More literature upon request.

**THE FAMOUS "PUTT-PUTT" Gasoline Generator (HRU-28)**

**32 - 32 Volts D.C. ONLY**

Single cylinder, 2-cycle gasoline engine with generator that is rated at 2000 watts direct current, 79 amps. Has unlimited use around a farm; useful as field day power supply. More literature upon request.

**$74.50**

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**DUAL POWER SUPPLY**

**LOW DRAIN & VOLT TRANSMITTER**

AND RECEIVER POWER SUPPLY

Use our dual dynamotors by wiring them in series and use one on receivers and both in transmitter. High voltage output 600 volts at 48 watts. Low voltage 300 volts at 24 watts.

**SAVE YOUR BATTERY!**

**$4.95 each**

Both for $8.95

---

**INTER-COM**

Factory Close-Out!

Brand New and Priced for Quick Clearance!

**Limited Quantity**

**$14.95**

(List price $34.95)

Price includes master station, one remote, and 59¢ of price. Use it up as a "baby-sitter" with pickup at baby's crib, useful in office, or for instant contact with basement, garage, attic, kitchen. Simple to install—plug it in to 110 v. AC or DC socket.

---

**TRANSFORMERS**

For converting SCR-274-N to 115 Volts AC.

**No. 1 Power Transformer. Pri.—115v 60 cycle; sec.—500 CT. .06 Amp. 24v 4% amp.**

Price only $3.90

**No. 2 Filament Transformer. Pri.—115v 60 cycle; sec.—1—14v 7½ amp.; sec. 2 14v 7½ amp. Series 500 7½ amp. Parallel 14v 15 amp.**

Price only $4.50

**No. 3 Filament XMF. Pri.—115v 60 cycle; Sec. 24v 2 amps.**

Price only $2.25

---

**Speakers—Brand New Permanent Magnet**

4" $1.60

5" $2.00

6" Jensen in Metal Case $4.50

10% discount, purchase of 2 or more

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**Heavy Duty Transmitting Chokes**

8 HY—500 MA—5000 V INS.

Price each $8.95

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**Condensers—Fixed**

05 Mfd. 600 Volts .015

10 Mfd. 600 Volts .03

15 Mfd. 150 Volts .06

16 Mfd. 450 Volts 1.20

20 Volts .69

40 Volts .75

50 Volts .69

150 25 Volts .94

400 10 Volts .45

8 x 8 Can. Electrolytic 1.50

---

**Tubes**

(Tubes, New, in Original Cartons. For the SCR-274-N Command Set & Others.

**12A6** 69¢ OD8-75c

**12AK7** 77¢ 78c

**12B6** 74¢ 75c

**12B7** 69¢ 69¢

**12BS7** 80¢ 89¢

**12BS** 85¢ 95¢

**12ES** 85¢ 85¢

**12ES7** 95¢ 95¢

**12ES8** 85¢ 85¢

**12ES9** 85¢ 85¢

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**ALL EQUIPMENT F.O.B.**

BE SURE TO WRITE FOR BARGAIN BULLETIN

Name: ____________________________

Address: _________________________

City: _____________________________

Zone: ____________________________

State: ___________________________
GUARANTEED GOVT SURPLUS

420-750 MC OSCILLATOR.
Compact, beautifully built, built-in time output, employing two W.E. 34143 (44A) tubes. $21.95.

MAGNETRON MAGNET.
Male 10 slot, and plate tuning. Approximately 1/32" diameter. Approximately 1/32" thick. Supplied complete with terminal for 10mm amateur operation or for use in the 460-470mc citizen's radio band. No. 38/8A or 38A tube. $1.00.

UHF 50 OHM COAXIAL POWER MEASURING PANEL. Post mounting, silver-plated brass with integrally coated crystal mount. Type "U" UG-56F female receptacle. Original design for power measuring applications. $1.95.

252 MAGNETRON MAGNET 1000 GAUSS DIAM 1-1/4" IN. $7.00.

50 OHM COAXIAL RELAY, 1000V, 10A, 25W. Operates from 900VDC. $25.00.

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AIR CAPACITOR 2200 MFD MAX. .015% d.c. loss. Receiving type. Ceramic insulation. $0.25.


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ELECTRONICS CO. INC., 103-02 NORTHERN BLVD., CORONA, N. Y.

SIGNAL CORPS 400 CYCLE POWER SUPPLY. Input 480V/218D. Output 480VDC/275ma. 4.5 VAC/2A. Complete with tubes. 49"x71x12" Stock No. AH-05 $100.00.

