For Maximum Stability...
Permalloy Dust Toroids

The UTC type HQ permalloy dust toroids are ideal for all audio, carrier and supersonic applications. HQA coils have Q over 100 at 5,000 cycles... HQB coils Q over 200 at 4,000 cycles... HQC coils Q over 200 at 30KC... HOA coils Q over 200 at 60 KC. The toroid dust core provides very low hum pickup... excellent stability with voltage change... negligible inductance change with temperature, etc. Precision adjusted to 1% tolerance.

<table>
<thead>
<tr>
<th>Inductance Value</th>
<th>Type No.</th>
<th>Net Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 mhy.</td>
<td>HQA-1</td>
<td>$7.00</td>
</tr>
<tr>
<td>12.5 mhy.</td>
<td>HQA-2</td>
<td>7.00</td>
</tr>
<tr>
<td>20 mhy.</td>
<td>HQA-3</td>
<td>7.50</td>
</tr>
<tr>
<td>30 mhy.</td>
<td>HQA-4</td>
<td>7.50</td>
</tr>
<tr>
<td>50 mhy.</td>
<td>HQA-5</td>
<td>8.00</td>
</tr>
<tr>
<td>80 mhy.</td>
<td>HQA-6</td>
<td>8.00</td>
</tr>
<tr>
<td>125 mhy.</td>
<td>HQA-7</td>
<td>9.00</td>
</tr>
<tr>
<td>200 mhy.</td>
<td>HQA-8</td>
<td>9.00</td>
</tr>
<tr>
<td>300 mhy.</td>
<td>HQA-9</td>
<td>10.00</td>
</tr>
<tr>
<td>.5 hy.</td>
<td>HQA-10</td>
<td>10.00</td>
</tr>
<tr>
<td>.75 hy.</td>
<td>HQA-11</td>
<td>10.00</td>
</tr>
<tr>
<td>1.25 hy.</td>
<td>HQA-12</td>
<td>11.00</td>
</tr>
<tr>
<td>2 hy.</td>
<td>HQA-13</td>
<td>11.00</td>
</tr>
<tr>
<td>3 hy.</td>
<td>HQA-14</td>
<td>13.00</td>
</tr>
<tr>
<td>5 hy.</td>
<td>HQA-15</td>
<td>14.00</td>
</tr>
<tr>
<td>7 hy.</td>
<td>HQA-16</td>
<td>15.00</td>
</tr>
<tr>
<td>10 hy.</td>
<td>HQA-17</td>
<td>16.00</td>
</tr>
<tr>
<td>15 hy.</td>
<td>HQA-18</td>
<td>17.00</td>
</tr>
<tr>
<td>20 hy.</td>
<td>HQA-19</td>
<td>18.00</td>
</tr>
<tr>
<td>25 hy.</td>
<td>HQA-20</td>
<td>20.00</td>
</tr>
<tr>
<td>30 hy.</td>
<td>HQA-21</td>
<td>24.00</td>
</tr>
</tbody>
</table>

For Maximum Flexibility...
The VIC Variable Inductor

The set screw on VIC units permits positive adjustment of inductance to plus 90% minus 50% from rated value. Revolutionary approach for tuned audio circuits. Q and L vs. screw adjustment for a typical coil are illustrated.

<table>
<thead>
<tr>
<th>Type</th>
<th>Mean Hys.</th>
<th>List Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIC-1</td>
<td>.0085</td>
<td>$11.00</td>
</tr>
<tr>
<td>VIC-2</td>
<td>.013</td>
<td>11.00</td>
</tr>
<tr>
<td>VIC-3</td>
<td>.019</td>
<td>11.00</td>
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<tr>
<td>VIC-4</td>
<td>.034</td>
<td>11.00</td>
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<td>VIC-5</td>
<td>.053</td>
<td>11.00</td>
</tr>
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<td>VIC-6</td>
<td>.084</td>
<td>11.00</td>
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<tr>
<td>VIC-7</td>
<td>.15</td>
<td>14.00</td>
</tr>
<tr>
<td>VIC-8</td>
<td>.21</td>
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<tr>
<td>VIC-9</td>
<td>.34</td>
<td>14.00</td>
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<tr>
<td>VIC-10</td>
<td>.54</td>
<td>14.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type</th>
<th>Mean Hys.</th>
<th>List Price</th>
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</thead>
<tbody>
<tr>
<td>VIC-11</td>
<td>.85</td>
<td>$14.00</td>
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<tr>
<td>VIC-12</td>
<td>1.3</td>
<td>14.00</td>
</tr>
<tr>
<td>VIC-13</td>
<td>2.2</td>
<td>14.00</td>
</tr>
<tr>
<td>VIC-14</td>
<td>3.4</td>
<td>14.00</td>
</tr>
<tr>
<td>VIC-15</td>
<td>5.4</td>
<td>16.50</td>
</tr>
<tr>
<td>VIC-16</td>
<td>8.5</td>
<td>16.50</td>
</tr>
<tr>
<td>VIC-17</td>
<td>13</td>
<td>16.50</td>
</tr>
<tr>
<td>VIC-18</td>
<td>21</td>
<td>16.50</td>
</tr>
<tr>
<td>VIC-19</td>
<td>33</td>
<td>16.50</td>
</tr>
<tr>
<td>VIC-20</td>
<td>52</td>
<td>16.50</td>
</tr>
<tr>
<td>VIC-21</td>
<td>83</td>
<td>17.50</td>
</tr>
</tbody>
</table>
AXLE TESTER
Testing locomotive axle in New York Central roundhouse, using Sperry Products, Inc., Supersonic Reflectoscope. Erie Railroad, another user, announced savings of over $75,000 in one year through replacing axles only when incipient failures are revealed by this pulse-type ultrasonic instrument.

CAR-CARD RADIO
Music for the bus passenger provides new advertising revenue for 1-m broadcast and transit company

ENGINEERING THE SCHEMATIC DIAGRAM, by James M. Henry and Millett G. Morgan.
Step-by-step procedure for incorporating maximum readability into intricate diagrams, using APS-3 radar as example

LIGHT METER FOR ELECTRIC FLASH LAMPS, by Harold E. Edgerton.
Battery-operated phototube-amplifier-meter circuit integrates flash of light and indicates correct aperture

FACSIMILE MODULATOR TUBE, by J. R. Shonnard.
Phototube has two dynodes and conducts in direction determined by applied voltage

RADIO IN THE MERCHANT MARINE, by John J. Canavan.
Survey of ship communications from before the Titanic to the present, with a forecast of future trends

SOLDERING ALUMINUM ALLOYS, by Frank W. Thomas and Eli Simon.
Bonding of metals is accomplished by vibrating the iron tip at an ultrasonic frequency

ROCKET-ENGINE TESTER, by A. E. Gersch.
Fuel-pump speed and torque is measured without adding external load

FREQUENCY-SCANNING VHF IMPEDANCE METER, by Lester L. Libby.
Instrument uses principle similar to that of aircraft f-m terrain-clearance indicators

SOFA, by W. W. Stifler, Jr., and W. F. Saars.
A sea rescue system depending upon time of arrival of energy from a depth bomb at three hydrophone stations

AN OSCILLOSCOPE CAMERA, by H. E. Hale and H. P. Mansberg.
Cathode-ray tube patterns are photographed on film or paper at speeds up to five feet per second

DESIGNING INDUSTRIAL CONTROLLERS BY ANALOG, by George A. Philbrick.
High-speed analog computer simplifies designing controllers

ELECTRON DIFFRACTION FOR FILM AND SURFACE STUDIES, by G. A. Daxey.
Applications and equipment for technique similar to x-ray diffraction are described

TECHNIQUE FOR DISTORTION ANALYSIS, by Samuel Sabaroff.
Clipped sine waves received through equipment under test are modified by circuit response

MULTIVIBRATOR DESIGN BY GRAPHIC METHODS, by A. E. Abbot.
Simple graphic method with nomograph gives high accuracy, eliminating tedious and repeated calculations

F-M SERVICE AREAS, by John H. Battison.
Chart shows approximate distance to 1 mv/m and 50 µv/m contours

BUSINESS BRIEFS 66 ELECTRON ART 128 NEW BOOKS BACKTALK 71 NEW PRODUCTS 128 TUBES AT WORK 124 NEWS OF THE INDUSTRY 138 INDEX TO ADVERTISERS

JUNE 1948
National's new NC-183 Receiver is designed particularly for discriminating radio operators... men who appreciate quality of performance... engineering skill.

Every demand was made by the National Company that components used in this brilliant, new receiver be consistent with their established reputation for building fine communications receivers.

The Marion Electrical Instrument Company designed a special S-Meter for the NC-183 to answer National's demand for quality... radio operators' demand for an accurate, dependable means of measuring and logging signals being received.

This "special" has an unbreakable plexiglass, anti-static coated window and Marion engineered dial illumination that eliminates the two principal drawbacks of conventional dial lighting...

A transparent lucite cavity for the bulb seals the delicate mechanism from dust drawn in by thermal currents and prevents insertion of oversized replacement bulbs which often damage the meter movement.

In addition, this "S-Meter" incorporates a special zero set in the back, in addition to a dust seal and other features available in all Marion Standard Electrical Indicating Instruments.

Let Marion give your product salient selling points... through "special" instruments, tailored to fit the job... consistent with your policy of quality.

Write for complete information.

Also a complete line of standard electrical indicating instruments.

MARION ELECTRICAL INSTRUMENT COMPANY
Manchester, New Hampshire

IN CANADA: THE ASTRAL ELECTRIC COMPANY, SCARBORO BLUFFS, ONTARIO

June, 1948 — ELECTRONICS
A NEW PARTNER IN CREATING

ONLY AN ACTUAL SAMPLE CAN SHOW YOU THE AMAZING LEGIBILITY OF THIS NEW TYPE K+E BLUEPRINT PAPER

SEND FOR YOUR SAMPLE TODAY!

The deep, even color of the blue background... the sharp contrast of the intense white lines... these are features of Challenge "Eighty" Blueprint Paper that cannot be shown on a printed page. You are invited, therefore, to send for a sample of this new K&E Blueprint Paper and see for yourself why we believe it to be the greatest improvement in blueprint papers in years.

Challenge "Eighty" papers are made by a new process that assures startling legibility over a wide printing range. Prints made on Challenge "Eighty," no matter whether from pencil or ink original, have amazing brilliance and clarity. Every detail shows up. The problem of illegible, error-inviting prints has been overcome.

Challenge "Eighty" papers are printed and washed in the same way and on the same equipment as other blueprint papers. They are available in an assortment of speeds to meet your requirements.

For 80 years, K&E instruments and materials have helped engineers and draftsmen attain precision and clarity in the designs they create. We believe that you will welcome this new "partner in creating" that insures smooth production in the blueprint room and uniformly superior prints.

Send for your sample of Challenge "Eighty" Blueprint Paper today. Write on your office letterhead to Keuffel & Esser Co., Hoboken, N. J., and please be sure to mention the speed you are now using.

KEUFFEL & ESSER CO.

NEW YORK • HOBOKEN, N. J.

CHICAGO • ST. LOUIS • DETROIT • SAN FRANCISCO • LOS ANGELES • MONTREAL

ELECTRONICS — June, 1948

www.americanradiohistory.com
How stabilized feedback reduces amplifier distortion... keeps gain constant

Like many other major advances in electronics, the development of stabilized (negative) feedback was a direct outgrowth of telephone progress. To produce telephone repeaters with the necessary gain stability and low distortion, H. S. Black, of Bell Telephone Laboratories, took a sample voltage of the amplifier output and fed it back into the amplifier in opposing phase. Before-and-after effects are shown in simplified form in the accompanying figures.

How Feedback Reduces Distortion
Signal portion of feedback subtracts from input signal. (In practice, input receives additional amplification to maintain original output voltage.) Distortion portion, encountering no opposing voltage in input, is amplified in opposition to distortion voltage arising in amplifier. Hence distortion voltage largely cancels itself out—output corresponds closely to input. Noise originating in the amplifier is reduced in a similar way.

How Feedback Stabilizes Gain
The relations of input, output and gain can be shown as follows:

<table>
<thead>
<tr>
<th>Voltage Gain without Feedback</th>
<th>Total Input</th>
<th>Feedback Voltage (negative)</th>
<th>Net Input (less feedback)</th>
<th>Output</th>
<th>Overall Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>10.1</td>
<td>10</td>
<td>.1</td>
<td>100</td>
<td>9.9</td>
</tr>
<tr>
<td>500</td>
<td>10.2</td>
<td>10</td>
<td>.2</td>
<td>100</td>
<td>9.8</td>
</tr>
</tbody>
</table>

As shown, the gain of the amplifier stages incorporating feedback can drop 50 percent, with a drop in overall gain of only 1 percent. Hence gain remains virtually constant, regardless of changes in power supply or performance of components.

Users of all line and power amplifiers and all AM transmitters designed by Bell Laboratories and made by Western Electric benefit by these outstanding advantages of stabilized feedback: greatly reduced distortion and noise, virtually constant gain.

Bell Telephone Laboratories

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

June, 1948 — Electronics
While stabilized feedback is now accepted as an indispensable technique in the communications art, actual design of a stabilized-feedback amplifier calls for painstaking mathematical analysis and control of phase and gain characteristics over a wide frequency spectrum. Without such control, feedback may introduce new faults more objectionable than those eliminated. The extensive experience of Bell Laboratories engineers gives to the users of Western Electric equipment assurance that the outstanding advantages of feedback will actually be realized.

Assurance of Quality Performance
As used in all Western Electric Audio Amplifiers (except one-tube pre-amplifiers) properly applied stabilized feedback insures flatter gain-frequency characteristic and automatic suppression of noise and distortion arising from sources within the amplifier. In new loudspeaker amplifiers (which include the output coil within the feedback loop), output impedance is so low that matching to multiple loudspeakers is as simple as adding lamps to a lighting circuit.

Flat Frequency Response
Flat frequency response is maintained in Western Electric AM Transmitters by stabilized feedback actuated by the final radio frequency output. Hence attenuation of high modulating frequencies is virtually eliminated. No hum suppression circuits are needed, because of reduction of noise and distortion from all sources, including final amplifiers.

Stabilized feedback, correctly applied, is just one of the factors in the outstanding performance of Western Electric Amplifiers and AM Transmitters. For full information on all operating features, call your local Graybar Broadcast Representative, or write Graybar Electric Company, 420 Lexington Avenue, New York 17, N. Y.

Western Electric
Manufacturing unit of the Bell System and the nation’s largest producer of communications equipment.

ELECTRONICS — June, 1948
FM reception reaches a new high in fidelity when this new Model XFM-1 is used in conjunction with any radio receiver or amplifier designed for phono operation.

The r-f stage of this translator is unusual in a number of respects. Variable inductance tuning is employed instead of using a conventional tuning capacitor. This design has two distinct advantages. It provides a highly efficient circuit in our range (88 to 108 mc) which would not be possible with the more conventional methods of tuning and provides drift-free frequency stability.

**SPECIFICATIONS** (These specifications prove beyond doubt that this FM tuner excels...no other FM tuner on the market can compare.)

**CABINET:**
Beautiful hand-rubbed natural walnut, 10¾” high, 11½” deep, 15¾” wide. Tuning dial is slide-rule type, wide open, with frequencies clearly marked.

**ELECTRICAL RATING:**
Nominal voltage, 110 at 50-60 cycles, 65 watts. Has built-in tapped transformer with selector switch for voltages: 110 (102-117); 125 (117-133); 150 (140-160); 200 (185-213); 225 (213-234); 245 (234-260).

The chassis has been tropicalized.

Telephone: LOngacre 3-1800

**OPERATING FREQUENCIES:**
88 mc to 108 mc, 300-ohm input for folded dipole antenna. Also has built-in antenna.

**TUBE COMPLEMENT:**
R-F amplifier, 6AG5; Oscillator, 6AK5; Converter, 6AK5; 1st I-F amplifier, 6SG7; 2nd I-F amplifier, 6SV7; Limiter, 6SH7; Discriminator and audio amplifier, 6AQ7GT; Rectifier, 5Y3GT/G; Dial light Mazda No. 44.

Prices are F.O.B. New York City and are subject to change without notice.

While they last
Harvey Special Price

$49.50
Research and development problems, involving the manufacture of prototypes, are routine Sherron Electronics projects. We offer a comprehensive service—design, development, consultation on and completion of research, and the manufacturing of working models.

We can assist you by working from an idea, theory, or laboratory design—or manufacturing units from your own completed designs.

In the performance of this service, we have the advantage of expertly staffed, modern electronics and electro-mechanical laboratories. All the experience, skills and facilities, which Sherron Electronics has been applying to the broad needs of electronics, are also available for the specialized requirements of Nucleonics.

Sherron projects include: Counters, computers, servo mechanisms... Amplifiers, oscillators... Power supplies, power regulators... Process control, generator control... Parameter measurement, control and production (temperature, flow, radiation) Synchrotron, Betatron, Cyclotron controls and accessories.

Your inquiries are invited.
Here’s how the CONTROLLER answers typical regulation problems.

Q: An AC requirement. Can you stabilize the output of a transformer?

ANSWER

Q: Can you selectively regulate a number of DC voltages and currents?

ANSWER

Q: Can the CONTROLLER stabilize a generator field to regulate its output?

ANSWER

The AC output of the CONTROLLER will swing between 85-145 VAC, AUTOMATICALLY adjusting the output of your unit against line and load variations. By referencing this output back to the CONTROLLER you get output regulation.

TECHNICAL SPECIFICATIONS

The controlled circuit must make available at least one watt of power to the CONTROLLER.

- Input voltage range: 95-125 volts AC (50 or 60 cycles)
- Load range: 200 to 2000 VA
- Regulation accuracy: 0.5% at the controlled point

Write today for more information on the new CONTROLLER. Arrange to have a Sorensen Engineer analyze voltage regulation requirements in your plant. He can select a Sorensen unit or suggest a special design to fit your unusual application.

Represented in all principal domestic and foreign cities.
With CT's Famous
Sealed in Steel Construction

The clean, streamlined appearance and compactness of CT's new Sealed in Steel construction contribute immeasurably to the trim, precision-like effect of any electronic equipment.

In addition, CT Transformers provide "steel wall" protection against atmospheric moisture, efficient magnetic and electro-static shielding, unsurpassed strength and rigidity to withstand shock and vibration, and unusual convenience of mounting.

Two base styles are available for most of the units in this catalog line, one with clearly identified solder lugs in a phenolic terminal board, the other with RMA color coded leads, stripped and tinned for easy soldering.

The design of these new power transformers assures maximum performance with minimum physical size and minimum temperature rise in accordance with RMA standards.

The wide range of carefully selected ratings achieves maximum flexibility of application, close matching with today's preferred types of tubes, and conformance with all industry standards.

Write direct for catalog illustrating, describing and listing the complete line, or contact your nearest radio parts jobber at once.
"WHEN WE THINK OF V-R TUBES,
WE THINK OF HYTRON."

When leaders automatically order their gaseous voltage-regulator tubes from Hytron, there must be a reason. Companies with top names can afford to select only top quality components. To have sold over 2,500,000, these Hytron OA2, OB2, OC3/VR105, and OD3/VR150 tubes must offer something special. They do! Better performance. Their advanced engineering—rigidly controlled processing and assembly—and tougher-than-JAN factory tests make these apparently simple tubes actually easy to make—better.

Yes, you are in good company if you instinctively associate V-R tubes with Hytron. Army, Navy, Air Force, AEC, famous university research laboratories—as well as industrial leaders—repeatedly order Hytron V-R tubes. Pick either the standard OC3/VR105 and OD3/VR150 or the space-saving OB2, and OA2; you, too, will prefer Hytron. That goes double, if you're "from Missouri." Find out for yourself why so many turn automatically to Hytron.
How Sentinel Radio uses two "P. E. C." units to save space and simplify production of table-model radios!

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

YES, here is a typical illustration of how Centralab's "Printed Electronic Circuits, have simplified wiring and assembly by 1) reducing number of components required and 2) by reducing number of leads to be soldered." That's why Sentinel Radio Corp., Evanston, Ill., has adopted CRL's Couplate (printed interstage coupling plate) and CRL's Filpec (printed electronic circuit filter) — and that's why you'll want to see and test these exciting new electronic developments.

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.

**NEW!**

Division of GLOBE-UNION INC., Milwaukee

Chassis courtesy of Sentinel Radio Corp., Evanston, Ill.

Look closely and you'll see where Sentinel engineers have applied Centralab's "Couplate" and "Filpec" in this special small receiver circuit. Result: important savings in production and space.

Made with high dielectric Ceramic-X, both Couplate (above) and Filpec (below) assure long life, low internal inductance, positive resistance to humidity and vibration. All units provided with special phenolic coating.
NEW INSTRUMENT-TYPE DATA RECORDERS

NEW INSTRUMENT-TYPE DATA RECORDERS

These new instruments are capable of recording and reproducing in graphical form, variable or transient data under conditions of severe shock acceleration up to 75 G's. Sectional unit design enables tape recording to be performed in moving vehicles, aircraft, guided missiles, rockets or other mobile units. Tape is then transferred to data interpretation unit and a graphical record obtained directly. Miniature magnetic recorders weighing less than 1 1/2 lbs. or standard complete systems having any number of information channels are available.

Outstanding Features

- **ERROR SOURCES ELIMINATED**
  
  Conversion of datum to FM signals before transfer to tape eliminates possible sources of error.

- **HIGH ACCURACY**
  
  Overall data interpretation accuracy is maintained within plus or minus 2 percent.

- **WIDE SIGNAL LEVEL RANGE**
  
  Responsive to sensing instrument outputs as low as 0.3 volts for D.C. and 12 mv for A.C. High level signals are also usable by proper attenuation.

- **TIME BASE CHANNEL**
  
  Included in all type designs is a time base channel for speed and error compensation.

- **FLEXIBLE DESIGN**
  
  Equipment adaptable for use with customer's sensing elements or to conform to special instruments, shapes and installation requirements.

Graphic Channel Data Interpretation Equipment—Type DI-2: showing front compartment doors open for tape loading and adjustment. Unit provides 1 time base and 2 information channels.

Information Channel Magnetic Type Recorder Mechanism — Type MR-2: applicable to flight tests of engine temperatures, accelerations, strains, etc. especially suited to guided missile applications.

Information Channel Miniature Magnetic Tape Recorder Mechanism — Type MR-3; especially suited to flight tests of engine temperatures, accelerations, strains, etc. especially suited to guided missile applications.

Standard Information Channel Magnetic Tape Recorder Mechanism — Type MR-6.

June, 1948 — ELECTRONICS
Cook Research Laboratories have established a new service and now maintain a trained staff to render complete data recording and analytical services. This includes the making of permanent graphic recordings of virtually any measurement that can be made in the form of electrical impulses, over a frequency range from D.C. to 100cps. In addition, a complete mathematical analysis of the data can be made by means of:

**Computing Mechanisms**
- Averages
- Integrations
- Differentiations
- Statistical Analysis

The effect on savings in man hours and increased efficiencies is obvious.

Detailed information on Cook Research data recording equipment and data interpretation service is available upon request. Please phone or write on company letterhead for Bulletin No. MR-B1.
STANDARDIZATION CONTROLS

Aware from the outset that the commonest disc recording complaint has always been variations from batch to batch, Soundcraft engineers determined to build disc manufacturing equipment that would not be at the mercy of such conventional ills as impurities in lacquer, inaccuracies in raw material handling, and inadequate control of the critical drying air.

To this end Soundcraft has spared no expense to safeguard the precision of each step of its disc manufacturing processes. Electronic pre-testing of lacquer batches . . . mechanical re-working of new aluminum bases . . . viscometer control of lacquer consistency . . . synchronous motor-control of conveyor speed . . . micrometer adjustment of coating thickness . . . automatic removal of even microscopic foreign matter in lacquer . . . electrostatic elimination of minute dust in drying air . . . automatic humidistat and thermostat control of weather-making equipment to assure constant fume absorption of drying air . . . continuous velometer test of air flow . . . all these and dozens of other double checks and inspections have made possible Soundcraft's widespread reputation as "the most consistent disc".*

*Watch this space for succeeding ads in this informative series on how Soundcraft discs are made.  
No. 6 of a series

When the utmost in recording quality is needed, ask for the 'Broadcaster', a master-disc selection in instantaneous sizes at an "extra-fare" price. 

For work-a-day broadcast-quality recordings, the Soundcraft 'Playback' offers superior cutting properties in competition with other "best-grade" blanks. 

Soundcraft discs are sold by over 250 radio parts distributors in principle U. S. cities. Foreign sales by Reeves International, Inc., 10 East 52nd St., New York 22, N. Y. Cable REEVINTL.
CONSTANT VOLTAGE with low harmonic distortion

TYPE CVH, an important newcomer in a famous line—a SOLA CONSTANT VOLTAGE Transformer designed for use with equipment that requires a source of undistorted voltage. These new transformers, available in 250, 500 and 1,000 VA capacities, provide all of the voltage stabilizing characteristics of the standard SOLA Constant Voltage Transformer, with less than 3% harmonic distortion of the output voltage wave.