SWAC/DC OSCILLATING WINDSHIELD WIPER ELECTRIC MOTOR. Completely enclosed 54 volt electric windshield wiper motor with gear & front cover containing rotating motor action to oscillating action. 30 to 200 (150) strokes per minute depending on voltage. 3/16" output shaft. Easily installed. Great for hobbyists or moving display purposes. Shaft has high mechanical output. Makes a neat attachment for photograph use. Draws 1.2 amp. 3"x3"x2". 1.1 lb. Stock No. AMO-85 $10.00.


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ELECTRONICS — April, 1949

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52 ohm, for use in switching

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42 mc. AM only
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The above units have an I.F. output of 30
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AN/APA 8A Indicator -has 5-25-100 micro-

SCR 274N complete

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Western Electric type. 19'$
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ELECTRONICS


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<tr>
<th>Descrip.</th>
<th>Price per Foot</th>
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<tbody>
<tr>
<td>83-15P</td>
<td>35¢/ft</td>
</tr>
<tr>
<td>83-16B</td>
<td>15¢/ft</td>
</tr>
</tbody>
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Coaxial cables are suitable for use in UHF coaxial chains at frequencies up to 400 MHz, with a maximum attenuation factor of 0.2 dB per 100 ft. These cables are also suitable for use in public address systems, where they offer reduced interference compared to open-wire systems.

UG TYPE CONNECTORS

Deduct 10% from prices shown on orders of 100 or more per type

<table>
<thead>
<tr>
<th>Type</th>
<th>AN No.</th>
<th>Price</th>
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<tbody>
<tr>
<td>AN</td>
<td>12-6-10</td>
<td>UG-500</td>
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<tr>
<td>AN</td>
<td>12-6-10</td>
<td>UG-1000</td>
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<tr>
<td>AN</td>
<td>12-6-10</td>
<td>UG-1500</td>
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<td>AN</td>
<td>12-6-10</td>
<td>UG-2000</td>
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<td>AN</td>
<td>12-6-10</td>
<td>UG-2500</td>
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<tr>
<td>AN</td>
<td>12-6-10</td>
<td>UG-3000</td>
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Life Electronic Sales

91 Gold St. Tel: Di gby 9-4154 N. Y. 7, N. Y.

D. C. MICROAMMETERS

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<tr>
<th>Type</th>
<th>Price</th>
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<tbody>
<tr>
<td>3-100 15° C.G. G.E. D-50</td>
<td>$12.00</td>
</tr>
<tr>
<td>3-100 4° C.G. Western 452</td>
<td>$14.00</td>
</tr>
<tr>
<td>3-100 10° C.G. Western 457</td>
<td>$12.50</td>
</tr>
<tr>
<td>3-200 6° C.G. G.E. D-50</td>
<td>$15.00</td>
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R. F. MILLIAMMETERS

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<tr>
<th>Type</th>
<th>Price</th>
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<tbody>
<tr>
<td>900-600 3 1/2° C.G. Western 452</td>
<td>$11.00</td>
</tr>
<tr>
<td>900-600 3 1/2° C.G. Western 447</td>
<td>$9.00</td>
</tr>
<tr>
<td>900-600 4 1/2° C.G. Western 456 (vaccum)</td>
<td>$28.00</td>
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A. C. VOLTMETERS

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<thead>
<tr>
<th>Type</th>
<th>Price</th>
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<tbody>
<tr>
<td>0-300 2 1/2° C.G. Western 476</td>
<td>$28.00</td>
</tr>
</tbody>
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RADAR ANTENNAS
YAGE ANTENNA—AB-5B Radar 8 element wide spaced array (450 to 600 MC). $7.00
SABRE with Spher. type F hydraulic servo controls for remote rotation. $386.62
DOUGT STACKER & YAGE—Same freq. consists of two 6 element beams. $13.70
SABRE with hydraulic servo controls for remote rotation. $386.62
DOBRO STACKER & YAGE—Two 6 element beams (670 to 430 MC). $29.40
SABRE with servo hydraulic controls for remote rotation. $386.62
ALL SABRE STACKERS (AB-5, 6, 7, 8) (250 MC to 490 MC). $13.70
AT-38/AFT (70 to 490 MC). $13.70

WESTINGHOUSE HYPERSONS Transformers
Prl. 111V 69 cy ¾ KVA—Sec. 21 145V at 1.5A, Sec. 23 240V at 1.56A, Wt. 28 lbs. $33.00/$31.50
$10.00 each in lots of 10

HYDRAULIC SERVO CONTROLS
Type 1—Bendix type F (or equivalent) for transmitting remote motor.
Type 2—Bendix except receiver produces linear motion. Either type $20.00 per set (transmitter and receiver). $17.85 each in lots of 10.