Since the output voltage wave is essentially sinusoidal, these transformers may be used for the most exacting applications such as general laboratory work, instrument calibration, precision electronic equipment or other equipment having elements which are sensitive to power frequencies harmonically related to the fundamental.

As in all SOLA Constant Voltage Transformers the regulation is automatic and instantaneous. There are no moving parts, no manual adjustments and every unit is self-protecting against short circuit.

Type CVH represents an outstanding advance in automatic voltage regulation and an important contribution to precise electronic equipment.

WRITE FOR THESE BULLETINS

DCVH-136—complete electrical and mechanical characteristics of the new Type CVH Constant Voltage Transformers.

DCV-102—complete engineering handbook and catalog of standard Constant Voltage Transformers available for remedial or built-in applications.
Centralab reports to

JUNE, 1948

How Beltone uses "Printed Electronic Circuit" to design and produce "the world's smallest hearing aid"!

**Problem:**
How to overcome size and weight limitations of ordinary electronic components and design a smaller, lighter Beltone hearing aid.

**Solution:**
Using Centralab's "Printed Electronic Circuit", 45 parts, including capacitors and resistors, have been combined into one compact chassis.

**Result:**
The new, vastly improved 1948 Beltone Hearing Aid — smaller and lighter with improved performance and important production savings.

Where miniature size is of the utmost importance, nothing else combines ruggedness, dependability, and resistance to humidity and moisture in such a small unit package. That's what Beltone engineers say about Centralab's Printed Electronic Circuit and that's what you will say when you have seen and tested this amazing new electronic development. Working with your engineers, Centralab may be able to fit its Printed Electronic Circuit to your specific needs. Write us today for further information.

Rear view of Beltone-CRL unit shows integral construction — ceramic disc capacitors, "printed" silver leads and resistors (black paths).

Engineers of Sonora Radio and Television Corp., Chicago, use CRL's Couplate ("printed" interstage coupling plate) to improve manufacturing, reduce servicing. Couplate's long life, high efficiency, mechanical strength and resistance to humidity mean more dependable performance, simplified production for Sonora Radios.
Let Centralab's complete Radiohm line take care of your special needs. Wide range of variations: Model "R" — wire wound, 3 watts; or composition type, 1 watt. Model "E" — composition type, ¼ watt. Direct contact, 6 resistance tapers. Model "M"—composition type, ½ watt. For complete information, write for Bulletin 697.

For quality and dependability, more and more manufacturers are switching to Centralab's line of ceramic capacitors. Order Bulletin 933.

In its new Lever Switch, Centralab guarantees a minimum life of 50,000 cycles. Reason: an exclusive, new coil spring index. Write for Bulletin 970.

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

LOOK TO CENTRALAB IN 1948! 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!
An ADLAKE Relay for your every need

Not all of the Adlake Relay line is shown on this page. But whatever your relay needs may be, there's an Adlake to do the job. Adlake Relays have handled hundreds of tough and unusual assignments for American industry—offering dependable, tamperproof control.

Adlake Mercury Plunger-Type Relays are hermetically sealed against dust, dirt, moisture and oxidation. Their mercury-to-mercury contact makes them silent and chatterless, impervious to burning, pitting and sticking. They are absolutely safe, require no maintenance.

Let us give you the benefit of our experience in making your Adlake Relay selection. Address your request for catalog to The Adams & Westlake Company, 1107 North Michigan Avenue, Elkhart, Indiana.

THE Adams & Westlake COMPANY
Established 1857 - ELKHART, IND. • New York • Chicago
Manufacturers of Adlake
Hermetically Sealed Mercury Relays for Timing, Load and Control Circuits

Type 1040-8
Time delay
contact normally open
maximum time delay up to 20 minutes

Type 1040-34
Time delay
contact normally closed for A.C. energization

Type 1040-87
Heavy duty load relay
contact normally open

Type 1040-97
Heavy duty load relay
contact normally closed

Type 1045
Quick acting relay
with terminal block
designed for use with sensitive thermo regulators

Type 1101-8
Time delay
contact normally open

Type 1101-87
Heavy duty load relay
contact normally closed

Type 1101-34
Time delay
contact normally closed

Type 1101-100
Light duty load relay
contact normally open or normally closed

Type 1110 Relay with terminal block
contact normally open or closed; handles 30 amps.

Type 1200
Time delay

Type 1200 Double unit relay
contacts normally open or normally closed; for D.C. energization

Type 1200 Double unit relay
contacts normally open or normally closed; for D.C. energization

June, 1948 — ELECTRONICS
Federal

The FIRST NAME in
SELENIUM RECTIFIERS

Gives you BETTER PRODUCT DESIGN

Electrically, Mechanically, and Thermally

Wherever your product calls for conversion of A-C to D-C, Federal Selenium Rectifiers can simplify your design problems three ways:

Electrically—because of their inherent high efficiency and lasting characteristics. No power-consuming filaments—less wattage loss—and no time lag. D-C output is delivered instantly on application of A-C potential.

Mechanically—because of their unusually rugged construction. Designed to withstand shocks and vibration. No fragile internal elements—no moving parts to wear out. Available in a wide range of space-saving, weight-saving designs.

Thermally—because they run cooler, without hot filaments or magnetic core losses. Construction permits highly efficient convection or forced air cooling where desired.

Whatever your power conversion requirements, from milliwatts to kilowatts, there's a Federal Selenium Rectifier that will fit into your plans. And every Federal Selenium Rectifier is backed by the research, engineering and production skill of America's oldest and largest manufacturer of selenium rectifiers. Write Federal today for information on your rectifier requirements. Dept. F-813.

Federal Telephone and Radio Corporation

KEEPING FEDERAL YEARS AHEAD...is IT&T's world-wide research and engineering organization, of which the Federal Telecommunication Laboratories, Nutley, N J., is a unit.

SELENIUM and INTELIN DIVISION, 900 Passaic Ave., East Newark, New Jersey

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

ELECTRONICS — June, 1948

www.americanradiohistory.com
Whether your terminal problem involves vibration, temperature, hermetic sealing or ordinary lead termination, GENERAL CERAMICS Steatite Sealex Bushings and Multiple Headers offer important advantages that reduce assembly costs and improve product quality. Mounting as a single unit, they can be quickly soldered, welded or sweated to the equipment enclosure and provide perfect termination for one or as many leads as required.

GENERAL CERAMICS Sealex Bushings and Multiple Headers are available in many standard sizes and types suitable for most applications. Special types can be supplied on short notice. Hermetic sealing is absolute and each unit is individually pressure tested at 50 psi; all metal parts are hot-tinned for fast soldering. Sealex Bushings are available in sizes from 0.5 to 20 amps with flashover ratings to 40 Kilovolts. Steatite—the insulation used in these products—has a low loss factor of only 0.7% at 1000 K.C., which recommends the use of these terminals at practically any frequency.

WRITE TODAY FOR CATALOG!

Pressure tested, shockproof Sealed Leads and Multiple Headers

Whether your terminal problem involves vibration, temperature, hermetic sealing or ordinary lead termination, GENERAL CERAMICS Steatite Sealex Bushings and Multiple Headers offer important advantages that reduce assembly costs and improve product quality. Mounting as a single unit, they can be quickly soldered, welded or sweated to the equipment enclosure and provide perfect termination for one or as many leads as required.

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WRITE TODAY FOR CATALOG!
Entirely New! Completely Service-Tested!

RAYTHEON Voltage Stabilizers

An Outstanding New Line of High Performance, Space and Weight Saving Models that Make It Easy to Build Enduring Accuracy Into Your Product.

The new Raytheon voltage stabilizers enable you to build voltage stability right into your electrical or electronic equipment. They come to you in neat, compact, easy-to-install packages—ruggedly built and performance-engineered for lifetime satisfaction. Choose your models from a wide range of standard catalog types... or have them custom-engineered to suit your special needs. In either case, count on Raytheon experience and skill to provide the electrical characteristics you want in the most convenient, compact and economical unit.

Build these Advantages Into Your Equipment

- Control of output voltage to within ±½%.
- Stabilization at any load within rated capacity.
- Many designs with very low harmonic distortion of the output voltage wave at any load.
- Quick response. Stabilizes varying input voltage within 1/20 second.
- Entirely automatic. No adjustments. No moving parts. No maintenance.
- Wide range of designs including hermetically sealed types.

Now on the press...complete information

A new bulletin covering applications, performance features, operating characteristics, graphs, specifications, etc., for the entire new line of Raytheon Voltage Stabilizers.

SEND FOR IT TODAY
For keeping video operations under control—
from modest start to mighty operations...

DU MONT
MASTER CONTROL

FUNCTIONS...

1. Generation of synchronizing signals conforming to RMA recommendations.
2. Distribution of sync signals.
3. Push-button selection of program sources for use by the transmitter ("on-the-air" signal).
4. Monitoring and distribution of the "on-the-air" picture signal.
5. Push-button selection of program sources next to be used as "on-the-air" signal (preview signal).
7. Monitoring of "on-the-air" and preview signal waveforms.
8. Stabilization of picture and sync signals from remote program sources.
9. Test monitoring of master control signals for maintenance purposes.
10. Exclusive Du Mont "fully automatic" lap dissolve and fade control—the standard of all Du Mont control equipment.

Split-second timing—smooth-flowing program continuity—that's the assurance the Du Mont Master Control Line offers television broadcasters.

Multiple-studio live programs, network participation, local remote pickups, films and rehearsals, are selected and integrated at will. The Du Mont Master Control Line consists of groups of integrated equipment capable of performing any desired function of television broadcasting in the professional manner long associated with sound broadcasting.

The number of functions incorporated in any one master control "package" depends on the complexity of the telecasting station. Five basic Du Mont master control "packages" meet the requirements of the smallest to the largest telecasting station. In typical Du Mont manner, you can start as small as you like and grow as large as you like, with Du Mont equipment.

DESCRIPTIVE LITERATURE ON REQUEST
Aerovox proudly presents a basically new capacitor designed and produced to meet today's more critical requirements.

Duranite capacitors are not to be confused with conventional molded tubulars encased in usual materials. Duranite capacitors are entirely new—Aerolene, the new impregnant; the new processing methods; the new Duranite casing—all adding up to an entirely new concept in the capacitor art.

Note some of Duranite's extraordinary features herewith presented! Make comparative tests! You be the judge!

- Literature on request. Samples available to manufacturers. Let us quote on your needs.

TYPICAL DURANITE FEATURES . . .
- Toughest capacitors ever offered, critical manufacturers and users of radio-electronic equipment.
- Positive insurance against troublesome and costly failures in the field.
- Permanent, non-varying, rock-hard casing. Smooth, clean surface. Drop them; bang them; scratch them—no damage.
- Pigtail leads firmly imbedded. Won't pull out or work loose. Wire breaks before it can be loosened.
- Really moisture-proof. Thoroughly and permanently sealed.
- Withstand high operating temperatures—no wax ends to melt. Operation from sub-zero to over 212° F. without damage.
- Temperature coefficient of capacitance comparable to wax and oil capacitors.
- Aerolene impregnant eliminates necessity of stocking and using both wax and oil capacitors. One impregnant does work of both.
- Results in lower inventories and manufacturing costs.
- 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. Stays tightly sealed.
- Smaller dimensions than usual paper tubulars.
- Standard marking: color-coding—capacitance, tolerance, voltage.

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.
Solving Many Resistance Problems

Excellent voltage and temperature characteristics are provided by GLOBAR Type CX Resistors. These characteristics make them especially suited for many applications including Dummy Antenna... Rhombic Antenna Termination... Parasitic current suppression... Voltage dropping devices... Induction and R.F. Heating.

An extremely small voltage and temperature coefficient together with an ability to carry loads up to 3 watts per square inch of radiating area puts these resistors in a class by themselves. When equipped with special terminals, they can be loaded to 10 watts per square inch. For immediate attention to inquiries write Dept. V-68. The Carborundum Company, GLOBAR Division, Niagara Falls, New York.

RESISTANCE RANGE AND RATING IN WATTS FOR STANDARD SIZES

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Rating in Watts</th>
<th>Resistance Range*</th>
<th>Overall Length in Inches</th>
<th>Overall Diameter in Inches</th>
<th>Tinned Copper Wire Leads</th>
</tr>
</thead>
<tbody>
<tr>
<td>997-CX</td>
<td>1/4</td>
<td>1 ohm to 150 ohms</td>
<td>2 1/4</td>
<td>7/64</td>
<td>1 1/4” 0.016”</td>
</tr>
<tr>
<td>763-CX</td>
<td>1/2</td>
<td>1 ohm to 47 ohms</td>
<td>5/8</td>
<td>3/16</td>
<td>1 1/2” 0.032”</td>
</tr>
<tr>
<td>759-CX</td>
<td>1</td>
<td>1 ohm to 33 ohms</td>
<td>3/4</td>
<td>1/4</td>
<td>1 1/2” 0.032”</td>
</tr>
<tr>
<td>766-CX</td>
<td>2</td>
<td>1 ohm to 47 ohms</td>
<td>1 1/8</td>
<td>1/4</td>
<td>1 1/2” 0.032”</td>
</tr>
<tr>
<td>792-CX</td>
<td>4</td>
<td>1 ohm to 22 ohms</td>
<td>1 1/8</td>
<td>15/32</td>
<td>1 1/2” 0.040”</td>
</tr>
<tr>
<td>774-CX</td>
<td>6</td>
<td>1 ohm to 33 ohms</td>
<td>2 3/8</td>
<td>15/32</td>
<td>1 1/2” 0.040”</td>
</tr>
</tbody>
</table>

*RMA Values only. Tolerances ± 10%, and ± 20%.

TABLE II

<table>
<thead>
<tr>
<th>Diameter in inches</th>
<th>Resistance in Ohms per Inch of Length</th>
<th>Length in Inches</th>
<th>RATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4</td>
<td>Minimum 0.10  100</td>
<td>Minimum 2</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Maximum 100</td>
<td>Maximum 10</td>
<td></td>
</tr>
<tr>
<td>5/8</td>
<td>Minimum 0.10  100</td>
<td>Minimum 2</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Maximum 100</td>
<td>Maximum 18</td>
<td></td>
</tr>
<tr>
<td>3/4</td>
<td>Minimum 0.10  75</td>
<td>Minimum 4</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Maximum 50</td>
<td>Maximum 18</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Minimum 0.05  50</td>
<td>Minimum 4</td>
<td>18</td>
</tr>
</tbody>
</table>

Continuous duty rating is based on 3 watts per square inch of external radiating surface.

Type “CX” power resistors can be supplied with metallized ends of brass, copper, nickel, monel, aluminum, tinned brass or tinned copper, also with tinned copper wire (No. 14 B & S Gage) leads, approximately six inches long. Resistance tolerances are limited to ± 10% and ± 20% only.
HERE'S FLAT RESPONSE UP TO 700 MC

410A VACUUM TUBE VOLTMETER

with its new -hp- low-capacity diode probe, measures all the important radio voltages without disturbing circuits under test.

CHECK THESE FACTS ABOUT THE NEW -hp- PROBE*:

- Small size for ease in contacting hard-to-get-at components.
- Ultra-short leads, direct grounding assure high frequency response.
- Rugged, mechanical construction, dural shell, polystyrene insulation.
- Ultra-short leads, direct grounding assure high frequency response.
- Specially-designed diode has short transit time, low input capacity, high resonant frequency of 2000 mc.
- Detachable tip lowers input capacity, shortens diode lead, utilizes maximum capabilities of diode.

The specially-designed diode, in combination with the -hp- probe design, makes possible the exceedingly flat frequency response shown graphically in Figure 1.

With this flat frequency response are combined the factors of low input capacity and high input resistance. The variation of these factors with frequency is shown in Figure 2. The input resistance and reactance are high throughout the entire range of the instrument, and thus measurements are made without appreciable detuning or loading of circuit. Maximum measuring accuracy is assured.

In addition to swiftly, easily, accurately making uhf radio measurements, this -hp- 410A is a convenient voltage indicator up to 3000 mc. And it serves equally well as an audio or d-c voltmeter, or an ohmmeter. A-c measurements are made in 6 ranges ...full scale readings 1 to 300 v. D-c full scale readings from 1 to 1000 v in 7 ranges. Input resistance all ranges -100 megohms. As an ohmmeter, the -hp- 410A measures resistances from 0.2 ohms to 500 megohms in 7 ranges.

In short, this -hp- 410A Vacuum Tube Voltmeter is ideal for obtaining most important parameters in radio design, manufacture, or servicing. Write today for full details. Hewlett-Packard Company, 1407E Page Mill Road, Palo Alto, California.
A QUIET REVOLUTION IN CAPACITOR DESIGN

THE SMALLEST MOLDED TUBULAR EVER MANUFACTURED!... and rated up to 125° C!

A PROVEN PRODUCT NOW IN MASS PRODUCTION!

ACTUAL SIZE ILLUSTRATION TYPE 65P

UNIQUE, MINERAL-FILLED MOLDING MATERIAL!... Provides unequalled protection against moisture absorption even under conditions of extreme humidity!

NEW SPRAGUE MOLDED PROKARS*
... dependable capacitors for sub-miniature assemblies

SUB-MINIATURE PAPER CAPACITORS IN METAL CANS WITH HERMETIC, GLASS-TO-METAL SEAL

for the most severe applications

Yes, this little can houses a high quality hermetically sealed Paper Capacitor! Rated at 100 volts, D.C. Working, this 5 mfd. unit measures 4" x 1 1/2". Presently being manufactured in quantity, variations of this sub-miniature type can be made to your specifications. Write for complete information about this and even smaller hermetically sealed units now in production as shown below.

These new molded Prokars were designed specifically to satisfy stringent military requirements. Types 65P & 75P are now in mass production and are available in a wide range of capacities—from .00047 mfd. to .15 mfd! Though higher in price than standard units, they easily justify the term "premium" in performance. Rated for —50° C to 125° C operation, these small but rugged units are ideally suited for any electrical or electronic application in which size, temperature, humidity and physical stress are dominant considerations.

Write for Engineering Bulletin No. 205 A

SPRAGUE ELECTRIC COMPANY, NORTH ADAMS, MASS.

ELECTRIC AND ELECTRONIC PROGRESS

26 June, 1948 — ELECTRONICS
Save Time and Money...
Increase Operating Efficiency

with PHILCO

2-WAY F-M MOBILE RADIOPHONE COMMUNICATIONS SYSTEMS

30 to 44 Mc. and 152 to 162 Mc. Sensational new developments... advanced engineering... proven reliability... new operating efficiency and economy for F-M Radiophone Communications Systems, permitting clear, crisp, two-way voice communications under all conditions.

Philco Industrial Division

Industries Division

Philadelphia 34 • Pennsylvania
Millions of People Changed Our Name

You may think it strange that millions of people could have a voice in changing a company's name, but that is what has happened to The American Rolling Mill Company.

Several years after the company started operations in 1900, it adopted the trademark "ARMco" for its special grades of steel. The ARMco trademark—composed of the first letter in each word of the company name—has been widely advertised and appears on all the company's products. Many ARMco customers identify their use of these special-purpose steels with this familiar trademark.

Through the years—as the original small mill grew into one of the country's great steel companies—our customers, dealers and the public alike have preferred to call the company "ARMco." So, in recognition of this preference, the name of the company has been changed from The American Rolling Mill Company to Armco Steel Corporation.

The change is one of name only. It does not affect ARMco management, personnel and long-established policies. It does emphasize more strongly the importance of the ARMco trademark, and increases its value to those who use ARMco Special-Purpose Steels in the things they make.

Alert research and production men who have perfected so many special-purpose grades of ARMco Steel will continue to improve present steels while developing new ones to help manufacturers build better products for home, farm and industry. Armco Steel Corporation, Middletown, Ohio.

Export: The Armco International Corporation.

ARMCO STEEL CORPORATION

June, 1948 — ELECTRONICS
NOW... The CLARE Type "J" Relay can be Mounted as Conveniently as a Radio Tube!

Famous Clare Type "J" d-c Relay now available in plug-in type where quick removal or replacement is desirable.

Clare Type "J" d-c Relays combine the best features of the conventional telephone type relay with the small size and light weight which modern compact design requires.

Check these outstanding features of Clare Type "J" design which provide hitherto unheard of performance by a small relay:

* Independent Twin Contacts
* High Current-Carrying Capacity
* Large Armature Bearing Area
* Efficient Magnetic Structure

Clare sales engineers, with long experience in every type of relay problem, are located in principal cities. They will be glad to provide you with complete engineering data on the Clare Type "J" Relay, show you how it may be "custom-built" to meet your exact requirements.

Look for them under "Clare Relays" in your classified phone book... or write C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 36, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable Address CLARELAY.

CLARE RELAYS
First in the Industrial Field
Memo to...DESIGN ENGINEERS
about...MYCALEX 410-MOLDED

In the design of components or complete equipment for industrial controls or communications—where insulation qualities are of critical importance—where mechanical precision must be a fixed factor—where strength is essential—where electrical characteristics must accurately meet high frequency circuit needs...then remember MYCALEX 410 as the insulation that designs-in with your most exacting requirements.
MYCALEX is today’s improved insulation – designed to meet the exacting demands of all types of high-frequency circuits. MYCALEX is unusual in that it possesses a combination of peculiar characteristics that make it ideally suited for insulation in all types of electronic circuits. In tomorrow’s designs for communications and industrial control equipment, MYCALEX 410 will be specified more than ever before because of its... Low dielectric loss · High dielectric strength · High arc resistance · Dimensional stability over wide humidity and temperature changes · Resistance to high temperatures · Mechanical precision · Mechanical strength · Ability to mold metal inserts in place. If you have any insulation problems, our engineers will be glad to help you in their solutions.

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.

<table>
<thead>
<tr>
<th>PART NAME</th>
<th>APPLICATION</th>
<th>INSERTS</th>
<th>MAX. DIMEN.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Bushing</td>
<td>Motor Generator</td>
<td>None</td>
<td>1.75”</td>
</tr>
<tr>
<td>2 Insulator</td>
<td>Electrical Instrument</td>
<td>None</td>
<td>3.35</td>
</tr>
<tr>
<td>3 End Seal</td>
<td>Thermostat Shell</td>
<td>Stainless Steel</td>
<td>3.15</td>
</tr>
<tr>
<td>4 Insulator</td>
<td>Electrical Instrument</td>
<td>None</td>
<td>3.00</td>
</tr>
<tr>
<td>5 Hermetic Seal</td>
<td>Crystal housing</td>
<td>Nickel and Copper</td>
<td>0.88</td>
</tr>
<tr>
<td>6 Hermetic Seal</td>
<td>Crystal housing</td>
<td>Copper</td>
<td>1.09</td>
</tr>
<tr>
<td>7 Insulator</td>
<td>Automobile Antenna</td>
<td>None</td>
<td>1.06</td>
</tr>
<tr>
<td>8 Bushing</td>
<td>Ignition</td>
<td>Steel</td>
<td>4.50</td>
</tr>
<tr>
<td>9 Stand-Off Insulator</td>
<td>Electronics circuit</td>
<td>Brass</td>
<td>0.56</td>
</tr>
<tr>
<td>10 Panel</td>
<td>Television Selector Switch</td>
<td>Silver</td>
<td>1.38</td>
</tr>
<tr>
<td>11 Switch Wafer</td>
<td>Television Selector Switch</td>
<td>None</td>
<td>2.31</td>
</tr>
<tr>
<td>12 Elbow</td>
<td>Aircraft Ignition</td>
<td>Steel and Brass</td>
<td>2.75</td>
</tr>
<tr>
<td>13 Lead</td>
<td>Transformer</td>
<td>Monel</td>
<td>1.75</td>
</tr>
<tr>
<td>14 Insulator</td>
<td>Polarizing relay</td>
<td>None</td>
<td>1.09</td>
</tr>
<tr>
<td>15 Lead through block</td>
<td>Oscillator</td>
<td>Brass</td>
<td>1.69</td>
</tr>
<tr>
<td>16 Insulator</td>
<td>Telephone Transmitter</td>
<td>None</td>
<td>0.88</td>
</tr>
<tr>
<td>17 Dual Bushing</td>
<td>Oil Burner Transformer</td>
<td>None</td>
<td>3.00</td>
</tr>
<tr>
<td>18 Lead</td>
<td>Transformer</td>
<td>Monel</td>
<td>2.50</td>
</tr>
<tr>
<td>19 Actuating Bar</td>
<td>Telephone relay</td>
<td>None</td>
<td>1.44</td>
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<tr>
<td>20 Actuating Bar</td>
<td>Telephone relay</td>
<td>None</td>
<td>0.78</td>
</tr>
<tr>
<td>21 Spacer</td>
<td>Radio vibrator</td>
<td>None</td>
<td>0.56</td>
</tr>
<tr>
<td>22 Panel</td>
<td>Television Selector Switch</td>
<td>None</td>
<td>1.75</td>
</tr>
<tr>
<td>23 Spacer</td>
<td>Telephone relay</td>
<td>None</td>
<td>1.00</td>
</tr>
<tr>
<td>24 Spacer</td>
<td>Relay</td>
<td>None</td>
<td>0.91</td>
</tr>
<tr>
<td>25 Spacer</td>
<td>Telephone relay</td>
<td>None</td>
<td>1.00</td>
</tr>
<tr>
<td>26 Spacer</td>
<td>Telephone relay</td>
<td>None</td>
<td>1.00</td>
</tr>
<tr>
<td>27 Clamping Plate</td>
<td>Telephone relay</td>
<td>None</td>
<td>1.00</td>
</tr>
<tr>
<td>28 Electrode Mounting</td>
<td>Level Indicator</td>
<td>Brass</td>
<td>1.13</td>
</tr>
<tr>
<td>29 Spacer</td>
<td>Telephone relay</td>
<td>None</td>
<td>1.00</td>
</tr>
<tr>
<td>30 Six Terminal Header</td>
<td>Transformer</td>
<td>Monel</td>
<td>1.42</td>
</tr>
<tr>
<td>31 Test jack body</td>
<td>High Frequency Circuits</td>
<td>Monel</td>
<td>0.75</td>
</tr>
<tr>
<td>32 Clamping Plate</td>
<td>Telephone relay</td>
<td>None</td>
<td>1.00</td>
</tr>
<tr>
<td>33 Printed Circuit Base</td>
<td>Experimental</td>
<td>Silver</td>
<td>1.38</td>
</tr>
</tbody>
</table>

www.americanradiohistory.com
What's your problem?
Fine Wire?  Tungsten?  Molybdenum?