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ELECTRONIC RESEARCH LABORATORIES
1021-23 Callowhill St. New Location
Telephones: Market 7-6590 and 6591

ELECTRONIC TUBE-MAKING MACHINES
AMERICAN ELECTRONIC SALES CO.
67 E. 7 St.
New York, N. Y.

TURBO GOVERNOR—Type R-Max RPM 3750 $2.50
OCTAL SOCKETS—mounted-40s 1.75/16 ea.
RELAYS—telephone type—P-193—cold contacts—12,000 cycles. 90c ea. 100 or more.
POLARIZED RELAYS—WE D-108185 $5.00 ea.
NICHROME WIRE—34 1000 0.002—Sec. 25c.
SPARK GENERATOR—for flame throwers....90c

TUBE PARTS AND SUPPLIES
BELTS—THIAKIC
Letters—Keystone Types 677-6613-P-5585 200c
Ni ribbons—0192. Cad. 0191. 75d/1b.
Transformers and tubes—many sizes—write for price.
Cold test chokes—equipped with terminal, humidity, and altitude controls, with recorders.
Photocells, relays, complete. 13.50
Dynamite mix and complete signal—sealed tubes. $7.35

GLASS TUBING 25c LB
25 B 4603 0903 727 800 lbs.
24 B 715 1039 308 729 1100 lbs.
25 B 727 354 026 025 150 lbs.
15 B 1000 000 000 900 lbs.
15 B 727 510 046 095 120 lbs.
5 B 8038 514 060 900 lbs.
23 B 727 112 045 150 lbs.
45 B 8040 065 750 lbs.
45 B 8040 065 750 lbs.
118 B 0279 080 075 lbs.
118 B 0279 080 075 lbs.
23 A G 12 023 542 035 090 lbs.
23 A G 12 023 542 035 090 lbs.

ELECTRONIC PRODUCTS
ST. CHARLES, ILL.

1/15 H.P. REVERSIBLE MOTOR
$6.85

POSTPAID
Add 25c for shipping
Add 25c if outside 50 Mile Radius

115 V. A.C. 1000 R.P.M. brand new, complete with cabinet and grinding wheel adapter. Intermittent duty. Perfect for small tools, displays, bars, grinders, polishers, radio antennas, model railroads, small machines and home use.

SEND CHECK OR MONEY ORDER

HOMETOOL APPLIANCE CO.
130 FLATBUSH AVE., BROOKLYN, N. Y.

RA.42 Molybdenum Power Plates
AN/CRC7 VHF Emissitites, 140.58mc.
BC7200 Constant Volt. Amplifiers.
TCE-15, MG, starter, 6 coils.
Fed. Tel. and Radiomarine Receivers.
CRT-3 Gibson Girls, 2 Channel.
AT/RTJ-50 watt trans, 12 or 24v. 6 stak.
Productive work, Comm. measurement

Subject to prior sale, inquiries invited

GEORGE BELLING
4107 Brookdale Ave.
Oakland 19, Cal.
Kellogg 2-1640

April, 1949—ELECTRONICS
ELECTRON & TRANSFORMERS: AUTO BAND AUTHORIZED RPM. FEW on ALNICO GRAIN.

A Paper Tube Value. All types have standard 14 V dials. $24.75. 16 mfd, 5000 volts. $20.50. 50 mfd, 6000 volts. $27.50.

STEATITE VARIABLE CONDENSERS: Ideal for high-frequency applications in receivers and low-power transmitter stages. All types have standard 14 V dials. $24.75. 16 mfd, 5000 volts. $20.50. 50 mfd, 6000 volts. $27.50.

BUFFRAH CAR RADIO ANTENNAS: All of our antennas are of the highest quality and are made up of copper plated Brass Tubing and high-quality fittings.

BUFRAD MOUNTS: Stepped up 110, or step down 220 to 110 $2.85.

FIL TRASPB: 63, 38, Art. $1.49.

AUTO-TRANSFORMERS: Steps up 110, or step down 220 to 110 $1.49.

POWER TRANSFORMERS: Half-shell type. 115V, 60, Center tapped 115V winder. Specify either 15 or 6.3V filament.

SIDE COWL - HC-1, 2 sections extend to 60. Your price - single units $2.45; lots of 13 $2.25 ea.

TILT ANGLE - H-3, may be adjusted to all body sections. 9 sections extend to 30. Single unit price $1.90; lot price $1.75 ea.

VERIFIED - H-4, single hole finder or top mount coupling may be adjusted to conform with all body contours. 9 sections extend to 30. Single unit price $2.90; lot price $2.75 ea.

THE MONARCH - H-5, single hole top mount; 3 sections extend to 35. Single unit price $2.50; lot price $2.35 ea.

After seeing our antennas and comparing, you will never buy another make!

BUFFALO RADIO SUPPLY, 219-221 Genesse St., Dept. E, BUFFALO, N. Y.

GRAIN or WHEAT LAMPS

Used for illuminating meters, compass, dials, airplane instruments, etc. Solarization removes lamp from base to use in models, doll houses, in miniature trains, Xmas trees, etc.

Mazda U. E. 328 6V .25, $1.18

Photo, 3 times actual size. Glass bulb "4 x 4."

Either type $1.50 doz. $75.00 per M.

ALNICO FIELD MOTOR

31/4" x 1 1/4"

Operates on flashlight batteries, saving depending on the voltage, and will run on 6 volts full power and speed on 27 volts. Designed to be used in hand-held transmitting circuits in $290, 220, 221 etc.

$5.00

A newly written (1948) Book on Photo-telephone and Steve Circuits and Relay Controls.

HAYDON OR TELEPHONIC ELECTRONIC MOUNTS TO OPERATE SWITCHES, etc. A new and special price only $1.00.

$1.00

Surplus Laboratory Equipment

GENERAL RADIO

107-V VARIABLE INDUCTORS: $35.00

275A FREQUENCY LIMIT MONITOR: $125.00

FERRIS

10-0 STD. SIGNAL GENERATOR: $25.00

34A U.H.F. CRYSTAL CALIBRATOR: $125.00

© 1950, 10, 0 M.C. Crystals — useful to 500 M.C.

RUBICON

340U DC SPOTLIGHT CALIBRATOR: $40.00

50 volt per MM.

1050 WHEATSTONE BRIDGE: $70.00

Murray & Varley Loops

GRAY

E0108 WHEATSTONE BRIDGE: $70.00

Murray & Varley Loops

L & W

5430A WHEATSTONE BRIDGE: $80.00

Murray & Varley Loops

G. E.

LU RADAR TEST EQUIPMENT: $50.00

INDUSTRIAL INSTRUMENTS

MB-690 MILLIAMMETER BRIDGE: $60.00

1-100 Megaohms 2%

RZ WHEATSTONE BRIDGE: $70.00

Murray & Varley Loops

ALL PRICES F0B. N.Y.C. WAREHOUSE SUBJECT TO PRIOR SALE

THE NATIONAL INSTRUMENT CO.

FAR ROCKAWAY, N. Y.

CABLE ADDRESS, NASTRINUS, NEW YORK

TELEPHONE Far Rockaway 7-1123
WANTED

SECONDARY STANDARD OF FREQUENCY

And Associated Measuring Equipment. General Radio Co. manufactured D. & S. Navy L & K. Meter and Calibrator, Direct Readout, 100KC to 10MC. Useful to 60 KC by Means of Harmonics, 1000 or below..pattern.

Write for listings of other surplus bargains.

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360 Bleeker St. New York 14, New York

WANTED

WESTERN ELECTRIC VACUUM TUBES


W-6911, Electrons.
330 West 42nd St., New York 18, N. Y.

WANTED

W. E. Carrier Telephone and Carrier Telegraph Equipment and components. Filters, repeating coils, Transformers, Equalizers. Type CF1, CF2, H, C, and other carrier equipment, telephone and telegraph repeaters.

W-6669, Electrons.
330 West 42nd St., New York 18, N. Y.

WANTED

PN-8223, Electrons.
330 West 42nd Street, New York 18, N. Y.

WANTED

WANTED

MARINE and AIRCRAFT

Receivers, Transmitters, Radar, Direction Finders, Echo Sounders, RAL-7, RCM, DAG, DAF, DAE, DAK, DAB, DTA, TAQ, TBM. Also MN-26C, AN/ARC-1, -ARC-6, -APN-9, etc. Also Motor Generators, Converters, Dynamotors, Insulators, Meters and Special Tubes. Give full details. Cash waiting.

AMBER COMPANY
37 Montgomery Street Jersey City, N. J.

WANTED

Teletypewriters complete, components or parts. Any quantity and condition.

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WANTED

TELETYPEWRITERS

Complete equipment, components, transformers, resistors, spares, etc., Unlimited quantities. Plenty of ready cash.

W-7085, Electrons.
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WANTED

BC-348, 28V or 110V modified

Price $60.00 all letters except "D" & "Q".

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WANTED

Ford Instrument type SDDG Synchros in new condition

 preferring large lot.

Write W-8351, Electrons.
330 West 42nd Street, New York 18, N. Y.

April, 1949 — ELECTRONICS
### SPECIAL SURPLUS BROADCAST OF OUR TUBE SPECIALS!!

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All Leading Mfrs. Branded, New Tubes—subject to prior sale—subject to price change without notice.

F. O. B. Boston, 25% deposit with orders unless rated — minimum order $5.00.