Problem 1

MR. N. AMMELLING needed 339,000 feet of .001 enamelled copper wire. He called Fine Wire Headquarters and in good time received a one-pound package...his 64 miles of wire enamelled to his specifications.

Problem 2

A customer's needs called for a material with a high tensile strength at elevated temperature. He called North American Philips and received ELMET Molybdenum which performed to his complete satisfaction...fulfilling every requirement.

Problem 3

MR. MUST B. PLATED, who required metal-clad wire for a specific application, phoned Fine Wire Headquarters. We supplied the base material to provide the physical characteristics desired, and plated it to meet his exacting specifications for special surface qualities.

the answer

WHY not call Fine Wire Headquarters when you have a question about fine wire? We can't do the impossible, but we can do lots of things that can bring you the right fine wire for the job.

So—when you have a problem on Fine Wire, Tungsten or Molybdenum—wire, phone or write to North American Philips, makers of NORELCO Fine Wires, and ELMET Tungsten and Molybdenum products.

NORTH AMERICAN PHILIPS COMPANY, INC.
Dept. E-6, 100 East 42nd Street, New York 17, N. Y.
Export Representative • Philips Export Corporation • 100 East 42nd Street, New York 17, N. Y.

June, 1948 — ELECTRONICS
You get an extra dividend with every shipment of Ohmite rheostats or resistors. You get the accumulated experience of the entire Ohmite engineering staff... the combined thinking of its many specialists... to help you analyze your requirements and select the correct unit to fit your specific application. If circumstances warrant, your equipment may even be sent to our laboratory for further study. Years of experience in building dependable rheostats and resistors and in helping others solve specialized resistance problems is your assurance that Ohmite “know-how” can help you. We invite you to submit your problems to us.
RHEOSTATS for every Need
Ten Standard Sizes—25 to 1,000 watts

You can get a standard Ohmite rheostat for practically any application. The Ohmite line of standard rheostats is the most extensive available. Furthermore, six wattage sizes, in many resistance values, are carried in stock for immediate shipment. Special resistance values, tapered windings, tandem assemblies, and many other variations can be made to order quickly at small extra cost. All models are carefully engineered to give long operating life. All have the distinctive, time-proven Ohmite features—the all-ceramic construction, windings permanently locked in vitreous enamel, and smoothly gliding metal-graphite brush. Whatever your needs, Ohmite engineers can provide a rheostat of unfailing dependability to meet your exact requirements.

How to Select a RHEOSTAT

1 UNIFORM WINDING
It’s easy to choose the right uniformly wound rheostat if you have certain basic data. Knowing the resistance required and the maximum current for the circuit (circuit current with rheostat shorted out), the rheostat wattage can be calculated by the formula: W=I²R. A standard rheostat, the wattage of which is not less than the calculated value, can then be selected from the Ohmite catalog. If the resistance and maximum current are not known, Ohmite engineers can calculate them from various circuit information you can supply about the application.

2 TAPERED WINDING
In a tapered winding rheostat the winding is made up of two to six sections of diminishing wire sizes. This construction allows a large resistance change to be "telescoped" into a small part of the winding, thus providing more uniform control and reducing over-all rheostat size.

The design of a tapered rheostat is not as simple as choosing a uniformly wound unit. Taper-wound rheostats can be selected from the standard designs listed in the Ohmite catalog for field control of generators, or Ohmite engineers will be glad to make specific recommendations.

Send for Catalog and Engineering Manual No. 40
Write for this Ohmite Catalog and Engineering Manual on your letterhead. It contains the complete line plus a wealth of engineering information.

OHMITE
MFG. COMPANY
4818 FLOURNOY ST.
CHICAGO 44, ILL.
In the streamlined Proctor Toaster it takes a 1-inch length of BH Fiberglas Sleeving to provide supplementary insulation over the asbestos-covered leads on the built-in heater cord. With BH Fiberglas Sleeving there is no possibility of a partly uncovered braid... no threads to break or unravel. This extra margin of safety means trouble-free service.

In every industry, BH Fiberglas Sleeving gets the tough insulation jobs—where high heat, excessive current load or the possibility of insulation breakdown make extra protection a necessity.

Here is the reason. In BH Fiberglas Sleeving, no hardening varnish or lacquer is used. You can see the difference in:

1. Remarkable flexibility... BH Sleeving fits snug, spreads to cover knobs or terminals. Will never harden or dry out because no varnish is used;
2. Non-fraying qualities... BH Sleeving cuts clean, will not feather. It is treated to retard fraying without the use of varnish;
3. Lasting performance... BH Sleeving does not disintegrate even after long use because varnish is not used.

Prove it to yourself—let us send you a sample of BH Fiberglas Sleeving today.


USE COUPON NOW.


I am interested in BH Non-Fraying Fiberglas Sleeving for... (product)

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

NAME... COMPANY... ADDRESS...

ELECTRONICS — June, 1948
HERE IT IS

NEW!
DIFFERENT!
BETTER!

The ONLY RADIO BATTERY
That Has The
OLIN Interlocked Flat Cell

PLAYING HEART

Enlarged Cutaway Section Shows...
EACH CELL INTERLOCKS WITH ITS NEIGHBOR-
FORMS THE PLAYING-HEART OF YOUR RADIO

LOOK!

- Each Cell Holds More Power-Producing Chemicals.
- No Waste Space.
- Lasts Hours Longer.
- Costs No More.
- Already Standard Equipment with 12 Radio Manufacturers.

EXCLUSIVE!

- Result of 5 years' Scientific Electronic Research.
- Patented U.S. Pat. No. 2416576.
- Triple-Sealed Against Power Leakage.
- No Binding Tapes.
- No Sealing Wax.
- Greatly reduces Battery Failure...
  91% Less Soldered Connections.

June, 1948 — ELECTRONICS

www.americanradiohistory.com
Increase Your Radio Battery Sales This Summer with the Sensational Interlocked Flat Cell Battery

The demand for portable radio batteries this summer promises to be the greatest in radio history... estimated to be $52,000,000. All over America, portable radio owners will be customers for this startling new electronic development that gives more hours of listening pleasure... yet costs no more.

Available in 2 Brands

Make your store headquarters for the OLIN Interlocked Flat Cell Radio Battery. Fill in coupon below, for descriptive Catalog and get the complete Product and Sales story.

Don't Disappoint Your Customers They'll Want...

THE ONLY RADIO BATTERY That has the Interlocked Flat Cell PLAYING-HEART

Olin Industries, Inc. Electrical Division New Haven, Conn. Dept. C Mail me at once Descriptive Catalog □ Bond-Olin or □ Winchester-Olin. (Check brand desired.)

NAME

ADDRESS

CITY STATE
For the Industrial and Electronic Market—

Custom built to your specific
JOB REQUIREMENTS

Where your specifications call for an extra margin of performance and dependability—that's a job for Federal transformers. For years, Federal has been designing and producing special transformers to meet the most exacting requirements—for Federal's own radio and electronic equipment, as well as for military and commercial service.

This engineering and production skill is at your service—ready to help solve your toughest transformer problems. Federal will design the right transformer for your circuit conditions, with exactly the right voltage and impedance ratios, insulation strength, load capacity, and mechanical construction. Available in sizes up to 25 kva.

For prices and data, write Federal today, outlining your design requirements. Dept. J113

This FEDERAL transformer helps to MILK COWS ELECTRICALLY

Designed for use in the pulsing circuit of an automatic milking machine, this transformer, with 115-volt input and 15-volt, 5-ampere output, provides the right combination of electrical, physical and thermal characteristics to assure optimum performance of the complete equipment—a typical example of a Federal transformer specially designed for a specific job.

Federal Telephone and Radio Corporation

June, 1948 — ELECTRONICS
Power Loss = 55.5$\varepsilon^1 \tan S \times f \times V^2 \times 10^{-6}$ 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
- Special Zircon Porcelain

**TAM**

**TITANIUM ALLOY MANUFACTURING COMPANY**

EXECUTIVE AND SALES OFFICES . 111 BROADWAY, NEW YORK CITY

GENERAL OFFICES AND WORKS . NIAGARA FALLS, NEW YORK

ELECTRONICS — June, 1948
The right material for your job

How to Save 2 Ways with an Engineering Service that Always Gives You Unbiased Recommendations

First, you save production hours and dollars because you can be sure of getting electrical insulating materials that are "right for your jobs."

That's because Continental-Diamond makes a complete range of products with the physicals you want. Instead of having only one, two, or three materials to recommend, C-D offers you a choice of five different insulating materials subdivided into grades or combinations of grades to fit your specific applications. Thus, you stand a much better chance of getting the one material that will reduce fabricating costs and improve product performance because it's right on the job.

Second, you save time and effort because you have a convenient, "one-stop" source for all your electrical insulating needs. To give you fast, complete shipment, large stocks of every C-D product are constantly kept on hand. And, if you request it, trained C-D technicians can give you practical, personal help that can lead to better, lower-cost applications. Save two ways, today. Call or drop us a line for anything you need in the way of top-quality electrical insulating materials.

DE-3-48

BRANCH OFFICES: NEW YORK 17 • CLEVELAND 14 • CHICAGO 11 • SPARTANBURG, S. C. • SALES OFFICES IN PRINCIPAL CITIES WEST COAST REPRESENTATIVE: MARWOOD LTD., SAN FRANCISCO 3 • IN CANADA: DIAMOND STATE FIBRE CO., OF CANADA, LTD., TORONTO 8

Continen tal = Diamond FIBRE COMPANY
Established 1895, Manufacturers of Laminated Plastics since 1911—NEWARK 16 • DELAWARE

June, 1948 — ELECTRONICS

www.americanradiohistory.com
**RM-251** is a distinguished addition to the Jensen reproducer family. This "decorator-designed" Bass Reflex cabinet utilizes any fifteen inch Jensen loud speaker including the coaxial. Of sufficient size, it makes an ideal base for almost any television or receiver equipment.
ERIE TRIMMERS

for easy assembly and dependable performance at reasonable cost

HERE are six popular ERIE Resistor trimmers, all notable for their fidelity to specifications, their rugged stability, and their straight-line capacity change throughout the total range.

The new miniature style Tubular Trimmers and Styles 554 and 557 open up many design possibilities for added efficiency in chassis layout.

General specifications are given below. Samples will be sent to interested manufacturers on request.

**STYLES 531 and 532**
- Capacity Ranges: 0.5-5 MMF & 1-8 MMF
- Working Voltage: 500 V.D.C.
- Max. Temperature: 75°C
- Q Factor @ 1 MC: 1,000 min.
- Initial Leakage Resistance: 10,000 megohms min.
- Styles: 531 for panels .015” to .039”; 532 for .040” to .065”

**STYLES TS2A and TD2A**
- Capacity Ranges:
  - Zero Temp. Coeff: 1.5-7 MMF & 3-12 MMF
  - N300 Temp. Coeff: 3-13 MMF & 5-20 MMF
  - N500 Temp. Coeff: 4-30 MMF & 7-45 MMF
- Working Voltage: 500 V.D.C.
- Q Factor @ 1 MC: 500 min.
- Initial Leakage Resistance: 10,000 megohms min.
- Styles: TS2A, Single Condenser; TD2A, Dual Condenser

**STYLES 554 and 557**
- Capacity Ranges:
  - Zero Temp. Coeff: 3.12 MMF & 5.25 MMF
  - N750 Temp. Coeff: 5.30 MMF & 8.50 MMF
- Working Voltage: 350 V.D.C.
- Q Factor @ 1 MC: 500 min.
- Initial Leakage Resistance: 10,000 megohms min.
- Styles: 554 Mounted with Spring-Clip; 557 for Sub-panel or Bracket Mounting
MAKE THINGS GO!

with alliance motors

Reliable, high-speed mass production of motors at low cost—
that's the big job at Alliance! Makers of mass consumer prod-
ucts need Alliance motors for their small load tasks. Noted for
long life, they are compact and light weight. Many weigh
less than a pound! Power ratings range from less than
1/400th h.p. to 1/20th h.p. Some are uni-directional—
others are reversible and can be made for continuous or
intermittent duty.

Practical uses for Alliance motors are to power automatic
controls, switches, valves, motion displays, movie projectors,
vending and business machines, toys, record players,
and radio tuning devices. The newer Alliance Model A
and Model B motors are especially built for driving
fan blades in air circulators, room heaters, hair dryers,
coolers, and air conditioning appliances. Model B is also
an excellent power source for sound recorders.

Alliance Motors pack more motion and automatic action into new products!

WHEN YOU DESIGN—KEEP

alliance motors

IN MIND

ALLIANCE MANUFACTURING COMPANY • ALLIANCE, OHIO

Export Department: 401 Broadway, New York 13, N. Y., U. S. A.

ELECTRONICS — June, 1948

www.americanradiohistory.com
outstanding advantage offered in Highest Quality Potentiometer

**GIBBS MICROPOT GUARANTEES**

±0.1% ACCURACY

"Integral Molding" ... Exclusive Gibbs Engineering Development...
Forever Locks Coiled Resistance Element and Terminals into One Integral Unit with Housing... Assures Unequaled and Permanent Operational Accuracy.

...and only the **MICROPOT** has it!

The coiled resistance element is threaded on the molded core

Resistance element and terminals are one integral part of housing

**OTHER IMPORTANT FEATURES OF GIBBS TEN-TURN MICROPOT**

- Resistance output is directly proportional to shaft rotation through a full 3,600 degrees within ±0.1%: this linearity is carried right to the counter clockwise stop. In the Gibbs MICROPOT such results are obtained by precision manufacturing and methods.
- Precision ground, stainless steel, double thread, lead screw guides the rotating contact, guarantees smooth action, low uniform torque and accurate settings — permanently.
- Rotor assembly, supported on two bearings, assures long life and low torque.
- Ends of resistance element soldered to terminals before molding.
- Anti backlash spring in contact guide—assures you positive setting and resetting.
- The 43⅞ inch length of resistance element gives you a finer resolution.

Write Today! For engineering specifications and complete detail folder. Submit any problems to our engineering staff for recommendations. Units for immediate shipment. — 1,000 to 30,000 ohm range. Special resistance values made to order.

DEPT. 34 GIBBS Division

**THE GEORGE W. BORG CORPORATION**

Delavan • Wisconsin

June, 1948 — ELECTRONICS
The New WEBSTER ELECTRIC

Featheride
magnetic
CARTRIDGE

Rugged construction ... holds adjustment

Light in weight (25 grams) ... small size

Tracking pressure, 1 ounce

Uncompensated Cut-Off starting at 6,000 cycles

Ideal for home record-playing equipment

Uncompensated output at 1,000 CPS, .1 volt

No critical air gap ... no bearings to wear out

Supplied with retractable osmium-tipped needle

Magnetically shielded

High needle-point compliance

Quiet Playing

The new Webster Electric "Featheride" magnetic cartridge fits universally, from a mechanical standpoint, into practically all tone arms. This will meet your requirements for tone arms you may have on hand. As shown above it has all the features for top performance ... this is a result of sound fundamental design, careful engineering and precision manufacturing methods.

Write today to Webster Electric Co., Racine, Wisconsin for specification sheets and literature showing performance curve and all technical features.

WEBSTER ELECTRIC
RACINE WISCONSIN

Established 1909
Export Dept. 13 E. 40th Street, New York, 16, N. Y.
Cable Address "ARLAB" New York City

"Where Quality is a Responsibility and Fair Dealing an Obligation"

ELECTRONICS — June, 1948

www.americanradiohistory.com
Frequency Standards

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

Uses
Time bases, rate indicators, clock systems, chronographs, geophysical prospecting, control devices and for running small synchronous motors.

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

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

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

AMERICAN TIME PRODUCTS
580 Fifth Avenue INC. New York 19, N. Y.
Operating under patents of the Western Electric Company

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

Name
Company
Address
City State

June, 1948 — ELECTRONICS
We have designed—and have available—many types of C-D Quietones which are equally effective on both radio and video bands. They meet every requirement of manufacturers' cost and production schedules. One of these standard types may remove your product from the list of radio interference generators. If not, we're ready and waiting—with a modern and complete laboratory and experienced engineers—to design and build a Quietone to meet your specific needs. Your inquiry is cordially invited. Cornell-Dubilier Electric Corporation, Dept. K-6 South Plainfield, New Jersey. Other large plants in New Bedford, Worcester and Brookline, Massachusetts, and Providence, Rhode Island.

Cornell-Dubilier World's Largest Manufacturer of Capacitors

ELECTRONICS — June, 1948
Celenamel magnet wire—newly developed by Belden—is copper wire insulated with a film of cellulose acetate combined under heat with other resinous materials. The film so produced is tough, flexible, continuous, and of high dielectric strength.

Celenamel is practically impervious to the action of hot coal tar as well as petroleum naphthas. The properties are such that Celenamel meets and in some respects exceeds industry standards for oleo-resinous enameled magnet wire.

In soldering operations it is unnecessary to remove the Celenamel insulation. Soldering of leads is accomplished by dipping in a low-temperature lead-tin bath or direct application of a soldering iron. A flux of rosin-alcohol should be used.

Celenamel films are produced with insulation additions that have closer and more uniform tolerances than have heretofore been available. The film withstands the usual temperatures encountered during coil impregnation and baking.

Celenamel insulation possesses very good aging qualities. Celenamel magnet wire produced several years ago still exhibits its original mechanical and electrical properties.

Celenamel is available in sizes 41 and finer.
IN THE PRODUCTION
OF OUR TOROIDAL COIL PRODUCTS

KEYBOARD OSCILLATOR

Present day methods of checking the frequency response of Audio Networks in production were so inadequate that it became necessary for our engineers to conceive a radically new method of accurate frequency selection using the decade principle. The result is our KEYBOARD OSCILLATOR, developed for our own use, which provides instantaneous selection of any audio frequency from 1.00 cycles to 100,000 cycles accurately and without the use of interpolation methods.

We consider this to be one of our finest achievements in modernizing the production of audio filters.

TC-1 Inductance up to 7.5 Henries
Freq. range 250 to 20,000 cycles

TC-2 Inductance up to 30 Hys
Freq. range 100 to 20,000 cycles

TC-3 Inductance up to 500 Mhys.
Freq. range 5KC to 100KC

TOROIDAL COIL FILTERS

Audio Filters
Audio Discriminators
Equalizers and Noise Control Filters
Phase Networks

www.americanradiohistory.com
COMMUNICATIONS AND SIGNALING  Designed specifically for use in industrial electronic equipment, communications and signaling equipment, this General Electric telephone-type relay has a service life measured in many millions of operations. Working from five basic contact arrangements, combinations can be stacked to satisfy intricate circuit switching requirements. Welded-crossbar palladium contacts, new-type molded insulation and stainless steel bearings contribute to this d-c relay's longevity. Coils rated 1 to 250 volts, 0.1 to 26,000 ohms; contacts 3 amps maximum. Bulletin GEA-4859.

HEAVY-DUTY GENERAL-PURPOSE  Three contact arrangements—spst, dpst, and dpdt—plus four mounting arrangements give the CR2790E real versatility. Mounting arrangements available are the enclosed form shown here, open form, back-connected form for panel mounting, and a plug-in form for use in process control equipment. Its heavy silver contacts are rated 10 amps continuous at 115/230 volts, 60 cycles; normally open contacts will make and break 45 amps, normally closed contacts 20 amps. Bulletin GEC-257 gives full details.
TIMELY HIGHLIGHTS ON G-E COMPONENTS

DYNAMOTORS FOR QUICK DELIVERY!

Shopping for fractional-hp dynamos? General Electric can now supply you on a short-shipment basis! Production has finally caught up on these d-c to a-c converters for communications service. Standard dynamos are available in ratings of 200 and 500 volt-amperes, 60 cycles, continuous duty. Specials are also available, but on a slightly longer shipment. For more complete information on these fhp equipment, contact your G-E representative or write Fractional-horsepower Motor Div., General Electric Co., Fort Wayne, Indiana.

MORE PULL IN LESS SPACE

You'll find these new, small, all-welded solenoids useful in any application where a straight-line thrust is required...they're a natural for vending machines. The small unit requires only three cubic inches of space, and develops 0.26 pounds pull at ¼-inch stroke; its "big brother" produces 3.7 pounds at ¾-inch stroke.


SHOW IT, THEN THEY'LL KNOW IT

If your organization has an educational program underway, or plans one, ask your G-E representative to show you the Industrial Electronics Training Course. Rated tops in visual training by the nation's industrials, schools and institutions now using it, the complete kit contains twelve half-hour slide films with records, individual lesson guides keyed to the film, and a manual for the course instructor.

Everything from fundamental electronics to up-to-the-minute electronic production tools are forcefully described and explained in this easy-to-take visual course. Check Bulletin GES-3303.

NEED SOMETHING SPECIAL IN CAPACITORS?

Here's a new .0075-muf, 10-kv d-c capacitor for television, precipitation, and similar electronic equipment requiring filtering in high-voltage power supply. Other capacitances (.0005 to .01 muf) and voltages (3 to 30 kv) can be supplied.

Ceramic container acts as insulator, simplifies mounting, cuts size (volume) to 1/5th without lowering quality in any way. Ingenious internal hermetic silicone cone seal eliminates solder. Pyranol filled. Contact your G-E representative or write Transformer Div., General Electric Co., Pittsfield, Mass., for quotation.

LOOKING FOR PERMANENT MAGNET DATA?

These two new bulletins are packed full of application and design information to help you build magnets into your electronic equipment. CDM-1 covers "Permanent Magnets"; CDM-2 describes "Cast and Sintered Alnico Magnets." Coupon below will bring this valuable information to your desk quickly. Check it now.

GENERAL ELECTRIC COMPANY, Section E-642-17
Apparatus Department, Schenectady, N. Y.

Please send me the following bulletins:
☐ GEA-4859 Telephone-type Relay
☐ GES-3303 Electronics Training Course
☐ GEA-4864 Appliance Relay
☐ CDM-1 Permanent Magnets
☐ GEC-257 General-purpose Relay
☐ CDM-2 Cast & Sintered Alnico Magnets
☐ GEA-4897 Solenoids

Name: ____________________________
Company: _________________________
Address: __________________________
City: _____________________________ State: ____________

ELECTRONICS — June, 1948
Because OFHC Copper looks like any other copper, Revere takes great pains to identify it throughout processing, to see it is not lost track of or mixed up with other types. The obvious thing is to mark each piece, which is done, but markings are obliterated by operations such as rolling, and so Revere goes to the length of assigning special personnel to follow each lot of OFHC Copper from one operation to another, watching carefully to be sure each load is kept intact.

In addition, Revere takes full cognizance of the fact that OFHC Copper for radio purposes must have special qualities. In making anodes, it must be deep drawn, and for the feather-edge seal, it must be capable of being rolled or machined down to .002"/.010". By carefully controlling mill processing, grain size is kept at or below permissible limits. Freedom from oxygen, and from voids, is guaranteed by the method of casting the bars from which we roll the forms required. In addition, there is an operation which results in Revere OFHC Copper being not just commercially free but nearly absolutely free of internal and external defects. This great care in producing copper for radio and radar purposes probably accounts for the fact that Revere is a preferred source of supply.
The new Lapp Gas-Filled Condensers save about 30% of space requirements as compared with previous units. Current paths are only one-third as long, with consequent lower losses. Current ratings, effective voltage ratings and safety factors have been increased. On variable models the tuning shaft is at ground potential, which eliminates need for special insulated tuning shafts. Puncture-proof. Constant capacitance without need for "warm-up," Lapp Gas-Filled Condensers are a source of proved dependability for capacitance at high voltages or high currents for radio or industrial electronic circuits. Write for bulletin No. 265.
For over 20 years, the KENYON "K" has been a sign of transformer reliability. Ever since the cat's-whisker, crystal-set days, KENYON has pioneered high quality transformers. Skillful engineering, progressive design and sound construction have resulted in dependable, conservatively-rated transformers with an enviable record for minimum field rejections. Cut engineering and replacement costs. Improve products. Insure repeat business. Specify KENYON!

Consult KENYON About Your Transformer Problems

KENYON TRANSFORMER CO., Inc.
840 BARRY STREET
NEW YORK 59, N.Y.

June, 1948 — ELECTRONICS
When water in municipal systems contains dissolved minerals and chlorine, it becomes a fairly efficient electrolyte.

To avoid electrolytic corrosion which may occur if dissimilar metals are in contact with the water, the Toastmaster Water Heater employs "LIFE BELT" heating elements attached to the outside of the tank. In such an application, the ability of the elements to give long, trouble-free, economical service rests solely upon the quality of the electrical resistance material used. To assure top-level performance for a lifetime, the McGraw Electric Co., maker of the Toastmaster Water Heater, specifies Nichrome.*

The tank of the Toastmaster Heater is further protected by McGraw's new "Ionodic" system of corrosion prevention, where a magnesium rod anode, immersed in the water, saves the cathodic material of the tank from electrolytic attack.

Thus the manufacturers are able proudly to state: "We guarantee the Toastmaster Electric Water Heater for 10 years, and we deem this to be a conservative commitment. Many water heaters made by this company are still in daily use after several times this length of service, and elements in the old water heaters show little wear and no loss of efficiency."

Profit by the example of the McGraw Electric Co. and specify Nichrome. And remember, Driver-Harris manufactures over 80 alloys designed to fill the numerous requirements of the Electrical and Electronic industries... fully described in our catalog R-46.

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

Values for the physical properties of electrical insulation, as determined by methods standardized by the American Society for Testing Materials, should be interpreted with the same caution as dielectric strength values. For physical characteristics which are at the thickness of the material and its temperature and moisture content.

**IMPACT TESTS**

ASTM Designation D256-47T sets up methods for determining the relative toughness or resistance to shock of electrical insulating materials. Impact values are indicated by the energy expended by the machine in fracturing a standard sample of material, \(\frac{1}{4}'' \times \frac{1}{4}''\) square, with a notch approximately \(\frac{1}{160}'\) deep, so that thickness of the sample to the notch is exactly \(\frac{1}{160}'\).

Two methods are used. Method A employs a Cantilever Beam (Izod Type) Impact Machine in which the specimen is clamped at one end as a cantilever beam (Figure 1). Method B employs a Simple Beam (Charpy Type) Impact Machine which is similar except in the design of the impact head, and in that the test sample is supported at both ends. The pendulum is released from such a height that linear velocity of striking edge at impact is about 11 fps.

Test reports include: (1) specimen size, (2) method of test, (3) conditioning, (4) direction of testing (sheet materials), (5) whether samples were cut lengthwise or crosswise from the sheet, (6) value of energy expended in breaking sample, expressed in ft-lb per inch of notch, (7) average thickness of sample and (8) number of such samples broken in each operation of the machine.

**LAMICOID SHEETS—**

MINIMUM IMPACT STRENGTH

<table>
<thead>
<tr>
<th>NEMA Grade</th>
<th>Izod Impact Strength</th>
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<tbody>
<tr>
<td></td>
<td>Ft-lb/in. notch</td>
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<tr>
<td></td>
<td>(Flatwise) (Edgewise)</td>
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<tr>
<td>X (Paper Base)</td>
<td>1.3 0.50</td>
</tr>
<tr>
<td>P (Paper Base)</td>
<td>&quot; 0.50</td>
</tr>
<tr>
<td>XX (Paper Base)</td>
<td>1.0 0.40</td>
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<tr>
<td>XXP (Paper Base)</td>
<td>0.80 0.35</td>
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<tr>
<td>XXX (Paper Base)</td>
<td>&quot; 0.30</td>
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<tr>
<td>C (Canvas Base)</td>
<td>3.2 2.0</td>
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<tr>
<td>CE (Canvas Base)</td>
<td>2.3 1.3</td>
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<tr>
<td>L (Linen Base)</td>
<td>2.5 1.2</td>
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<tr>
<td>LE (Linen Base)</td>
<td>1.8 1.0</td>
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<tr>
<td>A (Asbestos Paper Base)</td>
<td>1.8 0.80</td>
</tr>
<tr>
<td>AA (Asbestos Fabric Base)</td>
<td>3.5 3.0</td>
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</tbody>
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*Flatwise tests are applicable only to sheets having a thickness of \(\frac{1}{160}''\) or over. No flatwise values given as these grades are not available in thicknesses exceeding \(\frac{1}{160}''\).*

**Figure 1—Cantilever Beam (Izod Type) Impact Machine used in testing impact resistance of electrical insulating materials.**
MICA PRODUCTS OFFER WIDE RANGE OF PROPERTIES

Mica Insulator Company manufactures a highly diversified line of insulating materials which afford many combinations of physical and electrical properties. Longer life and better performance have been built into many different products through careful selection and application of materials possessing the proper balance of characteristics.

POST-FORMING LAMICOID

Ideal for deep drawing and forming, is used to advantage by RCA as an antenna case and insulating part for the 66X portable radio. In addition to its high dielectric strength and low power factor, this fabric-base laminated plastic has the advantages of high impact resistance and compressive strength, and is stable under varying atmospheric conditions.

EMPIRE ARMATITE SLOT INSULATION

Tough, flexible, easily-formed combinations of fabric and paper, provides relatively high dielectric strength and more compact finished insulation. It is used together with high-strength Lamicoid slot wedges and Empire cloth for phase insulation in this wound stator for a squirrel cage motor. Physical and dielectric properties complement each other in providing insulation dependability.

FIBERGLAS-BASE LAMICOID

Impregnated with Melamine resin, finds wide use where fire, arc and temperature resistance and high impact strength are important, as in terminal and panel boards, slot sticks, pole collars and coil spacers. It possesses very high dielectric strength and very low moisture absorption.

Over 50 years of experience have gone into the development and manufacture of Mica Insulator Company electrical insulation products. The accumulated knowledge of material properties and specialized experience in the problems of electrical insulation application is at your disposal. Consult our Technical Service Department on your insulation problems.
Always room for something NEW and BETTER

**NEW** Presto 8D-G Recorder

Extreme accuracy...designed for the finest instantaneous and master recordings. A special feature is the direct gear drive with separate motors for 33⅓ and for 78.26 rpm. Overhead driven independently of the turntable and has a choice of seven different feed pitches in each direction.

**NEW** Presto 92-A Recording Amplifier

Sixty-watt amplifier especially designed for high-fidelity recording. Vertically mounted chassis. Removal of front panel gives access to all circuits. Output stage has four 807's in push-pull parallel. Selector switch and meter provide both output level indicator and plate current readings for all tubes. Response: 20-17,000 cps.

**NEW** Presto 64-A Transcription Unit

Directly gear-driven at both 33⅓ and 78.26 rpm, with two separate motors, one for each speed. Instantaneous speed selection by turning mercury switch, without damage to mechanism. Speed: Total speed error is zero. Noise: At least 50 db below program. Starting: Table on speed in less than ¼ revolution at 33⅓ rpm.

**NEW** Presto 90-A

Complete portable recording console. Three low-level input channels with mixers, master gain control and variable high and low frequency equalizers. Four fixed characteristics: Flat between 30 and 15,000 cps, NAB recording, 78 rpm recording, and playback complementing NAB recording.

For further information about any of this new equipment, write or wire

PRESTO RECORDING CORPORATION, Paramus, New Jersey

Mailing Address: P. O. Box 500, Hackensack, New Jersey

WORLD'S LARGEST MANUFACTURER OF INSTANTANEOUS SOUND RECORDING EQUIPMENT & DISCS

June, 1948 — ELECTRONICS
Accurate performance of your product is limited by the precision of its component parts. It is only through selection of precision components that superior performance can be assured. Hi-Q Ceramic Capacitors, for example, can be held to a minimum tolerance of .25 MMF. Constant surveillance throughout every stage of manufacture...from raw material to finished product...is responsible for this uniformly high quality of all Hi-Q components. Specify Hi-Q components...your assurance of precision performance.

**Precise Performance Assurance**

- **Precision**
  - Tested step by step from raw material to finished product. Accuracy guaranteed to your specified tolerance.
- **Uniformity**
  - Consistency of quality is maintained over entire production through continuous manufacturing controls.
- **Dependability**
  - Interpreted this factor in terms of your customers' satisfaction...year after year of trouble-free performance. Our Hi-Q makes your product better.
- **Space Saving**
  - The smallest, biggest-value components in the business make possible space-savings factors which reduce your production costs...increase your profits.

---

**Hi-Q Electrical Reactance Corp.**

Franklinville, N.Y.


Sales Offices: Boston, New York, Philadelphia, Detroit, Chicago, Los Angeles

Electronics — June, 1948
MUTUAL-DON LEE'S brand new 3 million dollar Hollywood studios serve as the heart of the network's West Coast AM-FM-TV activities. The block-square building is as modern as tomorrow, and its audio facilities are unexcelled anywhere in completeness and flexibility.

The impressive Master Control—custom-built by Western Electric—is one of the world's largest and most complete control centers. It contains equipment for simultaneous multiple dispatching to 10 outgoing networks and 4 recording channels of programs originating in the 12 studios, 3 announce booths, 96 remote pick-up lines and 7 incoming networks. Many extra circuits are provided to handle special requirements and a complete monitor system makes all programs available to managerial, sales, and public rooms. Through the use of pre-set program control with automatic switching, only one master operator is required.

Besides the Master Control equipment, Western Electric supplied for the studios 14 custom audio desks of the three types shown on the opposite page.

The "king size" of this installation is indicated by the number of components in Master Control and the 14 desks: 212 amplifiers, 67 rectifiers, 996 relays and 6,999 jacks, joined by 145,500 feet of wire with 108,074 soldered connections.

Western Electric and Bell Laboratories engineers are experts in the design and construction of custom-built audio and switching systems for stations of every size—as simple or complex as you require. For details see your Graybar Broadcast Representative, or write to Graybar Electric Company, 420 Lexington Avenue, New York 17, N. Y.

QUALITY COUNTS

Western
STUDIO CONTROL CONSOLES—Eight of these serve the auditoriums and drama studios in the new Mutual-Don Lee headquarters. Each console provides for six microphone inputs, a reverberation circuit, two transcription inputs and a remote input channel.

STUDIO-TYPE TRANSCRIPTION CONSOLES
Three of these are used in the smaller studios for handling commentary and round-table discussion programs, disc jockey shows, and the playback of delayed broadcasts with facility for cut-in announcements.

ANNOUNCE-TYPE TRANSCRIPTION CONSOLES
Three of these provide facilities in the KHJ network and FM announce booths for fading into and out of programs, giving identification and spot announcements and playing transcribed commercials and recorded fills.

Mutual-Don Lee's new $3,000,000 block-square Hollywood home.
sensitive
ALLIED RELAYS

FOR A LIMITED POWER SUPPLY OR PRECISE OPERATING CHARACTERISTICS

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

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

TYPE B
ALLIED RELAY
SENSITIVITY: 9 MILLIWATTS
Supplied with contact arrangements up to 2-pole double-throw. Standard silver contacts rated at 1 ampere at 24 volts DC or 110 volts AC non-inductive. Coil rating 9 milliwatts up to 38 volts DC and 0.12 volt-amperes up to 110 volts AC. Dimensions: 1\(\frac{3}{4}\)" x 2\(\frac{3}{4}\)" x 2\(\frac{3}{4}\)".

TYPE BG
ALLIED RELAY
SENSITIVITY: 11 MILLIWATTS
Contact arrangements, single-pole double-throw. Standard silver contacts rated at 2 amperes at 24 volts DC or 110 volts AC non-inductive. Coil rating 11 milliwatts up to 25 volts DC. Coils available for DC operation only. Dimensions: 1\(\frac{1}{4}\)" x 1\(\frac{3}{4}\)" x 1\(\frac{3}{8}\)".

TYPE F
ALLIED RELAY
SENSITIVITY: 80 MILLIWATTS
Supplied with contact arrangements up to 2-pole double-throw. Standard silver contacts rated at 2 amperes at 24 volts DC or 110 volts AC non-inductive. Coil rating 80 milliwatts up to 31 volts DC. Coils available for DC operation only. Dimensions: 1\(\frac{3}{8}\)" x 1\(\frac{7}{8}\)" x 1\(\frac{3}{8}\)".

Type B
ALLIED RELAY
SENSITIVITY: 9 MILLIWATTS
Supplied with contact arrangements up to 2-pole double-throw. Standard silver contacts rated at 1 ampere at 24 volts DC or 110 volts AC non-inductive. Coil rating 9 milliwatts up to 38 volts DC and 0.12 volt-amperes up to 110 volts AC. Dimensions: 1\(\frac{3}{4}\)" x 2\(\frac{3}{4}\)" x 2\(\frac{3}{4}\)".

TYPE BG
ALLIED RELAY
SENSITIVITY: 11 MILLIWATTS
Contact arrangements, single-pole double-throw. Standard silver contacts rated at 2 amperes at 24 volts DC or 110 volts AC non-inductive. Coil rating 11 milliwatts up to 25 volts DC. Coils available for DC operation only. Dimensions: 1\(\frac{1}{4}\)" x 1\(\frac{3}{4}\)" x 1\(\frac{3}{8}\)".

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

June, 1948 — ELECTRONICS
Here are the outstanding features...

1. No "Air Gaps."
2. Necessity for delicate handling eliminated.
3. No troublesome, costly armature balancing problems.
4. Longer-lived, troublefree performance without distortion or changes in characteristics.
5. Transcription quality reproduction.
6. Velocity response flat to 12,000 cycles.
7. Output is 100 millivolts. This is approximately 20 db. greater than most previously available, light-weight magnetic pickups.
8. Needle pressure, 1 oz.
9. Impedance, 7,500 ohms at 1,000 c.p.s.—110,000 ohms at 10,000 c.p.s.
10. Interchangeability: Physical dimensions of this cartridge are such that it can be employed with a majority of present day standard pickup and transcription arms.

Now Available

The Magneto-Induction Pickup

Yes, this is it! An entirely new concept in record-reproduction engineering. A radically new pickup cartridge that opens broad new vistas of listening pleasure... offers unchanging faithfulness and quality of reproduction that is stable and trouble-free.

The Astatic Magneto-Induction Pickup represents the first clean break with traditional principles, employed in the manufacture of magnetic type reproducers, since the introduction of such devices in early phonographs. Discarded now by this amazing development is the need for delicately spaced "air gaps," which collect lint and dust, and thereby become a prime source of trouble in other type magnetic pickups. Their elimination in the Magneto-Induction cartridge is all the more revolutionary... a newly opened door to greater record enjoyment... to a peak fidelity of reproduction that LASTS, even under the most consistent service or adverse climatic conditions.

MODEL MI-1, Code ASAKA MODEL MI-2, Code: ASALZ
Standard Housing Mumetal Housing*

*Provides increased shielding effect for maximum reduction of hum

Two Equalizer-Amplifier models available:
Model EA-1, compact unit designed for installation in radio sets and audio amplifiers having insufficient gain for operation of Astatic Magneto-Induction Pickup Cartridges. Provides "bass boost."
Model EA-2, self-powered, provides adjustable "bass boost," adjustable treble "roll-off," and selection of "turnover frequency."

Manufactured under Massa Laboratories License

Copyright THE ASTATIC CORP. 1948

ELECTRONICS — June, 1948
When the circuit calls for "Q"...

STACKPOLE CUP CORES
save space • reduce costs
improve performance

Stackpole iron powder molded cup cores are ideally suited to save valuable space and to make important contributions to high "Q" circuits. They are compact, efficient; may be mounted close to the chassis or any other metal part.

Stackpole offers a broad range of shapes and types—and, where required, can produce special cup cores to the most exacting specifications. Write for samples. State your specifications and probable quantities required.

Above is a still further refinement of the loading coils shown at left. This coil may be wound more easily, and at less cost than the toroid type.

In Western Union carrier telegraph systems, Stackpole cup cores contribute to the performance shown above.
"Tested and Approved" in Western Union Radio Beam Equipment!

Made by Stackpole to meet rigid requirements of Western Union design, Powdered-Iron Cup Cores are a relatively recent development. Western Union Radio Beam and Carrier Systems Equipment engineers have taken full advantage of the many space and labor-saving possibilities they offer. Since 1942, progressive design improvements resulted in the pictures shown at the left.

Part of a recent Western Union report reads, "Subsequent research work has resulted in a new shell type of core. This form of core possesses marked advantages in that it permits the use of simple coils, wound on a plastic spool, in place of the laboriously wound (toroidal) type previously necessary. . . . The shell type powdered-iron cores also provide substantial improvement in carrier operation due to improved attenuation characteristics. These advantages, together with the reduction in cost, will doubtless result in shell type coils being used extensively."

Get All the Up-to-Date Information on Stackpole Cup Cores—Write for Bulletin RC-7B

STACKPOLE
STACKPOLE CARBON COMPANY • ST. MARYS, PA.
For low resistance, high stability in printed circuits...

Use DU PONT CONDUCTIVE COATINGS

For many electronic circuits, there is profitable economy in the use of flexible, high conductivity Du Pont Conductive Coatings in place of solder wire connections.

WHAT THEY ARE—Du Pont Conductive Coatings are carefully formulated compositions which contain specially prepared silver powder. They are designed to produce a surface of low electrical resistance when applied to metals and to non-conductive materials, such as: glass, porcelain, steatite, plastics, wood, cloth, paper, etc.

HOW THEY ARE USED—By spraying, dipping, brushing or stenciling at approximate paint thicknesses. A troy ounce covers about 3 square feet of material. Conductivity of the coating is only slightly affected by aging or exposure to sulfides. Applied to metal, the conductive coating inhibits rust and maintains inherent surface conductance.

WHERE THEY ARE USED

Printed Circuits—For radios, switchboards, meters, hearing aids, and a variety of equipment now using conventional solder wire connections.

High Voltage Capacitors—For television, FM and AM radios where economy, compactness, light weight and extreme stability are essential.

Static Shielding—The air-dry type is an efficient, practical replacement for foils and cans.

Electrical Equipment—For printed circuit amplifiers, and couplings.

ADVANTAGES of Du Pont Conductive Coatings

1—High conductivity (low resistance).
2—Flexible application—Composition may be formulated in suitable vehicles for desired methods.
3—Fired-on types are not affected by contaminating atmospheres.
4—Elimination of poor connections.
5—Easily applied with simple economical equipment.
6—Assist high-speed production.

Two types of Du Pont Conductive Coatings are available:

Type “F,” the fired-on type, specifically designed for bonding metals to ceramic bases.

Type “A,” which may be air-dried or baked on, is used chiefly for printed circuits and for electrical shielding by the radio industry.

For further information, clip the coupon below. E. I. du Pont de Nemours & Co. (Inc.), Electrochemicals Dept., Wilmington 98, Delaware.

Tune in Du Pont “Cavalcade of America” Monday Nights—NBC Coast to Coast

Du Pont Electrochemicals

BETTER THINGS FOR BETTER LIVING... THROUGH CHEMISTRY

June, 1948 — ELECTRONICS
DURING May 50 million American workers will get from the Congress of the United States a real incentive to work.

This incentive is called a tax cut. Beginning May 1, the withholding tax on incomes will be reduced, giving everyone a much-needed increase in take-home pay.

But the tax cut will have a far more important effect. It may be literally a life-saver for American employment and production — and, hence, for the stability of the world. It will help to do two things which must be done if our economy is to continue to furnish good jobs and good earnings.

1. It will generate part of the private funds for investment in common stocks — the "risk capital" which we need to sustain prosperity.

2. It will provide part of the incentives necessary to make American business management still more effective.

These two predictions are not advanced as matters of opinion. They are based on facts reported by McGraw-Hill field editors.

These facts show why the reductions in upper bracket income tax rates are most significant for our continued prosperity. For the first time in more than twenty years the tax burden on people who can afford to risk their savings has been lightened. To find out what this will mean to the economy, McGraw-Hill field editors all over the nation asked a group of business executives making $15,000 a year or more how they will use the money which the tax cut gives them. Here is what they said:

1. They plan to save — not spend — three-fourths of the money they keep as a result of tax reduction.

2. They plan to invest one-half of these savings in common stocks. If all persons making over $15,000 follow this pattern, they will make available about a half billion dollars of risk capital for American industry.

**WHAT THE TAX CUT WILL DO**

**What will upper bracket taxpayers do with their tax savings?**

**What can business expect as a result?**

To answer these questions, McGraw-Hill field editors interviewed a carefully selected sample of business executives earning $15,000 a year or more. Here, for the first time, are solid facts that show how tax reduction will affect the supply of risk capital and business incentives. These are the results:

1) How much of your tax reduction will you save? 74%

2) How much of your tax savings will you invest in common stocks? 52%

3) Will lower taxes lead you to switch some of your investment in bonds to stocks? Yes 28%

4) Have you passed up an opportunity to invest in a new business in the last five years because the return after taxes did not justify the risk? Yes 40%

5) Will lower taxes make you more inclined to take a risk on a new business? Yes 80%

6) Have you turned down the opportunity to take a bigger job in the last five years because taxes would take too much of the additional income offered? Yes 13%

7) Do you know of actual cases of executives who have turned down bigger jobs or more work because of taxes? Yes 38%

8) Will lower taxes make you more inclined to take on a bigger job or more work? Yes 59%
3. They also will switch some of their present savings from bonds and bank accounts to common stocks. This might easily add a billion dollars or more to the supply of risk capital.

The one-half billion dollars of tax savings and the funds switched from other investments into common stocks is not enough to end the shortage of risk capital. But it is a start.

Before passage of the tax law, risk capital had been growing increasingly scarce.

One measure of the scarcity is that last year only four-tenths of 1% of national income went into new common stocks. In 1925, a year of normal prosperity, almost 3% of national income was invested in new common stocks.

Another measure is that between 1940 and 1947 people actually reduced their holdings of corporate stocks and bonds by nearly a billion dollars. During the same period, people salted away almost $150 billion in such safe havens as cash, bank deposits, and government bonds.

This drought of risk capital hit us just when we need a vastly increased flow of risk capital to finance the expansion and improvement of our American productive machine. We need risk capital to search for new oil fields and to build new pipelines and refineries. We need capital to expand our over-loaded electric and gas utilities. We need it to finish re-equipping our airlines and railroads and bus lines. We need it to modernize our textile production. We need it to keep pace in the magical, booming chemical industries. We need it to launch the new industry of television.

We need capital for all this work and for much more besides. And we must do all this work if we are to keep the United States dynamic and if we are to create new and better jobs.

The tax cut comes just in time. As the last editorial in this series showed, the flow of risk capital must double or triple if we are to avoid a cutback in industrial expansion next year. A major reduction in industrial expansion because of a shortage of risk capital would menace our prosperity. Whenever capital expansion has sagged, the whole economy has sagged. That is the record. That is why every American has a crucial interest in breaking the shortage of risk capital.

The tax reduction now going into effect helps relieve that shortage. In my opinion, we need still other tax changes to assure enough risk capital for healthy industry and healthy employment.

We should encourage the rapid depreciation and replacement of plants and equipment to keep America efficient.

We should eliminate the double taxation of stockholders' incomes.

We should permit full averaging of good years and bad in calculating income tax payments.

We should cut tax rates again as soon as we can.

The tax cut of 1948 will prime the flow of capital. We must keep it flowing.

The tax cut also encourages our successful men and women to work harder and more effectively.

The McGraw-Hill editors collected some solid facts to show how seriously heavy taxes have discouraged business leaders. Here they are:

1. One out of seven persons the editors questioned said that they had turned down positions with greater responsibilities because heavy taxes would take most of the greater pay that went with the harder job.

2. Six out of ten executives would be more inclined to accept a more responsible job now that taxes will let them keep more of the added pay such a job would bring.

We all have a stake in incentives which make men work harder, especially talented men. The more we each work, the more we all have.

The tax reductions so far made will leave the government more than enough revenue to meet all its expenses, including the proposed defense expenses, and still reduce the national debt. If more defense money becomes necessary, vigorous economy on less essential government expenses will make possible both stronger military defenses and a better tax system. We need both.

Only a prosperous America can be strong enough to remain free—and to help keep the rest of the world free.

Here's the loudspeaker line that rocketed to stardom!

In just a few months after deliveries started, the Western Electric line of high-quality, wide range speakers has won a position of undisputed leadership wherever the ultimate in sound reproduction is desired.

All of these speakers combine, to a unique degree, unmatched realism in reproduction with exceptionally small space requirements and ease of installation. With their range of power capacities, you can select just the speaker you want for every sound radiation requirement.

Have you ordered some? Call your local Graybar Broadcast Representative, or write Graybar Electric Co., 420 Lexington Ave., New York 17, N.Y.

**Western Electric**

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**QUALITY COUNTS---**


DISTRIBUTED BY: GRAYBAR ELECTRIC COMPANY. OFFICE IN YOUR NEAREST CITY.

ELECTRONICS — June, 1948

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**THESE ARE AMONG THE BROADCAST STATIONS THAT ARE USING**

**THE NEW WESTERN ELECTRIC LOUDSPEAKERS**

- **ALABAMA**
  - WABM Birmingham
  - WLOM Dothan

- **ARIZONA**
  - KOY Phoenix
  - KPHX Phoenix
  - KTNV Tucson
  - KVOA Yuma

- **ARKANSAS**
  - KEPW Fort Smith
  - KYTN Jonesboro

- **CALIFORNIA**
  - KBME San Bernardino
  - KCSB Santa Barbara
  - KFCI San Francisco
  - KGJN Great Valley
  - KIEM Eureka
  - KIYF Glendale
  - KUAL Los Angeles
  - KXTE Santa Monica
  - KPOJ Berkeley
  - KSJO San Jose
  - KUSC San Diego
  - KRKD Burbank

- **COLORADO**
  - KOOC Denver
  - KRLD Fort Worth
  - KZDN San Antonio
  - KFST Austin
  - KXEO Beaumont
  - WHAP New Orleans
  - WXXL Baton Rouge
  - WJLP Shreveport

- **FLORIDA**
  - WALT Tampa
  - WCHC Quincy
  - WDAE Tampa
  - WOBQ Orlando
  - WCAT Miami Beach
  - WDAI Miami
  - WSIX St. Petersburg
  - WTAL Tallahassee

- **GEORGIA**
  - WCOK Atlanta
  - WGST Atlanta
  - WLEX Athens
  - WAAL Atlanta
  - WAIB Atlanta
  - WADM Atlanta

- **IDAHO**
  - KEXD Boise
  - KEWE Weiser

- **ILLINOIS**
  - WBBM Chicago
  - WFLD Chicago
  - WLS Chicago
  - WKOK Chicago
  - WBBJ Chicago

- **INDIANA**
  - WINS Indianapolis
  - WJIC Indianapolis
  - WASK New Albany
  - WGEN New York

- **IOWA**
  - KCRC Cedar Rapids
  - KDDM Dubuque
  - KSLA Sioux Falls
  - KSMY Topeka

- **KANSAS**
  - KMIV Hutchinson
  - WBNK Topeka

- **KENTUCKY**
  - WQRC Louisville

- **LOUISIANA**
  - WAEP Baton Rouge
  - WCOA Lake Charles
  - WTPS New Orleans

- **MASSACHUSETTS**
  - WRBZ Boston
  - WLYN Lynn
  - WMAQ Boston

- **MICHIGAN**
  - WWJ Detroit
  - WWRN Detroit
  - WJRZ Detroit
  - WWAR Lansing
  - WWJF Detroit
  - WWJW Detroit

- **MINNESOTA**
  - WABC Minneapolis
  - WCCO Minneapolis
  - WCCO Minneapolis
  - WBBM Minneapolis
  - WTCN Minneapolis

- **MISSISSIPPI**
  - WLOI Vicksburg

- **MISSOURI**
  - KNMO Kansas City
  - KWWO Kansas City
  - WTVI St. Louis

- **MONTANA**
  - KYKE Shelby
  - KOUM Havre
  - KPAX Livingston

- **NEBRASKA**
  - KFAO Omaha
  - KVOP Omaha

- **NEW JERSEY**
  - WPAT Paterson
  - WAAT New York

- **NEW YORK**
  - WOR New York
  - WINS New York
  - WNEW New York
  - WJZ New York

- **NEW HAMPSHIRE**
  - WHZI Concord
  - WJHS Claremont

- **NEW MEXICO**
  - KDBC Santa Fe
  - KZIQ Albuquerque

- **NEW YORK**
  - WNBT New York
  - WJZ New York
  - WOR New York

- **OHIO**
  - WBCU Akron
  - WWSX Columbus
  - WHIO Dayton
  - WYFM Cleveland
  - WAKR Akron
  - WJFK Columbus
  - WJMM Cleveland
  - WSUW Columbus
  - WSPD Toledo
  - WRSB Cleveland Heights

- **OKLAHOMA**
  - KNSC Oklahoma City
  - KSWO Oklahoma City
  - KOSU Oklahoma City
  - WOAM Oklahoma City

- **OREGON**
  - KALE Portland
  - KGOU Portland
  - KFYI Portland
  - KUNY Port Townsend
  - WSUI Seattle
  - WKNV Spokane

- **PENNSYLVANIA**
  - WDIA Pittsburgh
  - WCAE Pittsburgh
  - WOAM Pittsburgh
  - WJZ Pittsburgh
  - WJPS Pittsburgh
  - WYTI Pittsburgh
  - WYCP Pittsburgh
  - WYIP Pittsburgh
  - WYFP Pittsburgh

- **RHODE ISLAND**
  - WWIN Providence

- **SOUTH CAROLINA**
  - WIS Columbia

- **SOUTH DAKOTA**
  - WSDR Sioux Falls
  - WSDF Aberdeen
  - WSEF Sioux Falls

- **TENNESSEE**
  - WHIN Gatlinburg
  - WHAX Nashville

- **TEXAS**
  - KCAM San Antonio
  - KMCL San Antonio
  - KLVE Houston
  - KRAM San Antonio
  - KLRL Dallas
  - KTRO Beaumont
  - WTRA Fort Worth
  - WABK Dallas

- **VIRGINIA**
  - WRVA Richmond
  - WCFL Richmond
  - WOIR Richmond
  - WBOI Richmond

- **WASHINGTON**
  - KZCC Seattle
  - KZKN Seattle
  - KZMK Seattle
  - KZVI Seattle
  - KZTV Spokane

- **WEST VIRGINIA**
  - WABJ Morgantown
  - WCON Charleston
  - WLRN Logan
  - WVOI Princeton
  - WVPX Clarksburg
  - WWOZ White Sulphur Springs

- **WISCONSIN**
  - WATI Appleton
  - WCLD Janesville
  - WEAU Eau Claire
  - WIBA Madison
  - WJNC Roanoke
  - WJWQ Green Bay
  - WWCD La Crosse
  - WSMC Milwaukee
  - WBOY Rhinelander
  - WTAQ Green Bay
  - WWFC Payette

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- San Francisco: Graybar Electric Co., 450 Natoma St., San Francisco 3, Calif.
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- San Francisco: Graybar Electric Co., 450 Natoma St., San Francisco 3, Calif.
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- Boston: Graybar Electric Co., 255 South St., Boston 15, Mass.
- San Francisco: Graybar Electric Co., 450 Natoma St., San Francisco 3, Calif.
- Toronto: Graybar Electric Co., 25 Wellington St. W., Toronto 5, Ont.
NOW! HIGH-VOLTAGE HI-TEMP* SEALDTITE* TELEVISION TUBULARS

Dependable, yet moderately priced high-voltage molded paper capacitors for television receivers are the latest capacitor development to be introduced by Solar.

These new capacitors, latest addition to the famous Solar "Sealdtite" series, are impregnated with mineral oil and molded in Hi-Temp plastic compound for service at ambient temperatures up to 100°C. Identified as Solar Type STM, high-voltage Hi-Temp Sealdtites are available in standard voltage rating of from 2000 to 6000 volts.

The use of moisture-proof molded housings makes possible a surprising reduction in capacitor size over conventional cardboard type design. The maximum capacitances available in the 3/4" x 21/4" mold size, for example, are as follows: .035 mf @ 2000 wvdc; .03 mf @ 2500 wvdc; .02 mf @ 3000 wvdc; .015 @ 3500 wvdc; .01 mf @ 4000 wvdc; .005 @ 4500 wvdc; 5000 wvdc and 6000 wvdc.

Complete listings of standard ratings and sizes are given in Solar Catalog Bullerin SPD-200. Write for your copy today.

Solar Manufacturing Corporation 1445 Hudson Blvd., North Bergen, N. J.

BUSINESS BRIEFS

By W. W. MacDONALD

Biggest Customer for many RMA member-companies in 1947 was Uncle Sam. Here’s the way communications equipment sales (exclusive of home receivers) broke down, most of the volume covering transmitters and associated apparatus:

<table>
<thead>
<tr>
<th>Category</th>
<th>Sales (in $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. Government</td>
<td>48,848,976</td>
</tr>
<tr>
<td>Broadcast Stations</td>
<td>59,680,781</td>
</tr>
<tr>
<td>General Users</td>
<td>5,631,620</td>
</tr>
<tr>
<td>Aviation</td>
<td>3,591,235</td>
</tr>
<tr>
<td>Marine</td>
<td>292,385</td>
</tr>
</tbody>
</table>

Uncle was first by a wide margin on electronic navigation equipment, including radar and sonar:

<table>
<thead>
<tr>
<th>Category</th>
<th>Sales (in $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. Government</td>
<td>81,920,452</td>
</tr>
<tr>
<td>Aviation</td>
<td>2,805,627</td>
</tr>
<tr>
<td>Marine</td>
<td>799,734</td>
</tr>
</tbody>
</table>

And Uncle bought $4,601,257 worth of our laboratory and test equipment.

Movie People, now very conscious of the competition presented by home television, are out of the talking and into the doing stage. Paramount recently relayed a spot news event into a New York picture palace, transferred it to a film and ran the film thirty seconds later. The audience, not told about the stunt at the box office, took the program for granted.

Watch for more of this sort of thing, without benefit of cooperation from broadcast stations.

Multiple-Screen Tele, an idea broached some time ago in this column (p 68, March), appears to be taking hold. Commercial installations involving one set and several remotely-operated cathode-ray tubes have been made in taverns in the New York area. Adaptation of the scheme to home sets appears certain to follow.

Indoor Tele Antennas are badly needed, thought many dealers attending Televisers’ recent show at the Hotel New Yorker. It seems that thousands of apartment-house families are number-one prospects for sets but, for various reasons, see little chance that they can be connected to outdoor or master antenna systems for years to come.

Things that the public want have a habit of coming true, despite technical difficulties. One possible solution of the indoor television antenna problem involves a compact directive array positioned to catch signals on the second or third bounce off building walls, in conjunction with a preamplifier. Any other ideas floating around out there?

Major Impression gained at a recent meeting in Philadelphia attended by tube manufacturers and designers of industrial electronic equipment is that it is silly to put a $1 tube in a $1,000 control attached to a $10,000 machine unless the tube is completely suited to the application.

Makers of controls, it seems, are willing and anxious to spend more for tubes that have predictable life, particularly if they can be sure such tubes will be available on a long-term basis.

Miniature Tubes are in such demand that occasional shortages are anticipated. At least one manufacturer is urging equipment designers to play safe by (1) using types available from three or more suppliers, (2) planning chassis layouts readily convertible to octals and, (3) arranging to use miniatures having either of two base layouts.

Prediction by one tube maker is that by 1950 miniatures will represent 60 percent of receiving-type production, metal 20 percent and conventional glass 20 percent.

We Hear That Sperry Gyroscope has just received a contract from the U. S. Coast Guard for 20 loran sets. Some 40 sets were bought back in June of last year. Several aid weather ships to keep on their stations.

Just About Everything is used in the field of electronics. The other day we saw a camera set up to take pictures of oscilloscope...
**FREQUENCY UP 6X, (156.75-Mc. to 940.5-Mc.)**

**POWER UP 7X (2 watts to 15 watts)**

Here’s a STL transmitter that’s in operation on the new 950-Mc. band, fulfilling all the FCC requirements and powered by Eimac 4X150A tetrodes. It’s a part of the studio-transmitter-link between the San Bruno studios and the 250 Kw FM transmitter of station KSBR high atop 3849-foot Mt. Diablo some 33 miles away.

The R-F amplifier was specifically designed for the KSBR application by Eimac engineers. It is driven by an REL modulator delivering 2 watts output at 156.7-Mc. to one Eimac 4X150A in a tripler stage, which in turn drives a single 4X150A in a doubler stage, providing 15 watts useful output at 940.5-Mc.

The Eimac 4X150A is ideally suited for this application because of its high power gain at relatively low plate voltages, ability as a frequency multiplier without loss of amplification, low grid drive requirements, and a high ratio of transconductance to capacitance. It also has the advantage of being physically small and functionally designed for simple installation.

Complete data on the Eimac 4X150A for STL and other UHF applications is available by writing direct.

**EITEL-McCULLOUGH, INC.**

197 San Mateo Avenue, San Bruno, California

EXPORT AGENTS: Pastar & Hansen—301 Clay St.—San Francisco, Calif.

ELECTRONICS — June, 1948
OSCILLOGRAPHS

BY HATHAWAY

for EVERY purpose

S8-B General Purpose, 12 to 24 elements, for laboratory or field use, quick-change transmission for wide range of record speeds, automatic titling and numbering, automatic record-length control, tuning fork time marker, galvanometer attenuators, governor motor.

S8-C General Purpose, 24 to 36 elements, otherwise same as type S8-B.

S8-D General Purpose, 12 to 24 elements, similar to type S8-B except without automatic controls.

S12-A Small Portable, General Purpose, the smallest complete 12-element oscillograph.

S6-A Geophysical, 12 elements.

S6-B Geophysical, 24 elements.

S14-A Student's Oscillograph, 6 to 12 elements, ultra-simple, low in cost.

S15-A Portable Self-Powered, 6 elements, for use where very small size is essential and power is not available.

SC16-A Cathode Ray, 6 elements, very high frequency response and writing speed; record speed to 6000 inches per second.

RS9-A Automatic Oscillograph, 12 elements, for switchboard or portable use, for automatic recording of faults or staged system testing, high-speed starting.

WHATEVER YOUR REQUIREMENTS MAY BE THERE IS A HATHAWAY OSCILLOGRAPH FOR YOU

WRITE FOR TECHNICAL BULLETIN

BUSINESS BRIEFS

(continued)

receiver sales by RCA licensees during 1947 totaled 20,174,370 units, worth $702,798,118. here's the way the total broke down:

<table>
<thead>
<tr>
<th>TYPE</th>
<th>UNITS</th>
<th>DOLLARS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Table (under $17.50 billing price)</td>
<td>2,296,472</td>
<td>$23,531,360</td>
</tr>
<tr>
<td>Table (over $12.50 billing price)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A-M</td>
<td>7,879,370</td>
<td>160,549,298</td>
</tr>
<tr>
<td>A-M/F-M</td>
<td>201,386</td>
<td>10,702,665</td>
</tr>
<tr>
<td>F-M (including converters)</td>
<td>72,654</td>
<td>1,840,765</td>
</tr>
<tr>
<td>Consoles</td>
<td>133,084</td>
<td>13,581,157</td>
</tr>
<tr>
<td>A-M/F-M</td>
<td>45,865</td>
<td>5,412,562</td>
</tr>
<tr>
<td>Table-Radio-Phonos</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A-M</td>
<td>1,203,481</td>
<td>62,554,888</td>
</tr>
<tr>
<td>A-M/F-M</td>
<td>5,581</td>
<td>610,949</td>
</tr>
<tr>
<td>Console-Radio-Phonos</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A-M</td>
<td>953,386</td>
<td>96,566,151</td>
</tr>
<tr>
<td>A-M/F-M</td>
<td>702,780</td>
<td>123,570,950</td>
</tr>
<tr>
<td>Radios</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PortableA-C/D-C</td>
<td>2,427,613</td>
<td>54,655,928</td>
</tr>
<tr>
<td>Table</td>
<td>213,536</td>
<td>10,866,083</td>
</tr>
<tr>
<td>Consoles</td>
<td>5,011</td>
<td>589,014</td>
</tr>
<tr>
<td>Auto</td>
<td>2,862,466</td>
<td>87,120,258</td>
</tr>
<tr>
<td>Television</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Converters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radio Table Models</td>
<td>103,573</td>
<td>22,528,406</td>
</tr>
<tr>
<td>Radio Consoles Direct viewing</td>
<td>18,551</td>
<td>6,420,776</td>
</tr>
<tr>
<td>Projection</td>
<td>10,785</td>
<td>6,175,314</td>
</tr>
<tr>
<td>Radio Phonos Direct viewing</td>
<td>17,400</td>
<td>7,721,026</td>
</tr>
<tr>
<td>Projection</td>
<td>572</td>
<td>613,521</td>
</tr>
<tr>
<td>Phonographs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radio only</td>
<td>467,605</td>
<td>10,033,767</td>
</tr>
<tr>
<td>With radio attachment</td>
<td>74,271</td>
<td>2,100,013</td>
</tr>
<tr>
<td>Without Cabinets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A-M</td>
<td>101,819</td>
<td>2,577,098</td>
</tr>
<tr>
<td>A-M/F-M</td>
<td>17,456</td>
<td>1,725,951</td>
</tr>
<tr>
<td>Television</td>
<td>47</td>
<td>14,585</td>
</tr>
<tr>
<td>TOTAL</td>
<td>20,174,370</td>
<td>$702,798,118</td>
</tr>
</tbody>
</table>

Panel Instruments having 270-degree scales were developed during the war to simplify the reading of necessarily compact types. Now we note with interest that the idea is coming into more widespread use in power instruments both large and small. It seems to us that spreading out of scales is particularly important in the field of electronics, and that the idea merits extension to our kind of apparatus.

Radar Rat Trap promoted by an outfit up in Rochester intrigues us no end. If we were a betting man we'd offer two to one that while the thing may catch rodents it doesn't detect their presence by reflected radio waves.

Philco Sales in 1947 broke down as follows: refrigerators, freezers and air conditioners 32 percent; radio-phonographs and tele-
vision receivers 30 percent; radio sets 24 percent; tubes, parts, dry batteries, accessories and miscellaneous products 9 percent; government and industrial business 5 percent.

Stromberg-Carlson's 1947 sales were split three ways: radio 65 percent; telephone 31 percent; sound 4 percent.

Allen B. DuMont manufacturing division sales in 1947: television receivers $7,774,000; cathode-ray tubes $1,846,000; cathode-ray osciloscopes $1,702,000 and television transmitters $517,000.

Vernier Dial designed by one of our readers (p 68, April) appears to interest quite a few manufacturers looking for new things to make, and we have forwarded their inquiries to the designer. Anyone else out there we can help in a similar manner?

Magnet Wire produced in 1947 totalled 300 million pounds, according to the best estimates we have been able to obtain. About one third of this wire went into electronic apparatus.

Best Argument cathode-ray tube makers have for limitation of the number of television types is the cost reduction that can be obtained by mass production. Many students of the current trend toward lower-priced sets believe that savings that might be achieved by variations in tube design at this time are minor by comparison.

Highest Priced item ever offered by GE for use in the home is a new a-m and f-m phono-radio and television set listing at $2,100.

Government Specs cover over 4,000 tube types.

Norm Krim of Raytheon says it costs at least $50,000 to develop a really new tube.

New To Us is an expression heard the other day in a laboratory. We arrived in the middle of an obvious flurry of excitement. Questioned regarding the cause, one of the engineers replied, quite casually, that he thought it was just a "routine emergency."

It's a far cry from smoke signals to electronic communications. And at the heart of electronics lies the coil. We wind coils of great variety for many uses and our 30 years of experience is at your service. Send us your specifications. We shall be glad to quote.
After Six Years on the Shelf—These Mallory Capacitors Met Every Specification!

The proved long shelf life of Mallory Capacitors is a plus value to the man responsible for Inventory.

When you buy capacitors it's a relief to know that, should your production program change, the stock on hand may be held without becoming useless through deterioration. Mallory Capacitors have proved on many occasions that they can take long periods of storage without loss of efficiency.

We recently tested capacitors for several customers* who had shelved them for up to six years. All proved ready to use without re-aging. None took more than seven minutes to reach the leakage limit of new units. All characteristics were within the limits of new-unit inspection.

Such quality is added protection for the man who specifies Mallory Capacitors. Such quality is invariably built into Mallory Approved Precision Products.

*Names on request.

BUY MALLORY ASSURED QUALITY AT REGULAR PRICE LEVELS

MALLORY CAPACITORS (ELECTROLYTIC, OIL and WAX)

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

June, 1948 — ELECTRONICS
INTERCARRIER . . . One of the tempests raging in the television field is that around the intercarrier method of receiving the sound. In this system (see ELECTRONICS, Jan. 1947, p 102), the picture and sound carriers are amplified together in the picture i-f amplifier, developing a 4.5-mc beat frequency (the separation of picture and sound carriers) at the picture tube grid. This beat note is frequency modulated by virtue of the f-m on the sound carrier and hence may be passed through a limiter, frequency detector and audio amplifier to the loudspeaker. At first this idea sounded attractive principally on the grounds of economy, since no sound i-f amplifier is needed. Soon the economy idea was replaced by recognition of advantages relating to the shortcomings of the local oscillator in a standard receiver. The intercarrier system is highly tolerant of drift, microphonics and hum modulation in the local oscillator, since these affect the carriers in the same degree and hence do not disturb the 4.5-mc beat note. An intercarrier receiver would, in fact, require no fine tuning control.

Then a manufacturer was so brash as to bring out an inexpensive video receiver using the intercarrier system. Brash, because mutterings had been heard from the first that the system would fail if the picture carrier was frequency modulated to any extent by the picture waveform. Then a low pitched (60-cps) rattle which could not be separated from the sound modulation would appear at the loudspeaker. To be sure, interference of this type was soon discovered, particularly when the picture modulation was heavy, but the effect was not pronounced and certainly was tolerable in an inexpensive receiver. At least so it seemed on the low-band stations then on the air.

So the inexpensive sets continued to sell, and the mutterings of the transmitter manufacturers continued to be heard, and action to recommend to the FCC standards which would safeguard against excessively heavy picture modulation continued to be deferred. Then a station on channel 13 opened up in the New York area. This channel, on 210-216 mc, was expected to give the most trouble from unavoidable frequency-modulation of the picture carrier. But when listening tests were carried out, the intercarrier sets seemed to do as well, or nearly, as on the low band stations. The conventional receivers, for the most part, gave considerably inferior performance, due to hum modulation, microphonics and drift of the local oscillator, in the order named.

Thus often is confidence misplaced. The transmitter men had done better than they thought; the receiver men had done worse. The argument is not over yet. But the inexpensive receivers continue to sell and the recommended standard continues to be deferred. Our guess is that when enough of the intercarrier receivers are sold, the transmitter designers will have to lick incidental frequency-modulation of the picture or lose customers, and the broadcasters will have to monitor modulation or lose a good part of their audience. We don't argue for such de facto engineering, based on sales figures, but we recognize its power.

DECISION . . . Since we commented in February on the care with which marine radar must be used as an anti-collision device, a Canadian court has ruled, in another case, that the use of radar does not free the master of a vessel from the established rule of the sea, namely that he must operate at such speed as to be able to stop within a distance not greater than one-half the range of visibility. Visibility here means the distance the lookout can see with human, not radar, vision. If this decision establishes a precedent in admiralty law, the utility of radar in the marine field will be sharply restricted. No captain would dare run through fog at high speed with radar guidance if by so doing he placed himself and his owners in the position of being legally responsible for any collision which might occur, regardless of other circumstances. Before the courts can be expected to take a more liberal view, an impressive record of safe operation of radar-equipped vessels must be amassed. That drives the point home: radar is a safety aid only when it is properly installed, adequately maintained and intelligently used.
THE BANNS have been proclaimed for an interesting four-way marriage of transportation, f-m radio broadcasting, the riding public, and advertising. Proponents of the scheme claim that all the participants gain.

The Basic Idea

Predicated upon the fundamental premise that riders of a transportation system are captive during the period of their travel, the advertiser can be assured of a measured number of listeners to his sales talk for any given day and time of day. In return, the rider gets free music and news. Bus systems feeling the pinch of increased operating costs will welcome any device that supplements revenue from the sometimes provocative but as yet unvocal "car cards". And the station that keys its programs to the new advertising medium can be expected to reap some additional revenue at a time when f-m broadcasting needs it.

The broad contractual aspects of the system are simple. The f-m station enters into an agreement with the local transit company that provides exclusive rights for the broadcaster to install receiving equipment in the vehicles. The radio station pays a monthly fee to the transit company for each radio-equipped vehicle, in the manner of recompense for car card advertising. Another contract is made between the broadcaster and the organizing agency that provides for purchase of receiving units and all accessories (currently selling for about $141) and the appointment of the agency as exclusive advertising representative.

Taking the narrow view (the small city bus line) the suggested system of transportation radio looks simple; but ad men thinking in terms of the broad golden field are already causing engineers some worry. For example, interest has already been shown by certain railroads.

While the bus can get along with a normally sensitive, single-channel receiver, the railroad car must be equipped to pick up weaker signals at greater distance on a receiver that can be tuned from one frequency to another as the train progresses from one service area to another along its route. There is then nothing to insure that the receiver is tuned to the program desired by the sponsor of the service. Length of time that a given station will be heard satisfactorily depends not only upon transmitted power from the antenna but also upon such diverse factors as speed of the train and terrain between the transmitter and the moving receiver.

Planes are a special and more difficult problem.

Programming Problems

Transportation authorities are already discussing contracts that insure a minimum amount of advertising material, both as to length and frequency. Programs can't be all boogie-woogie or all Shostakovitch. The idea of a sports broadcast is enough to make any transportation executive's hair
Radio programs keyed to a captive listening audience in buses, trolleys, and trains constitute a new advertising medium and source of revenue for the f-m broadcaster.

Schaefer of Transit Radio, Inc. for WCTS-FM, Cincinnati, Ohio. This station operates on 101.9 mc (Channel 270) with an effective output power of 12.6 kw. Under a contract with Transit Radio, Inc., there are to be 400 single-frequency f-m receivers placed on vehicles of the Cincinnati Street Railway Co., the Covington, Cincinnati and Newport Railway Co., and the Dixie Traction Co. The audience is estimated at 380,000 riders per day. Guaranteed average circulation has been divided into three classes, the rates for which are shown in Table I. Announcements must not exceed 35 words. Three-minute news periods and sports summaries in which the total commercial time must not exceed 50 words is charged for at the announcement rate plus 50 percent. Weather reports and time signals are handled at special rates. The time rates for programs in excess of 3 minutes are covered only in the second Class C category.

**Equipment**

Under the normal conditions so far encountered, adequate signal has been obtained using a dipole antenna mounted horizontally above the front windshield (so as not to interfere with conveyor-type bus cleaning operations). A 50-ohm line connects the antenna to the receiver installed under one of the passenger seats.

The receiver itself is a crystal-controlled, fixed-tuned superheterodyne with eleven miniature tubes. Frequency response is within ± 2 db from 50 to 10,000 cycles, with an audio output of 8 watts. Ordinarily six 6-inch permanent magnet speakers mounted along the ceiling of each bus are adequate. Two volume controls are provided; one a master that is locked into place at the time of installation; the other a vernier control for adjustment over a 6-db range. Power is supplied from a dynamotor operating from the vehicle's battery. At 12 volts input the drain is less than 8 amperes. The receiver is shock mounted and any component weighing over 5 grams is tightly fastened to a terminal board so as to avoid breakage from vibration or jarring.—A. A. McK.
Engineering the Schematic Diagram

Step-by-step procedure for preparing intricate diagrams so that major circuitry stands out clearly, with stages arranged according to mechanical groupings of equipment yet still in logical order. Diagrams for APS-3 radar serve as examples.

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The ideal schematic diagram should present the features of a circuit in a form which is suitable for ready analysis in the fashion of the flow-of-function outline, exemplified by the organization chart, the production-line flow, the chemical-process diagram and other systematized arrays of information. Diagramming with lines which show only circuit components and their interconnecting copper wires, without a scheme, produces an impenetrable labyrinth when extended without refinement to modern complex electronic equipment. The scheme is the essence, and effective schematic diagrams should display clearly:

(1) A readily discernible pattern or general framework of the system that stands out boldly from a background of accurate but subordinate detail.

(2) The sequence of events or operations, such that cause is plainly related to effect, and the directions of flow of power, signals, impulses and functions.

(3) The relative importance of components or units.

(4) The roles that individual components play in circuit operation.

(5) Certain broad mechanical features of grouping of construction.

(6) The physical points of ready access to the circuits where tests may be applied, measurements made, or results obtained.

(7) The controls as to name, physical position, how the adjustment is made mechanically, how the controls are related to other controls and to the influences they exert.

(8) Copious annotations, including electrical values of components. Careful planning of a clear, rich schematic calls for the expenditure of time, thought, and ingenuity to achieve clarity and smoothness. It must be sketched again and again, rearranged and sketched over. A good schematic cannot be drawn casually. It must be done by one who knows thoroughly the operation and purposes of the equipment.

The Block Diagram

The positions on the paper of all parts of the drawing should conform to a general framework or plan which shows the flow of function. This bare framework is called a block diagram. It should first be sketched out in an ideally simple and straightforward manner as possible. The flow begins with the primary motivation of the equipment, generally at the left of the sheet. As the activating impulse or signal is carried through successive operations, such as amplification, reshaping, phasing, and the like, heavy black flow lines should be drawn toward the right, passing through these operators or modifiers sketched in as unit-function blocks without regard to their physical locations in the equipment. By unit-function block is meant a whole circuit operating as a unit, such as an amplifier, multivibrator, or oscillator. The path may branch and proceed through parallel paths or it may be joined by paths of impulses coming in from blocks above or below the main flow. For eye appeal, consecutive order, and readability, the flow should be kept moving in smooth unbroken streams from the cause, on the left, to the effect on the right.

Having sketched an ideally smooth flow, as illustrated by the diagram of an APS-3 radar equipment shown in Fig. 1, it will be necessary to modify this to some
extent to conform to the actual physical locations of the unit-function blocks in the equipment.

By moving these blocks up or down it will be possible to collect, in one general group on the sheet, those which are located in the same mechanical unit or box. Such a step is illustrated in Fig. 2. This will require the flow lines to dip downward or upward from the original ideal path. Any rearrangements which result in straighter flow lines or emphasis upon the relative importance of the paths should be used. This will often require related units to be above each other.

The blocks related by physical location are enclosed by a larger dashed outline, boldly drawn, designating the frame, unit, or box which contains them. Within this outline the blocks may be shifted about to preserve straight flow lines and to eliminate as many crossovers of paths as possible. From the schematic viewpoint these outlines may be rectangles, long, short, horizontal, vertical, notched, or otherwise shaped to accommodate blocks, without regard to similarity to the actual box shape in the equipment.

Frequently it is desirable to prepare the entire schematic so that it can be separated into individually complete numbered pages. This arrangement is particularly useful for instruction book or text book purposes. The appropriate section of the entire drawing may also be secured inside covers or doors of the individual apparatus boxes or cabinets. When the worker studies the overall system schematic drawing, he encounters the same familiar diagram patterns which he finds in the covers of the individual units. To provide this page sectioning, additional rearrangements of the drawing may be required so that reasonable divisions can be made. In general this is not too difficult once the mechanical grouping of unit-function blocks has been determined.

Figure 3 illustrates a rearrangement of the material of Fig. 2 into four separate quadrants or pages. Helpful general details have been filled in to form the complete block diagram as finally developed. The quadrant or page numbers refer to detailed drawings, one of which is shown in Fig. 4. Note the very close correlation between the patterns of the heavy flow lines on Fig. 3 with their counterparts on the detailed drawings of Fig. 4. For the reader, this preservation of the pattern simplifies the mental transition from block diagram to individual page. It is also a powerful assistance to the memory.

The Detailed Sheet

The positions of the unit-function blocks having been roughly determined by the layout of the block diagram, it becomes necessary to develop the detail within each block. This detail comprises resistors, capacitors, coils, tubes, etc, whose wiring must fit into the general scheme.

To achieve smoothness, it may be necessary to draw and redraw the circuitry of blocks top for bottom or right for left to conform to the straightforward block diagram. It should always be kept in mind that each block is a subsidiary link in the branching chain-of-function flow.

The component resistors, capacitors, and tubes should be so disposed with respect to each other that the circuit behavior and purpose is made clear. This may require readjustment of the block diagram as space requirements become defined. Where voltage divider chains of resistors provide graduated voltages, they should be arranged in the simple straight line or row with the high voltage impressed across the ends. Successively lower-voltage taps come out from it like steps in a ladder. A convenient concept is a potential gradient of the tapping wires.
highest near the top, lowest toward the bottom.

Bridge circuits should be drawn to look like a bridge. If the plate impedance of a vacuum tube is part of an arm of the bridge, it should be drawn in one of the sides of the diamond and oriented to match. This will immediately assist the reader to understand what the designer expected the tube to do.

When networks might require the application of Thévenin’s or Kirchhoff’s principles for analysis, the link elements, meshes, and junctions should be drawn to stand slightly apart from other circuits and be arranged so that the appropriate principle is apparent.

Electrical symmetry as exemplified in balanced circuits should be expressed as graphical symmetry. Symmetry of general function should also be so shown where appropriate. It should be emphasized that graphical symmetry should not be employed for the sake of pictorial composition when no such real electrical symmetry exists.

Electrical similitude should be emphasized, when valid, by graphical similitude. A group of R-C chains, selectable by a switch, all similar in principle but differing only in time constant, should be grouped; all pairs of resistors should be placed at the same level and the attitudes of one R-C combination repeated for all. Once the reader has decided what one is for, he can plainly see that all fulfill the same purpose. Such an R-C group should stand apart from other similarly appearing R-C links whose function is not immediately related to them.

Where cables connect one outlined unit to another, the sides of such units should be arranged so as to be adjacent and the elements so arranged within that the cable can be shown as a family of straight wires, free of cross-overs, running between the units. Some cable wires will carry the chain-of-function flow, standing out boldly and becoming part of the general framework of the diagram.

Too often the simple circuitry of primary power distribution involving on-off switches, fuses, automatic overload cut-outs, interlocks, time delays, gate and battle switches, can become woven into a complex web of advanced wireman-ship that would defy Maxwell himself, though he be armed with the finest of volt-ohmmeters. These primary circuits are usually set up sequentially: that is, the one most remote from the main fuse depends upon the functions of numerous devices preceding it. The diagram of this web should be drawn as branching chains of influence flowing across into rungs of a ladder whose rails are the two primary power leads. From the diagram it should be instantly apparent, without wire tracing, which units are controlled by a given switch and which chains of influence would be put out of commission by a blown fuse or open gate switch. The drawing should be deliberately set up so the man with the volt-ohmmeter can see immediately what

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voltage or resistance he might normally expect to encounter in making a measurement at any point.

**Designations and Markings**

The schematic drawing should carry identification of every resistor, capacitor, tube, and switch. This means a designation (or part) number together with the circuit value or type number. It should make unnecessary the usual frequent and aggravating reference to the parts list.

All pin numbers on all tube sockets should be shown. All jacks, plugs, terminals, fanning strips and cables should carry their designations and actual numbers. All supply voltages should be shown where appropriate.

To eliminate many conventional leads from the drawing, a system of margin coordinates on each numbered page of the drawing makes it practical to show an arrow head on the end of a lead with a simple legend giving the drawing page number and coordinates where the other end of the lead may be picked up. This is used principally for plate supply voltage leads or similar common sources. Thus, in Fig. 4, drawing 2, the screen supply for the modulator tube has the legend +1,250 V (2-A3). The 2 refers to the drawing sheet and A3 are the coordinates on drawing 2 where the screen supply source will be found.

Each control for adjustment, calibration or operation should be marked with the name it actually carries on the panel. This name (abbreviated) is usually enclosed in a box to designate that it is so marked.

It is desirable to designate by simple, appropriate symbols whether it is a screw-driver adjustment or a knob and whether it is accessible from the front panel or is within the chassis. Although the drawing examples printed herewith do not show the latter features, extensive and very helpful use was made of such designations in later drawings.

The several weights of letters and lines shown in the accompanying illustrations are the minimum found effective in providing the desired emphasis of flow and subordination of detail.

In the large amount of work done on drawings of this kind it has proved most satisfactory to standardize on 17” x 22” tracing cloth sheets for original ink drawings. This is a convenient scale for the draftsman and reduces to 8½” x 11” individual sheets in a 2 to 1 reduction. The examples shown here suffer unavoidably from a reduction somewhat more than this.

The authors wish to acknowledge the inestimable contributions of Richard L. Bliss of the MIT School of Architecture, who learned electronics for the sole purpose of producing the drawings described above and who wrestled with the fatiguing routines of countless redrawings to produce truly engineered schematics.
Battery-operated phototube-amplifier-meter circuit integrates incident light produced at subject to be photographed by capacitor-energized electric flash lamps. Meter is calibrated to read directly in aperture numbers for correct color or black-and-white exposures.

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The photoelectric light-integrating meter described here was developed for measuring the incident light from repeating electric-flash photographic light sources that are energized by discharge of a capacitor. The object of most light measurements of this nature is to determine the camera aperture, and for this purpose the meter can be calibrated to read directly in aperture numbers that will result in properly-exposed photographs for both color and black-and-white film.

The person most interested in the use of this meter is the one who is to take color photographs. He will place the meter at the subject and direct the phototube opening at the main light. A pushbutton will flash the key light or all the lights and the meter will indicate a given reading if the correct camera aperture for the type of film selected has been pre-set on the optical attenuator. The photographer can then adjust the camera aperture to the value indicated by the meter, or modify the distance to the key light to obtain some desired aperture.

As a next step, the fill-in light, background lights and spots can be measured and the light-to-subject spacing arranged so that the ratio of the key light to these others will produce the desired photographic effect.

A further use of the meter is to check the output of electric-flash lighting equipment, by comparing meter readings for standard and unknown lamps and power units. Also, the effectiveness and angular distribution of light from reflectors can be evaluated.

Design Data

The measurement of the quantity of light produced by a flash from an electric-flash lamp involves the integration of instantaneous values of light over the duration of the flash. A circuit that accomplishes this under certain conditions is given in Fig. 1A. The measurement of light requires that the phototube current and instantaneous light be proportional, so that \( i = KF \), where \( K \) is a constant relating phototube current \( i \) and light flux \( F \).

Figure 1B shows the general shape of the volt-ampere characteristics of an RCA Type 929 vacuum phototube with strong illumination. Note that the current and luminous flux can be proportional only for voltages above the knee (point A).

Should the instantaneous variation of luminous flux exceed that corresponding to the knee during a short, intense flash of light, the equation \( i = KF \) will not be satisfied and the meter indication will not be a true measure of the integrated light. Gas-filled phototubes cannot be used since, because of the effects of the gas, the current may not be proportional to flux. The curves of Fig. 1B show that about 100 volts is required on this phototube if 36 lumens is the greatest instantaneous illumination that is to be experienced. For 145 lumens, the voltage should be about 200 volts. From this limited number of data it appears that the saturation current is approximately a function of the square of phototube voltage.

A voltage proportional to the integrated light and thereby proportional to exposure is obtained across an integrating capacitor \( C \) if the phototube current flows into the capacitor. The voltage is

\[
e_i = \frac{1}{C} \int_0^t i \, dt = \frac{F}{C} \int_0^t F \, dt \tag{1}
\]

A vacuum-tube voltmeter with an indicating meter \( M \) is used to record the voltage without discharging the capacitor at a rate which interferes with the reading of the meter after the flash. The drift of the indicating meter after a flash reading will depend upon the grid current of the vacuum tube, the leakage current of the phototube,

FIG. 1—Circuit and characteristic curves of photoelectric light-integrating meter for capacitor-discharge electric flash lamps.
and the leakage of the circuit. The size of capacitor $C$ must be increased to such a value that the drift is inappreciable unless some method is provided to adjust the drift, such as grid current compensation.

In the practical design of an integrating light meter the capacitance for an uncompensated circuit is usually about 0.1 $\mu$F when the meter drift is limited to less than a full-scale deflection in about 30 seconds.

From the equation \( t_d = C \frac{de}{dt} \), the time to drift to full scale, if the grid and leakage currents are assumed constant, can be given by \( t_d = \frac{Ce}{i_0} \), where $e$, is input voltage to produce a full-scale deflection, $i_0$ is the time required for the meter to drift from zero to full scale, and $i_0$ is the current that causes drift in the integrating capacitor $C$. Thus the drift time is a function of the grid and leakage currents and the integrating capacitor once an amplifier design has been selected.

The grid current curve of a typical three-electrode vacuum tube appears in Fig. 1C. For most tubes the crossover point $X$ of zero grid current is about -1 volt with respect to the negative end of the cathode. It is inadvisable to operate on the right-hand side of the crossover point since the grid current increases rapidly due to electrons that arrive at the grid with energy obtained from thermal processes at the cathode. Positive ion currents are responsible for the negative slope of the grid current curve between the points $B$ and $C$ since the number of positive ions is directly a function of the plate current. To the left of point $C$ the plate current is cut off and the tube serves no useful function. Therefore the portion of the characteristic that can be used falls between $C$ and $X$.

Point $C$ as well as the entire curve depends upon plate voltage. A plate voltage is selected that is as low as possible, but still ample to produce plate current that is several times that of the maximum reading of the meter. The usual practical value of grid bias is well to the left of point $X$ for all operating conditions.

The type 1L4 tube connected as a triode with the screen and plate tied together can be used with 45 volts on the plate, a plate current of 0.5 ma and a grid bias of -1.3 volt. A 200-microampere meter is used as an indicator. Under this condition the grid current is less than 10⁻⁴ ampere for selected tubes that have been aged for two days with 90 volts on the plates.

**Self-Bias Connection**

Amplifiers with self-bias resistors have voltage calibrations that are relatively independent of the tube constants. This independence of calibration is gained at the expense of sensitivity in the conventional circuit design. However, for this special type of amplifier with a floating input capacitor, as used for light measurement, the advantages of self-bias can be gained without a loss of sensitivity. As long as the product of capacitance $C$ and the voltage necessary for full-scale deflection $e_x$ is constant, the light necessary for full-scale deflection of the meter and the drift time will not be changed. The drift time is also proportional to the same product.

A suitable design with degeneration by means of a cathode resistor is one that reduces the gain by a factor of five; this is provided by the circuit of Fig. 1. Such a design will decrease the influence of tube characteristics by a factor of about the same value.

**Testing the Instrument**

Should the phototube voltage be less than that required for saturation the meter will read low. A simple test of the meter, with any flashing light source of known duration, is to vary the phototube voltage and record the resultant meter reading. If the meter reading is constant as the voltage is increased, there is ample voltage on the phototube. The limiting phototube voltage can be found by decreasing the phototube voltage until the meters begin to drop.

If a flashtube with a shorter flash is used, but with the same quantity of light, the break will occur at a higher phototube voltage.

**Shortest Allowable Flash**

The duration of most flashlamps ranges from 50 to 1,000 microseconds. As a general rule, the duration is longer for the more powerful lamps.

The limiting time of flash can be calculated approximately as follows: Assume that the flash of light is of rectangular form providing $P$...
lumens on the phototube cathode for \( T \) seconds duration. The quantity of light is

\[
Q = \int_0^T F \, dt = PT 
\]

or

\[
e_i = \frac{1}{C} \frac{KFT}{i} = \frac{i}{C} T 
\]

The phototube current is \( KF \) amperes, and \( i = Ce_i/T \). From this it can be seen that the peak current through the phototube is a direct function of the integrating capacitance and the voltage required for full scale on the deflecting meter. Likewise, the required phototube current for full-scale deflection decreases inversely with change in duration of the flash. A short flash will require a larger phototube current and a higher phototube voltage if a full-scale reading without error is to result.

A phototube circuit with 100 volts on the 929 phototube and with a peak flux of 36 lumens will produce a photoelectric current of 1.7 ma, as shown by the lower curve of Fig. 1B. With \( C = 0.1 \mu F \) and \( e_i = 2.5 \) volt (sufficient for a full-scale deflection of a 200-microampere meter), \( T = Ce_i/i = 147 \) microseconds, assuming a rectangular pulse of light. The actual pulses of light from electric-flash tubes rise sharply to a peak and then decay with a form resembling an exponential.

With 200 volts on the phototube the current can be about four times greater and the time similarly decreases to 36 microseconds. By similar reasoning, a half-scale reading can be made with an 18-microsecond pulse with 200 volts on the phototube.

An approximate expression for the necessary phototube voltage required to give an accurate integration of a rectangular pulse of light of duration \( T \) can be obtained if the phototube saturation current \( i \) is taken to be a squared function of the phototube voltage \( E \). The expression is

\[
i = AE^2, \quad \text{where } A \text{ is a constant.} 
\]

This current, when substituted for the integrator capacitor voltage previously given, results in the following expression for the required phototube voltage

\[
E = \sqrt{Ce_i/AT} 
\]

As a numerical example, the required voltage calculated for a one-microsecond flash is 1,150 volts. This might cause a flashover in the phototube. If it is necessary to measure microsecond pulses, a more sensitive amplifier or a smaller integrating capacitor should be used. Such a modification requires a smaller grid current in order to keep the meter drift time at a reasonable value. The phototube voltage becomes 240 if \( e_i = 0.1 \) volt and \( C = 0.1 \mu F \). These are reasonable values that can be obtained with a two-stage amplifier with grid current compensation.

Some care is required in selecting a suitable integrating capacitor since some capacitors have leakage and others have absorption effects that are serious. It has been found that polystyrene and mica capacitors have very desirable characteristics. Certain types of oil capacitors can be used with success as integrating elements.

The light-meter calibration is made with a specific phototube (type 929) which is a vacuum-type tube with an S-4 surface. If other types are used, the calibration will not hold. The S-4 surface has a peak sensitivity in the blue portion of the spectrum, at 4,500 A. The sensitivity decreases from this peak to the cutoff value which is in the orange. Very little red light is measured. Thus the meter measures mainly the blue light. This is not a serious disadvantage since most photographic film, even the panchromatic types, also has a sensitivity peak in the blue.

For color photography the flash-tubes that are used are mainly filled with xenon gas at high pressure for high-efficiency use. The meter should then be calibrated experimentally with a xenon lamp under conditions that are known to produce a suitable color-photograph result. Fortunately xenon flash-tubes are of about the same color temperature regardless of the energy loading, and therefore the light meter can be used for comparison purposes with success even if only sensitive to blue light.

Figure 1D shows the spectral sensitivity of two types of photoelectric surfaces as well as the
standard eye visibility curve and film response. A different phototube, type 926 (S-S surface), has a sensitivity curve that covers the entire visual range as well as some of the infrared, but has a lower overall sensitivity than the 929.

The Corning Glass Works can make on special order a filter composed of two kinds of glass that will correct the 926 phototube spectral characteristic to correspond to the visibility curve. A filter composed of glasses 3304 and 4784 gives a suitable combination. An accurate match can be made to any particular phototube at two wavelengths (6,400 and 4,800 A) by adjusting the thickness of the two glasses.

The phototube in the light meter will respond to the light from any kind of light source. However, the meter output cannot be expressed in lumen seconds per square foot unless the spectral distribution is the same as that of the xenon flash tube that is used for calibration. All xenon flash tubes, to a first approximation, have a comparable spectral distribution and therefore the meter readings can be given in terms of lumen seconds.

**Maximum Meter Sensitivity**

The example given previously (e = 2.5 volt, C = 0.1 μF) will have a maximum reading of the meter corresponding to 36 lumens for 147 microseconds when a phototube voltage of 100 volts is used. This reading corresponds to 36 × 147 × 10^{-7} = 0.0053 lumen-second with a tungsten source having a color temperature of 2,850 Kelvin. Xenon lamps have an equivalent color temperature of from 6,000 to 9,000 and because of the proportionally greater blue light, require less than half as much visual light in lumen-seconds to produce the equivalent phototube current in the 929 phototube. For this reason a xenon flash tube will produce a full-scale reading of the meter with about 0.0026 lumen-second of incident light.

The projected area of a 929 phototube cathode is about 0.5 square inch, so the phototube cathode has a light density of about 0.005 lumen-second per square inch when used to measure the light from xenon flash tube. We will now calculate the distance from a standard flash tube that will give this deflection for calibration purposes. A standard FT-214 flash tube (General Electric Co.) flashed from 30 μF at 2,000 volts emits some 2,000 lumen-seconds and has an intensity I of 200 horizontal candlepower-seconds with a duration of about 150 microseconds. The number of lumen-seconds per square inch at a distance d in inches is L = I/d^2 = 0.0052 lumen-second per square inch, from which d = 1/L = 200 inches = 16.7 feet.

Calibration of the meter can be accomplished directly by this method, using a standard flash tube operated under specified conditions. Thus a full-scale meter reading corresponds to U = 200/16.7 = 0.715 lumen-seconds per sq ft.

The reading of incident photosite in lumen-seconds per square foot can likewise be calculated from U = kRM lumen-seconds per square foot, where M is the meter reading, R is the polaroid attenuation ratio as read on the front of the meter, and k is a constant of the instrument. The light transmission of the uncrossed Polaroids at the 1 setting of the instrument is about 30 percent and this influences the value of k.

A diffusing disc is shown on the attenuator, which also acts as a calibrator to make the meter directly reading in lumen-seconds per square foot; for this case k equals 1. With the diffuser removed, the value of k for most instruments is 0.015 with a 200-microampere meter, with 200 as the full-scale meter reading.

The beam-candlepower-second output of a given flash tube and reflector combination is kRMd or Ud^2, where d is the meter-lamp distance in feet.

Neutral-density filters can be used to extend the scale range. Thus a 1/10 transmission filter would give a multiplying factor of 10. Neutral-density filters are available in decimal, logarithmic and percentage steps.

The meter has an angular acceptance ratio depending upon the diffusion disc and other factors. With the disc, the meter reading decreases to half value when the meter is swung 25 degrees from the meter-lamp axis. This angle decreases to 15 or 20 degrees without the diffuser. Any type of diffuser can be used in the filter adapter ring on the instrument.

**Determining Camera Apertures**

Preliminary experiments show that about 100 incident lumen-seconds per square foot (U) are required to expose daylight Kodachrome properly with a CC15 filter at an aperture of f/3.5. The aperture f is then equal to \( \sqrt{0.122U} \), where phasor U is in lumen-seconds per sq ft. Values of average incident light U required for various apertures are as follows:

<table>
<thead>
<tr>
<th>Aperture f</th>
<th>Phasor U</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>1.56</td>
</tr>
<tr>
<td>1.5</td>
<td>2.58</td>
</tr>
<tr>
<td>2.0</td>
<td>3.94</td>
</tr>
<tr>
<td>2.5</td>
<td>5.69</td>
</tr>
<tr>
<td>3.0</td>
<td>8.38</td>
</tr>
<tr>
<td>3.5</td>
<td>10.70</td>
</tr>
<tr>
<td>4.0</td>
<td>14.00</td>
</tr>
<tr>
<td>4.5</td>
<td>17.30</td>
</tr>
<tr>
<td>5.0</td>
<td>21.00</td>
</tr>
<tr>
<td>5.6</td>
<td>25.80</td>
</tr>
<tr>
<td>6.3</td>
<td>32.60</td>
</tr>
<tr>
<td>8.0</td>
<td>43.00</td>
</tr>
<tr>
<td>11</td>
<td>68.60</td>
</tr>
<tr>
<td>16</td>
<td>288.00</td>
</tr>
<tr>
<td>22</td>
<td>1,180.00</td>
</tr>
<tr>
<td>52</td>
<td>5,380.00</td>
</tr>
</tbody>
</table>

As an example, suppose the lights are fixed and the meter is to be used to determine the aperture. Guess at an aperture such as f/3.5 and make a reading. If the meter reads 100, the guess was correct. If it reads 200, the light is double that needed at f/3.5. Therefore the aperture should be increased one stop to f/4.5. Likewise, if the meter reads 50, the correct stop is f/2.5.

Eventually tables of suitable values of incident lumen-seconds per square foot for all types of photographic emulsions and for different flash durations will be available from the film manufacturers.

The meter has an aperture scale on the Polaroid attenuator to read camera aperture directly. The aperture marks have been placed so that they correspond to a meter reading of U = 100 for the correct lighting condition for the indicated aperture with daylight Kodachrome. These readings require the calibrated diffusing disc on the attenuator that is furnished with the meter. This disc also makes the meter direct-reading in lumen-seconds per square foot.
Facsimile Modulator Tube

**High Resolution** facsimile signals are transmitted over existing communication facilities by amplitude-modulated low-frequency carriers. A new type phototube and bridge modulator have been developed that enable light from the facsimile scanner to produce the modulation directly without generating frequencies that have to be eliminated by costly filters. The tube and circuit may simplify other systems in a similar manner.

**Facsimile Transmission**

Before describing the phototube and its action in the circuit, it is best to review the modulation problems that lead to its development. In many communication systems, facsimile being a typical example, the lowest modulation frequency is zero cps, corresponding in this case to a picture area of uniform density. The highest frequency is limited by what can be transmitted by the channel. Modulation currents as such cannot be transmitted over existing facilities because they are essentially interrupted d-c. To transmit them without introducing excessive distortion the channel would have to be polarized from transmitter to recorder thus requiring d-c amplifiers.

The solution to the problem has been to transmit the signal as an amplitude-modulated low-frequency carrier of frequency \( f_c \). Under such condition the highest modulating frequency \( f_\nu \) is limited to half the carrier frequency, assuming that filters with ideal cutoffs are available. Therefore the highest possible carrier should be used. In practice, the upper frequency limit is determined by the top of the channel passband. The carrier frequency is thus selected near this limit. Only the lower sideband of the amplitude-modulated carrier can then be transmitted, but this is all that is necessary for faithful reproduction and provides an efficient way to use the available channel. The manner in which these frequencies occupy the channel spectrum is shown in Fig. 1A.

The modulation frequencies \( f_\nu \) produce lower sideband frequencies \( f_\nu \) extending from the carrier \( f_c \) to the lowest sideband frequency \( f'_\nu = f_c - f_\nu \). When \( f'_\nu = f_c / 2, f'_\nu = f_c / 4 \). If a higher modulation frequency is used the modulation band overlaps the lower sideband producing extraneous frequencies. Under such conditions filters cannot be used to prevent modulation frequencies from reaching the transmission circuit. If \( f'_\nu = f_\nu \), ideal filters could separate the modulation and sidebands and 50 percent of the transmission band would be used. Actually sufficient guard band must be left between modulation and sideband frequencies so that realizable filters can be used. If filters that do not have such sharp cutoffs as to introduce transient distortion are employed, the maximum use ratio of the channel is only 30 percent.

**Phototube Modulator**

The conventional type phototube bridge modulator shown in Fig. 1B produces both the modulation frequencies contained in the impinging light beam and the sideband frequencies of the modulated carrier in its output. The circuit is balanced for reactive and resistive currents. Light on the phototube upsets the resistive balance to produce the modulation.

When the RCA 5652 phototube, which has been designed for this service, is used, the output contains only the modulated carrier and sidebands. The signal can be connected directly to a conventional amplifier that is reasonably flat over its passband; filters are unnecessary. The phototube has two flat cathodes arranged at approximately right angles to each other. When both plates are illuminated, one acts as a cathode and the other as an anode, depending on the polarity of the
Phototube having two plates each acting alternately as cathode and anode simplifies bridge modulator. Because tube conducts alternately in one direction and then in the other, only desired modulated carrier and side bands appear across the output.

Potential applied between them. If the applied potential is alternating, equal current pulses flow in both directions with equal light on both plates. The average current is then zero. Even a flash of light for the duration of one cycle of the carrier causes equal but opposite pulses to flow so that the effective current remains zero up to modulating frequencies of half the carrier frequency. Contrasted to this action, the current flow in a conventional phototube in a modulator circuit is unidirectional.

As used in the modulator, the new phototube is a variable impedance, the two cathodes being connected as an arm of an a-c bridge. Capacitive current is balanced, preferably by an electrode built into the phototube and completely covered with a dielectric. The capacitance between this electrode and one cathode is made approximately equal to the capacitance between cathodes.

For modulation by this tube the bridge circuit can be arranged as in Fig. 1C. If no light reaches the tube and \( R_c = R_a \) and \( C_t = C_a \), there is no voltage output. As reflected light reaches the phototube, conduction takes place in the direction governed by the polarity of the carrier. Both electrodes are photoelectric and therefore act alternately as cathodes and as anodes.

The amplitude of the applied carrier is limited by saturation of the cathode current in this circuit. The phototube operates on the linear portion of its characteristic curve, shown in Fig. 1D, for a given range of light values. In the case of high definition facsimile the maximum light is in the order of \( 4 \times 10^4 \) lumens. The elemental area of illumination at the scanning drum is about \( 5 \times 10^{-2} \) square inches. The carrier potential applied to the bridge is about 0.7 rms volt. If the bridge is balanced with the light source off, when the light is turned on the output voltage will be undistorted modulated carrier proportional to the instantaneous light intensity, reflected from the rotating scanning drum; only carrier and sidebands will be present.

Operating Circuit and Tests

For convenience and ease of adjustment the circuit that is used has balancing controls. In addition, a diffusing plate is placed over the aperture to overcome two difficulties. First, a sharply focused image can cause uneven illumination of the two cathodes and thus produce occasional d-c keying components in the output. Second, the light beam passing through the aperture covers too small an area on the photocathodes for ease of adjustment when balancing the bridge to eliminate the modulation frequencies from the output, unless the optical system is very long. The diffusing plate defocuses the beam without sacrificing resolving power.

In operation, the output voltage varies from a maximum between 0.005 and 0.010 rms volts to a minimum controlled by the noise from the balanced bridge with the light off. The noise level of the bridge and the first stage of the amplifier is equivalent to 25 to 50 microvolts at the grid of the first stage. The load resistor, which also serves as the grid resistor of the first amplifier tube, can be from 1 to 20 megohms depending on the compromise that must be made between high sensitivity and stability against humidity, stray fields and input noise. The phototube noise does not seem to be a problem. The useful voltage ratio for light variations is therefore from 40 to 50 db.

When the scanner observes a 1.6-reflection density photographic black, the output rises about 10 db above the noise level. This level determines the minimum useful signal. When the scanner observes a bright white, the output rises an additional 30 to 35 db. However, such a range is beyond the capabilities of an average transmission channel. Therefore, after amplification, the signal is compressed to a range of about 20 db, within the limits of most channels.

Resolving power of any equipment with a given carrier frequency can be determined roughly by reducing the size of print being transmitted until the copy reproduced at the receiver is just illegible, assuming the receiver to be linear above the carrier frequency. A better but more complicated method is to select a type face and size that has a line width greater than is necessary to block light to the phototube. It is then certain that full interruption of the light to the phototube will be produced regardless of scanning velocity. Increasing the scanning velocity at both transmitter and receiver with a given carrier frequency will determine the maximum resolving power, and therefore the maximum usable modulation frequency for a given system. With the new phototube, 50-percent utilization of the channel can be realized and thus good resolution can be obtained.
Radio in the Merchant Marine

Survey of ship communications for message handling and safety of life at sea. Basic radio law and changing legal requirements are reviewed as background in the evolution of technical equipment to meet specifications. Current trends are analyzed.

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Historically, it was the maritime mobile service that first adopted commercial radio communication and demonstrated its value to the world. Radio has maintained a brilliant record in the saving of life and property at sea from a period more than a decade preceding that fateful night in 1912 when the distress call from the stricken Titanic dramatized its usefulness. But in spite of the impetus which this highly successful application gave to the radio industry during its infancy, technical progress in the marine field has been along conservative lines following, rather than leading, shore developments.

The first shipboard radio installations (circa 1901) utilized the discharge of a large spark coil across a straight gap into a tuned antenna system to radiate energy. A coherer, or rudimentary form of a multiple-point-contact rectifier, connected to an inker was used to record the received signals. Thus, it is to be noted that the first shipboard radio installations employed automatic recording and visual presentation of information! Within a short time the oscillatory discharge of a capacitor across a synchronous or quenched gap was adopted as an improved method of setting up oscillations in a large antenna system. Radio energy in the form of broad, highly damped waves, usually modulated at a convenient audio frequency, was radiated at frequencies in the order of 100 to 200 kilocycles. The received signal was demodulated by a magnetic detector. A significant improvement in receiver effectiveness was realized when the unilateral characteristic of mineral crystals was discovered and applied to signal rectification. Although some voltage gain was obtained from the rather low-Q tuned antenna primary and secondary circuits, the audio component effective in the magnetic-type reproducer was low. Range, even under conditions of moderate signal-to-noise ratio, was restricted and reliability of both receiver and transmitter not always of the highest order.

An improvement in system selectivity, increased range, lower antenna insulation requirements, and better signal note were some of the advantages gained through the introduction of the Poulsen arc type of continuous wave transmitter prior to World War I. The arc oscillator, however, was limited by
an inherent inefficiency to wavelengths longer than 1,000 meters (300 kc) and found its most useful application on wavelengths as high as 18,000 meters (17 kc). Rapid extension of the vacuum-tube oscillator to marine use and unsuitability for radiophone (A3) modulation were the important contributing factors to the eventual obsolescence of the arc transmitter. Nevertheless, standard 2-kw arcs remained as supplementary equipment on many ships throughout the 1930’s and high-power installations of several hundred kilowatts were used in commercial and government coastal and transoceanic stations for many years.

Although the spark, arc, Alexander alternator (for land stations), and vacuum tube were concurrently or successively employed as oscillators during the three decades ending in 1930, the superiority of the tube eventually forced its acceptance by the marine industry. Early tube transmitters were usually of the converted spark type; that is, the oscillatory circuit of the shipboard spark equipment was replaced by one or two electron tubes with appropriate changes in circuit and power supply. Primary and secondary tuned circuits were left intact. Either c-w (A1) or tone modulated c-w (A2) emission was provided. Later tube equipments were designed especially for marine use. Some form of master-oscillator power-amplifier lineup furnished a choice of several working frequencies centering around the two international marine calling frequencies of 148 and 500 kc.

**Improvements**

During the period 1930-40 the replacement of early v-t transmitters by improved types incorporating crystal control, and the almost complete disappearance of arc and spark equipment occurred. Tuned radio-frequency and superheterodyne receivers, designed for exclusive marine application, were adopted as standard. However, many merchant ships did not discard obsolete equipment until the late 1930’s.

Other innovations in this decade were: (1) the rapid expansion of high-frequency communication facilities and the production of several types of well-designed marine transmitters for this work; (2) the increasing use of low-powered marine radiotelephone, particularly on the smaller vessels and communications involving safety or ship’s business; (3) the mandatory installation of an automatic alarm, capable of giving visual and audible indication of impending distress or safety information, on all merchant
Typical packaged shipboard installation including automatic alarm (with keyer unit), high-frequency transmitter and receiver, intermediate-frequency transmitter and receiver, emergency transmitter, antenna switch, and charging panel. Motor generators are in lower section.

Ships over 1,600 tons where a continuous radio watch is not feasible; (4) the requirement for a battery-operated transmitter-receiver unit in motor lifeboats of certain classes of passenger vessels to reduce the hazard involved in ship abandonment.

Perhaps the most outstanding advance during the recent war was the development and production of the packaged shipboard radio station that is, one unit containing three v-t transmitters, three receivers, automatic alarm, main and emergency power motor-generator sets, and all switching and control circuits. This package could be disassembled for handling and reassembled aboard the ship. Installation time was reduced from days to hours.

Hand-cranked, portable and semi-portable lifeboat transceivers, high-frequency facilities on nearly every U.S. ocean-going vessel, and a keen but discriminating interest in the value of new electronic navigational aids were other evidences that post-war applications of radio in the marine industry would expand. Thus the modern shipboard installation, the mobile end of the communications loop, is the end product of a 47-year old sporadic evolution and includes most of the technological advances made during the pre-war and wartime years.

**Shipboard Radio Station**

Every ocean-going passenger vessel and cargo vessel of 1,600 tons or over (certain government vessels and ships of the armed forces excluded) must have, upon leaving any U.S. port, an efficient, properly licensed radio installation in operating condition and manned by competent operators. Similar requirements are enforced by the administrations of other maritime nations. A continuous radio watch must be maintained at all times the vessel is being navigated outside harbors or ports. However, cargo vessels in lieu of additional operators may employ the automatic alarm device to monitor the safety and distress frequency (500 kc) during periods when the operator is off duty.

The minimum prerequisites for an efficient radio installation, aboard compulsorily equipped vessels, are specifically fixed by law. However, equipment design, provided certain essential performance is assured, is not specified except in cases where the use of obsolete techniques would cause undue interference to other services.

Each shipboard radio station must have: (1) main transmitter and receiver; (2) emergency transmitter and receiver; (3) emergency source of primary power independent of ship supply, capable of 6 hours continuous service; (4) other ancillary equipment contributing to efficiency, such as a clock, and bridge communication. A normal range of 200 miles is required for the main transmitter and 100 miles for the emergency. Although at one time the low-frequency band between 100 and 200 kc carried the larger part of message traffic in the maritime mobile service, today nearly all work is done on medium or high frequencies. Most shipboard stations provide several working frequencies in the band between 350 and 515 kc, inclusive. The international
calling and distress frequency of 500 kc is used to make initial contact. Where supplementary high frequency is installed, it must comply with statutory regulations as to performance and use.

Regulatory performance specifications for marine radio equipment are not difficult to meet. There are, however, special considerations incurred by the stringent conditions of marine service. Ruggedness, compactness, part-replacement accessibility and protection against moisture and spray are some of the essential construction features. Efficient, well-standardized circuitry capable of easy and stable adjustment must be used throughout. Reliability must be of the highest order. It is necessary that operating controls be kept to the minimum consistent with good performance and that such controls be arranged conveniently. Provision for rapid on-control frequency shifting, simplified tuning, A1 or A2 emission at will of operator, use of 110 volts d-c as a primary power supply, or 12-volt storage batteries as an alternate emergency source, optional use of crystal control on medium and high-frequency transmitters, and a break-in system that will permit the operator to receive during keying intervals are features included in modern marine radio equipment.

Main and Emergency Transmitters

Power output of modern shipboard transmitters ranges from 50 watts for the emergency set to 500 watts for the main, medium-frequency equipment. Average power outputs of 150 to 200 watts are typical. From five to eight working and calling frequencies within the band from 350 to 615 kc are provided. Shifting frequency is accomplished rapidly by a ganged switch and antenna retuning.

The oscillator is conventional and usually has eight pretuned iron-core circuits, or ganged tapped inductances for easy switching. Provision for crystal control on all or any one of the frequencies can be obtained by substitution of appropriate crystal for a removable input capacitor. An alternative mopa lineup uses a self-excited oscillator, buffer, and paralleled-tube power amplifier. Antenna loading and tuning is accomplished typically by means of a tapped variometer. Plate modulation for A2 emission at 500 to 1,000 cycles originates in the power-supply motor generator which also supplies a high d-c voltage, or a low a-c that is increased and rectified for the plates.

Special precautions are taken to suppress harmonics and parasitics by complete shielding, oscillator-amplifier isolation, and r-f grid isolation. Primary, or some form of grid keying is used for carrier interruption in telegraphy.

**Equipment Characteristics**

The emergency transmitter, as an independent unit, has an output power of about 50 watts into a standard shipboard antenna, or single-wire (against ground) radiator of approximately one-quarter wavelength, end or center-fed. Antenna characteristics vary between 500 to 1,500 \( \mu f \) and 4 to 10 ohms. Modulated c-w (A2 emission) often due to raw a-c on plates, is frequently used. All power for the emergency transmitter is supplied from storage batteries through a motor-generator set of appropriate rating. Some main transmitters are so designed that they may be operated on reduced power from batteries, thus serving as emergency equipment.

Well-designed, rugged, dependable high-frequency transmitting equipment, specially built for shipboard use, is presently available. Power outputs of 150 to 200 watts, choice of A1 or A2 emission, provision for optional master oscillator or crystal control of eight frequency bands in the region 4.14 to 22.14 mc, are features of this equipment. Additionally, several working frequencies are included in each band. A stability percentage of \( \pm 0.05 \) for master oscillator, or \( \pm 0.02 \) for crystal oscillator is readily maintained under widely varying operating conditions. Oscillator circuitry is conventional. However, a form of temperature compensation is used by one manufacturer to insure the stability of a self-excited type. Convenient, rapid resetting of oscillator and doubler controls is provided for facile operation. Simultaneous cathode or grid-block keying of all tubes, and the use of the beam-power tubes in the power amplifiers is almost standard. For economy it is necessary that the high-frequency and main transmitters use the same motor generator through a suitable switching arrangement which permits alternate, but not simultaneous, operation.

**Marine Radio Receiver**

The receiver is a vital complement to the shipboard installation. A typical station includes three or four such adjuncts: (1) main receiver for the vlf, l-f, and m-f regions; (2) emergency receiver for the medium frequencies; (3) high-frequency receiver. For a standby watch on 500 kc while working on another medium frequency, an additional set is sometimes used.

The main receiver, although of straightforward design and construction, has special features for
marine radiotelegraph application. The trf type with regenerative detector is standard in the marine medium band. Band switching, or plug-in coils, for substantially continuous coverage from 16 to 600 kc gives considerable versatility. One or two stages of r-f, a regenerative detector, and two stages of audio amplification is a lineup commonly used. Designed primarily for reception of A1 or A2 emission, bandwidth considerations permit high gain and selectivity per stage. Response to modulated signals is still further improved in a receiver of one manufacturer by employing audio transformers peaked in the 500 to 1,000-cps region. A storage battery for heater supply and dry batteries for plates make the main receiver independent of the ship's power line.

The emergency receiver is a crystal-rectifier type as required by law. It covers a range from 350 to 515 kc and will respond to A2 or type-B (spark) emission.

Although special high-frequency receivers have been built for shipboard service, they possess few, if any, points of superiority over any standard, high-quality communications set. Generally, they use the superheterodyne principle and are engineered for ruggedness, reliability, and compactness rather than maximum performance and flexibility.

**Automatic Alarm**

Radio laws of the U. S. require that every ocean-going passenger vessel and every ocean-going cargo vessel of 1,600 tons or over shall maintain a continuous radio watch while at sea. However, cargo vessels, in lieu of additional personnel may use an automatic alarm device during the time operator is not on watch to guard the international distress and safety frequency of 500 kc. The automatic device must be capable of responding exclusively to an international alarm signal consisting of twelve dashes of four seconds length, spaced one second apart. To actuate, a minimum of 500 µv at the receiver input is specified. The alarm signal must precede all distress calls and may be used for urgent hydrographic or meteorological broadcasts.

Automatic alarms in use on U. S. ships are of two general types: one employs a superheterodyne receiver with an electronic selector; the other uses a sensitive trf receiver with a square-law detector and mechanical selector. Both instruments give audible indication when a true alarm signal is received and audible or visual notice or both when the alarm becomes inoperative owing to circuit failure or unusual external noise or interference conditions. Variable receiver gain permits a setting of sensitivity within the range 200 to 50,000 µv, thus allowing optimum adjustment for prevailing noise conditions. One equipment has auxiliary contacts that key the main transmitter to send out an alarm signal. A very recent development is an alarm responding directly to a specific ship's call letters or to an SOS call, thus expediting more immediate action in emergencies. Very few ships, however, are equipped with this device.

**Lifeboat Radio Installation**

International regulations make it mandatory that ocean-going passenger vessels maintain a complete radiotelegraph installation in one motor lifeboat where the number of lifeboats exceeds 13 and two such installations where the number exceeds 19.

The lifeboat transmitter and receiver unit are packaged together and mounted rigidly within a protective housing, usually in the bow. A fixed frequency of 500 kc is determined by a Colpitts oscillator arranged in a self-rectified, full-wave circuit. Modulation at 1,000 or 1,600 cps for A2 emission is obtained from a dynamotor of 110-volt, 500 or 800-cycle output. The primary source of transmitter plate and all filament power is two 12-volt, high capacity storage batteries; receiver plate voltage being furnished by dry batteries. An antenna of approximately 50 feet long, supported on collapsible masts gives a minimum reliable range of 50 miles. Power capacity must be such as to permit continuous operation for 4 hours.

Another type of lifeboat transmitter, an outgrowth of the Gibson Girl unit used in sea-air rescue work during the war, is frequently seen on merchant ships now. This equipment may be portable or semiportable and often incorporates a signalling facility only. Power is supplied by a hand-cranked generator integral with the equipment. Although the regulations requiring the installation of this device have been suspended, many merchant ships carry one or more as a means of extending the signalling area of a lifeboat.

**Marine Radiotelephone**

An increase in the convenience and economy in ship-to-shore, shore-to-ship, and intership communication has been effected through the establishment of medium-range marine radiotelephone networks. On the ten available frequencies in the 2- to 3 mc region a vast amount of information is exchanged. Through complementary coastal harbor stations connection can be made into the land-line telephone system.

Although certain large passenger vessels have complete facilities for long-distance radiotelephone communication open to public correspondence, equipment on most vessels is limited in range to coastal waters within coverage of harbor.

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stations. Smaller vessels, such as tugs, yachts, fishing boats, pilot boats, or those whose routes do not justify the expense of a radio telegraph station, have found the marine radiotelephone an invaluable aid to piloting or in transacting ship business.

Shipboard radiotelephone equipment, in addition to meeting the standard requirements of ruggedness, compactness, operational simplicity, and weatherproofing has, in its highest development, several features which increase its convenience and effectiveness. Since it is ordinarily installed on the bridge or in a chart room, it is operated by nontechnical personnel.

Crystal control on all frequencies is standard. A change in carrier frequency is accomplished by one switch and antenna retuning. A choice of the method of carrier interruption (for listening-in purposes) can be made by an operator using a button on his handset which can be released for listening, or automatic operation of a Vodas relay actuated by speech air pressure on handset transmitter diaphragm.

The radio receiver allows selection of tuned, spot frequencies corresponding to transmitter settings. An automatic selective ringer can be installed to permit signalling of an individual ship by transmission of coded impulses from harbor stations. Separate control units for operation of equipment on a preset frequency from a remote shipboard position can be furnished.

The marine radiotelephone is invaluable in cases of distress. The Coast Guard maintains a listening watch on 2,670 kc on the Great Lakes and the coasts.

A postwar development of great significance is the growing popularity of f-m radiotelephone in the 157 and 162-mc bands. Use of certain frequencies in this region in conjunction with harbor-approach radar is expected to facilitate movement of traffic in high-density areas.

Basic Radio Law

World-wide regulation of radio communications in the maritime mobile service is based on the

Articles of the Convention for the Safety of Life at Sea, London, 1929, and the International Telecommunications Convention of Madrid, 1932, with annexed Radio Regulations. Except for the Radio Regulations, the United States is signatory to both these agreements. The recent Telecommunications Conference at Atlantic City, under auspices of the International Telecommunications Union, revised many extant regulations and made certain frequency re-allocations.

Statutory supervision of all communications in the United States is pursued under authority of the Communications Act of 1934 which created the Federal Communications Commission. As amended in 1937, this Act includes provisions of the Safety Convention for ship radiotelegraph stations.

Business Administration

Coincident with the development of marine mobile communications there has been a comparable growth of commercial companies specializing in the administration of the technical, legal, and business aspects of marine radio. In the United States four of the larger radio service companies, Tropical Radio & Telegraph, Radiomarine Corporation of America, MacKay Radio & Telegraph, and Globe Wireless, Inc., maintain extensive facilities for servicing and operating radiotelegraph and telegraph stations ashore and afloat.

Many steamship companies maintain their own radio organizations. Today, for the ships of all nations, there exists a standardized, world-wide, radiotelegraph network made up of many systems but coordinated by the various administrations into a well-integrated, highly cooperative facility. There are few places on the high seas where a merchant ship need remain out of touch with its home port for more than a few hours at a time. However, since there can be no lessening in efforts to improve safety of life and property at sea, expedite ships' business, or improve public convenience in communications, progress in the marine radio field will continue.

Future Trends

Certain trends are already discernible; the next decade should see the following adjuncts widely accepted:

1. Universal adoption of crystal control on all working frequencies of high and medium-frequency equipment.

2. Replacement of many distributed-type shipboard radio stations by packaged, one-unit installations.

3. Widespread use of some form of call-signal and SOS-responder device for supplementary watch-standing on all merchant ships.

4. Greater use of the marine radiotelephone, particularly the vhf f-m type. Extension of present a-m radiotelephone ranges and use of vhf f-m in conjunction with navigational aids.

5. Increased popularity of high-frequency bands for normal ship-radio traffic.

6. Installation of radio facsimile on many passenger vessels.

7. Limited use of television for public entertainment on the larger passenger vessels.

8. Closer coordination of radio communication facilities, on shore and aboard ship, with sea and air safety and rescue work and with radio or electronic navigational systems.

The author wishes to thank the Radiomarine Corporation of America, 75 Varick Street, N. Y., and the MacKay Radio & Telegraph Co., Inc., Marine Division, 345 Hudson Street, N. Y., for supplying photographs accompanying this article.
Soldering

FIG. 1 — Experimental sonodizing setup. Left to right: 24-volt polarizing battery; magnetostrictive transducer and soldering iron; unit containing oscillator, loading capacitors, and controls; four 50-watt amplifiers

THE TINNING of aluminum alloys presents problems tending to limit applications of soldering. Experiments indicate that some of these problems can be solved by vibrating solder at an ultrasonic rate while applying it to the work. By this method the oxide coating is disrupted and alloying of the metals occurs before re-oxidation of the aluminum can take place.

The tinning of aluminum and its alloys through the application of magnetostrictive forces to a soldering iron is called sonodizing. Although sonodizing eliminates the use of a flux, if wide enough differences of surface potential exist between the metallic boundaries corrosion susceptibility exists and precautions must be taken commensurate with the conditions of exposure.

Transducer Selection

In order to establish satisfactory procedures for fluxless tinning, it was first necessary to select a vibration generator that could be readily modified to serve as a soldering iron. Selection of suitable equipment required analysis of the characteristics of several types of

FIG. 2—Magnetostrictive transducer with solid tinning tip and (right) with brush-type tip
Aluminum Alloys

Work is accomplished experimentally by vibrating the iron tip at an ultrasonic frequency by means of a vacuum-tube driven magnetostriction oscillator, to remove surface oxidation. Method is also applicable to stainless steel, chromium-plated and other hard-to-solder surfaces.

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existing generators. The four types considered were: (1) magnetostriction, (2) electromagnetic, (3) gas, and (4) quartz crystal.

The deciding factor which influenced the selection of the magnetostriction unit was the ease with which the magnetostrictive element could be modified and equipped with a suitable tip. Such a transducer can, in fact, be fabricated so that the vibrating element itself is capable of withstanding direct immersion in molten metals and can be used directly as a soldering iron.

Transducer Characteristics

A magnetostriction generator of the type described by Pierce has an effective frequency range of 1 to 50 kc. Amplitudes of 0.0001 to approximately 0.001 cm, which is the rupture point of nickel, can be obtained. Power up to 10,000 watts may be used. Less than 15 watts acoustic output is impractical where mechanical vibration is the objective. Transducer efficiency, which is the measure of coil output available as mechanical power or acoustic energy, seldom exceeds 15 percent. Operating temperature of the magnetostrictive tube within the coil is limited by the Curie point of the metal (300 F for Invar), but tip temperature of 800 F can be maintained for short intervals.

The electromagnetic generator is simpler and less costly than the magnetostrictor, but it is applicable mainly to low-frequency work with large volumes of fluid on a continuous basis. Similarly, a generator such as the Galton whistle has some desirable features but it has a transducer efficiency of only 5 percent and is not as readily con-

Diagram showing setup for tinning aluminum alloys. A switch (not shown) permits paralleling of 4, 7.5 or 15-ohm amplifier taps.
rolled as electronic devices. Again, the quartz-crystal oscillator is suitable for work requiring precise control, but unsuited at present to sudden temperature changes required in fluxless soldering. Fracture of the crystal is likely to occur.

The magnetostriction generator constructed by the authors with the assistance of Richard W. Powell of Lockheed, and Bodine Sound Drive, is pictured in Fig. 1 and has four component parts: (1) four paralleled 50-watt amplifiers, including an output meter and a switch for selection of various amplifier output taps; (2) a capacitor loading unit; (3) an oscillator tunable from 7 to 70 kc and a magnetostriction unit, the essential components of which include the magnetostriction coil consisting of a helix of 45 turns of 4-strand no. 13 Formex-insulated copper wire wound in two layers on a Micarta frame. The coil is 3/16 inches inside diameter and was designed to operate one-half of the metal transducer element, thus freeing the lower half of the nickel tube.

Polarizing Coil

Because magnetostriction is independent of the sense of the magnetic field, a polarizing coil consisting of 950 turns of no. 16 insulated copper wire was required. The solenoid is mounted between two soft iron plates to form a magnetic circuit. The arms of the pole pieces are shielded by wrapping with copper to prevent interaction between the magnetostrictor and polarizing coil.

The nickel tube, supplied by the International Nickel Co., is 9 inches long, 1 inch outside diameter, and has a 1/32-inch wall thickness. Nine longitudinal slots 1/32 inch long were cut in the tube along the section enclosed in the energizing helix to reduce heating. The soldering tip consists of a 1/8-inch stainless-steel rod, 4 inches long, silver soldered to the end of the nickel tube. A Nichrome heater coil is wound on a tube which maintains a loose sliding fit on the tip so that unnecessary mechanical loading is avoided.

The transducer is pictured in Fig. 2. The oscillator helix is mounted so as to cover one half of the transducer element. Iron arms enclosing the polarizing coil support both units. The magnetostrictor tube is supported at its center of mass in the dural holder shown in Fig. 2. The control equipment is mounted in two separate racks (Fig. 1).

**Equipment Operation**

To operate the system the power-amplifier, oscillator and polarizer-coil circuits are energized. The oscillator is tuned to give maximum vibrational intensity, activating the metal tube at resonance. The capacitance across the magnetostrictor coil is adjusted to give maximum deflection of the ammeter in this circuit. Amplifier impedences are adjusted for maximum output. Power is controlled by adjusting gain on the amplifier bank. Field strength of the polarizer coil is altered to give maximum magnetostrictive effect.

After the circuit is stabilized, the Variac is set to give proper tip temperature and the solder is applied and allowed to flow around the tip and onto the metal to be tinned. The operation produces an intense hissing and chattering noise which can be used by the operator to gage working efficiency. When the work under the tip reaches the temperature of melting solder, two or three rapid passes of the tip generally produce satisfactory tinning.

As the metal surface does not ordinarily need cleaning, pre-etching or fluxing, corrosion is not a factor in the operation. An ironwire brush tip was found to work well in some instances, with the added advantage that it more readily reaches inaccessible areas, scaled spots and scratches. Goggles and respirator are worn by the operator as the tendency of the brush or tip to throw metal constitutes a hazard.

With the apparatus operating at 8 kc, tests have been made on aluminum and its alloys, notably 25ST and 75ST, as well as stainless steel, chromium-plated surfaces and anodized and dyed aluminum. Typical results are shown in Figs. 3 and 4.

Stainless steel tinned easily when a small amount of cadmium was added to the solder as a wetting agent. The same was true with chromium-plated surfaces. Phenolic strips were metallized with zinc, lead, cadmium and aluminum. Castelin eutectic 19B solder was used. Anodized and dyed aluminum tinned satisfactorily, but required a longer time than bare alloy surfaces. Ferrous metals such as 1010 and 4130 steel do not tin readily, requiring greater energy output and greater solder wettability. Aluminum aircraft-generator cable tips and lugs were tinned and then sweated together, resulting in very low contact resistance.

Tested applications include the following:

- Jointing dural tubing — Test samples showed average strength of 3,800 psi.
- Assembly of dural chassis for electrical units — One panel satisfactorily joined.
- Hot-air duct assembly — Initial tests on one-inch and 0.025-inch dural satisfactorily.
- Replacement for metal-to-metal adhesives — Indicated success, but not yet thoroughly investigated.
- Airfoil smoothing — Scratched and grooved aluminum surfaces satisfactorily.
- Anodized dural surfaces — Heavily anodized and dural dural surfaces were tinned directly.

Other applications will no doubt be disclosed by continuing experimental tests.

**References**


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Rocket-Engine Tester

Photoelectric unit utilizing Polaroid discs to generate sine wave checks speed of fuel pumps operating at 40,000 rpm and measures torque required to overcome drag

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ROCKET-POWERED ENGINES of one particular type employ two kinds of fuel. To feed these two propellants to the engine a turbo-driven pump having an impeller at each end is used.

A seal is required at each end of the pump-turbine shaft, which is driven at speeds up to 40,000 rpm. In order to determine the life of the seals during development it was necessary to measure both speed and torque. This had to be accomplished without adding external torque, and the following description explains how it was done electronically.

Principle of Operation

As shown in the diagram, a rotating Polaroid disc and a stationary Polaroid disc, in combination with a system of light sources, lenses, and phototubes, comprise the sine-wave generator of the test device.

The rotating Polaroid disc is mounted on the pump driveshaft. Directly in front of it two light sources and lenses are mounted on a stationary bracket. In back of the rotating Polaroid disc are the stationary Polaroid disc and two phototubes. These are spaced 90 degrees apart to produce similar electrical phase-shift.

The output of the phototubes is fed to two voltage amplifiers. One of these amplifiers is connected to the X axis of an oscilloscope. The output of the other amplifier is connected to the input of an electronic switch, and the output of the electronic switch is connected to the Y axis of the oscilloscope. To the other input of the electronic switch an audio oscillator is connected.

A circle of 4-inch diameter is produced on the oscilloscope screen when the audio oscillator is tuned to the frequency of the Polaroid generator. The frequency of the audio oscillator multiplied by thirty gives the revolutions per minute of the shaft when the Polaroid generator provides two cycles per revolution.

Also mounted on the pump driving shaft is an opaque disc with a slit 0.008 inch wide and 3'" long, cut on the outer periphery. A light source, lens and phototube system much the same as that used in the Polaroid sine-wave generator is employed. Phototube output is fed through voltage amplifier to the Z axis of the oscilloscope. A dark spot appears on the circle developed by the Polaroid generator. An identical arrangement is used on the torque end of the shaft. This produces another spot on the circle, superimposed directly upon the first spot.

Method of Measurement

The spot remains true as long as no load is applied on the torque side of the pump. However, when loads are applied this produces an angular displacement of the torque member, which moves the superimposed spot an equivalent angle. The angular displacement is measured between the stationary spot and the moved spot, by placing a polar-coordinate chart in front of the oscilloscope tube.

Block diagram of the rocket-engine pump-seal tester

ELECTRONICS — June, 1948
**Frequency-Scanning VHF Impedance Meter**

**IMPEDANCE MEASUREMENTS** can be made at radio frequencies by several methods and techniques, using such instruments as the radio frequency bridge, the slotted line, the Q meter and the combination of a calibrated signal-generator with standardized r-f ammeter, voltmeter or reference impedance. Each of these methods has its own particular type of utility. However, in determining the impedance-versus-frequency curve of a particular device, all require tedious point-by-point measurements.

A new instrument has been developed which provides an instantaneous and visually-presented determination of impedance versus frequency. The design of the instrument is such as to enable it to handle almost all of the devices encountered by the radio engineer in the design and development of present-day vhf and h-f equipment.

The instrument is a frequency-scanning reflection meter designed for operation anywhere in the range from 10 to 250 megacycles. At any frequency within this range it will rapidly scan a bandwidth of up to 30 megacycles. Its output signal, suitable for use with any oscilloscope, is proportional to the amount of energy reflected from the end of a transmission delay line to which the device or system under test has been connected.

**Principle of Operation**

The instrument, shown in Fig. 1 and 2, embodies a principle originally used in the terrain clearance meter. It consists essentially of a wide-range sweeping oscillator which is arranged to propagate a frequency-modulated signal through a transmission system of finite propagation time. This propagation time is such that at any instant the reflected energy received back from the far end of the system will be of a measurably different frequency from that being fed into its input.

**FIG. 1—Frequency-scanning vhf impedance meter in use, with conventional oscilloscope used as indicator**

The pitch of the beat note produced by combining the incident and reflected waves in an internally-contained detector circuit is proportional to the rate at which the frequency is being varied and to the propagation time of the transmission system. The amplitude of
the beat note is proportional to the amplitude of the reflected wave.

With reference to Fig. 3 and 4, the conditions which prevail are as follows:

1. An r-f voltage of amplitude $A$ is linearly frequency-modulated between the limits $f_i$ and $f_s$ by a sawtooth waveform of period $T$.

2. This voltage is applied to a transmission line whose terminating impedance $Z_L$ does not equal its characteristic impedance $Z_0$.

3. The reflected energy due to this inequality is received back at the input after a delay time $\tau$ equal to twice the propagation time along the transmission line.

When attenuation in the transmission line is assumed to be negligible and $\rho$ is taken as the transmission-line reflection factor equal to $(Z_L - Z_0)/(Z_L + Z_0)$, the voltage amplitude of the reflected wave will be $\rho$ times the amplitude of the applied wave. The total frequency excursion $\Delta f$ of the reflected wave will be the same as that of the applied wave. The frequency of the beat note is given by

$$F = \frac{T}{T} \left( f_i - f_s \right) = \frac{T}{\tau} \Delta f$$

The beat note exists for a length of time equal to $T = T'$, where $T'$ is the time of the return sweep. At the end of this time, for the brief interval $T'$, a transient frequency is set up as the applied wave snaps back from $f_s$ to $f_i$ to repeat the sweeping sequence.

To a first order of magnitude, it is necessary that the beat-note frequency be such that at least one full cycle of the beat note is completed during the time interval $T$. As is apparent from Fig. 4, this condition must be fulfilled if a closely sinusoidal beat-note waveform is to be obtained. Therefore

$$T \geq \frac{1}{\Delta f}$$

(2)

For the case where $T = 1/F$, substituting for $T$ in Eq. 1 gives

$$\Delta f = \frac{1}{\tau}$$

(3)

In order, therefore, to secure at least one full cycle of beat note, the total frequency deviation must equal the inverse of the total propagation time outward and back through the transmission line. The amount of frequency excursion during one cycle of beat note will determine the frequency resolution
of a particular reflection measurement.

**Description of Instrument**

In the instrument, a band-pass audio amplifier with variable gain is used in conjunction with the beat-note detector. This combination results in high sensitivity of measurement of reflected energy. In order to reach the best compromise between high gain, good stability and low susceptibility to disturbance from unwanted signals, the amplifier is designed with a pass band of from 300 to 6,000 cycles per second. The beat-note detector is a silicon-crystal diode and the frequency-sweeping signal generator is an oscillator plus an auxiliary 2,000-cps sawtooth modulator of the phantastron type. Three fixed lengths of RG-58/U coaxial transmission line are included internally to provide a suitable transmission delay for most of the applications generally encountered. The propagation velocity along this type of line is about 660 feet per microsecond.

The diagram of Fig. 5 shows the essential elements of the frequency-scanning reflection meter. The portion within the dotted line is the oscillator with its normal 60-cps sawtooth frequency modulation applied to the high-level (local) oscillator. The frequency excursion can be adjusted to as high as 30 megacycles or more. The adjustable output of the 2,000-cps sawtooth modulator is applied to the low-level (signal) oscillator, permitting sweep excursions of up to 5 megacycles. The 60-cps sweep rate is intended for very-high-frequency (30 to 250 megacycles) broadband work, whereas the 2,000-cps sweep rate is designed for high-frequency (10 to 50 megacycles) medium and narrow-band work.

With the various combinations of transmission line lengths included in the instrument, total delay times of 0.2, 0.4, 0.6, 0.8 and 1.0 microseconds are available. From Eq. 3 the respective sweep widths for obtaining one complete cycle of beat note output are 5.0, 2.5, 1.67, 1.25 and 1.0 megacycles. For the condition of two full cycles of beat-note output per sweep, the above sweep widths are doubled; for three full cycles of beat note, the sweep widths are tripled; and so on. This permits operation of the instrument under a wide variety of conditions, using either the high-frequency sweep rate or the low-frequency sweep rate as the individual case may dictate, and patching in suitable lengths of internal or external transmission line as required.

**Applications**

One typical use of the instrument is described in the following paragraphs.

Suppose it is necessary to evaluate the impedance of a coaxial-sleeve broad-band vertical dipole antenna designed for operation in the 30 to 60 megacycle region from 53.5-ohm coaxial transmission line. The antenna is mounted on an elevated support about 80 feet from the point at which the test instrument is most conveniently located, and an attached 100-foot length of 53.5-ohm coaxial cable is brought down to the test location. It is desired to observe visually the reflected energy from this antenna over the frequency range of 40 to 70 megacycles, and this information is desired with a frequency resolution of about 2 megacycles.

The ratio of total sweep width to desired frequency resolution is 30/2 = 15, so that 15 full cycles of beat-note output per sweep are required. Hence, modifying Eq. 3 for this case.

\[
\Delta f = 15 (1/r)
\]

so that

\[
\tau = 15/30 = 0.5 \text{ microsecond}
\]

The same figure may be arrived at by noting that the 2-megacycle resolution requirement is equivalent to saying that the applied frequency must shift at the rate of 2 megacycles per beat-note cycle. It then follows directly from Eq. 3 that \( \tau = 4 \) microsecond.

A two-way delay of 0.5 microsecond requires a one-way length of solid-dielectric coaxial cable of 166 feet. Since the 100-foot feeder cable is already available externally, it is only necessary to add a single 66-foot length of internal cable from that available in the instrument to make up the necessary transmission system. The setup is as follows:

A patching cable is connected between connectors \( P \) and \( P_b \). Another patching cable is connected between \( P_b \) and \( P_a \). The feed cable from the antenna is connected to \( P_a \). The sweeping output is set up for a center frequency of 55 megacycles, with the 60-cps sawtooth generator set for 30 megacycles of total sweep width (the 2,000-cps sweep is set to zero for this particular application). The 60-cps sawtooth-sweep output terminals are connected to the horizontal sweep input of any commercial oscilloscope, and the output of the band-pass audio amplifier is connected to the vertical input of the oscilloscope.

The visual pattern of the desired data will resemble the sketch of Fig. 6. The 15 complete beat-note cycles, swept every 1/60 of a second (\( P_b = 900 \text{ cps} \)), are modulated by
an envelope whose amplitude represents the amount of reflected energy as a function of instantaneous frequency. As can be seen, the reflected energy approaches zero in the region of 55 megacycles, at which point the antenna impedance closely matches the characteristic impedance of the transmission line. At either extreme of the frequency excursion, the reflected energy approaches zero if the transmission line were terminated in an open circuit. It is thus possible to tell at a glance just how effectively a given antenna matches its transmission line, and over how wide a frequency band it does so.

Transmission-Line Attenuation

Since attenuation is present to some extent in all practical transmission systems, the amplitude of the reflected energy wave as received back at the beat-note detector is not strictly equal to \( \rho \) times the voltage amplitude of the applied wave, but is \( \gamma \rho \) times this amplitude, where \( \gamma \) is the voltage attenuation ratio suffered by the wave in traversing the length of the line one way. However, it remains true that the amplitude of the reflected wave received back at the beat note detector is proportional to the magnitude of the reflection factor. For an open-circuited or short-circuited termination of the transmission line, the magnitude of \( \rho \) is always unity. For an arbitrary terminating impedance it is possible to evaluate the magnitude of the reflection factor, and hence the magnitude of the terminating impedance, by the following procedure:

First, the transmission line to be used is terminated in a short-circuit, corresponding to a reflection factor of amplitude unity, and the amplitude of the resultant beat note is adjusted to any convenient reference value, such as two inches peak-to-peak. Then the arbitrary terminating impedance is connected across the transmission line in place of the short-circuit and the peak-to-peak height of the resultant beat-note wave displayed on the oscilloscope screen is measured. The ratio of the height at any particular frequency to the two-inch reference height is then the magnitude of the reflection factor at that frequency. The phase angle of the reflection factor may be obtained by comparing the phase of the beat-note wave at any particular frequency to the phase of the two-inch reference wave. With this information, the terminating impedance may then be calculated with the aid of the Smith Chart.

From the above description it is apparent that a knowledge of the transmission-line attenuation is not essential to the operation of the instrument. However, excessive transmission line attenuation is to be avoided since there is a practical limit even in the most carefully manufactured delay cable or transmission line to the uniformity of characteristic impedance with length. The minute irregularities in \( Z \), which exist cause small reflections to occur early in the line which may completely mask the reflection due to the terminating impedance when the cable attenuation per unit length is high and the line length large. It is fortunate that for vhf applications, where the transmission line attenuation is rather high, it is generally satisfactory to work with frequency resolutions of the order of about three megacycles.

Transmission-line lengths of the order of 100 feet may then be employed without excessive total attenuation. For frequencies below the vhf range the transmission-line attenuation is conveniently low, so that longer lengths may be used to achieve the finer absolute frequency resolution which is usually desired here. A relative frequency resolution of from 2 percent to 5 percent of the center frequency is satisfactory in most cases. The sum of the lengths of cable contained within the instrument provides a minimum absolute frequency resolution of about one megacycle. For narrower resolutions than this, the addition of a suitable length of external transmission line is required. Similarly, if resolutions of less than about 2 megacycles are desired in the upper portion of the vhf band it will probably be necessary to use a suitable length of lower-loss transmission line than that contained within the instrument.

Operation With Balanced Circuits

For measurement of balanced impedances two methods have proved satisfactory. The first method involves the use of coaxial transmission line in conjunction with a suitable balanced-to-unbalanced transformer to connect the impedance to be measured to the line. The second method makes use of an external length of balanced transmission line of the twin-lead type developed for use with present-day television and f-m receivers. This transmission line may be set up in the laboratory by stringing a suitable length back and forth between pegs located on the walls in such positions that the sections of line thus formed are spaced two or three feet from each other. The balanced impedance to be measured may then be connected to one end of this line, while the other end of the line is connected to the coaxial output connector of the instrument.

Tests have shown that this type of balanced transmission line arrangement then acts as its own balanced-to-unbalanced conversion system to a satisfactory degree. Furthermore, tests have also shown that transmission-line impedances of from 50 to 300 ohms may be used without encountering trouble from second-time reflected waves.

References

SO FAR, from the initial letters of the words Sound Fixing And Ranging, is the code name of a position-determining system. The sound transmissions on which it depends have been heard all the way from Dakar to the Bahamas. The system was designed specifically as a rescue measure in locating castaways at sea or survivors from a ditched plane.

In operation, the castaway drops a bomb weighing 1 to 4 pounds into the water. The bomb has been set to explode at a depth of about three-quarters of a mile. Observers at each of three or more continuously operating receiving stations time the instant of arrival of the peak sound pressure to the nearest tenth of a second. The bomb is then located on one of a family of hyperbolas confocal to a pair of receiving stations. Any two of the three observation points constitutes a pair and the fix, or actual location in terms of latitude and longitude, is the point at which two lines of position cross. The lines of position are generated by the differences in time of arrival of the underwater signal.

The geometry is comparable to that of navigational systems like loran except that the transmitting and receiving stations are interchanged. Accuracy of a fix is within five miles at a range of 2,000 miles.

Sound Channel Effect

The sofar system is based on a phenomenon in the field of sound physics which was verified experimentally during the war. This phenomenon, which has been called the sound channel effect, is the result of refraction of sound waves by layers of water. Practically speaking, because of these refraction effects, there is a horizontal channel deep down in the ocean through which the sound of an explosion can travel for thousands of miles.

Sound waves, like light waves, are bent as they travel through media in which the velocity of propagation varies. Such refraction, caused by velocity changes in the water, is accountable for the sound channel effect.

In the open sea, the velocity of sound is dependent primarily on temperature and pressure. The velocity decreases with decreasing temperature and increases very slightly with increasing pressure. Generally speaking, temperature decreases with depth. At the same time, the hydrostatic pressure increases. The two effects, therefore, work in opposition. This effect can be seen graphically in Fig. 1, which was prepared from studies of the North Atlantic Ocean by the Woods Hole Oceanographic Institution.

At depths of less than about 4,000 feet (this critical depth varies from ocean to ocean), the variation in temperature is relatively more important than the change due to pressure variation. Below this depth, there is practically no change in temperature, but because of increasing pressure the velocity increases. The 4,000-ft level, therefore, becomes a stratum

![Graph](https://example.com/graph.png)

FIG. 1.—Graphic explanation of the sound channel effect upon which the sofar system depends

A hyperbolic position-determining system that depends upon propagation of sound from a bomb exploded at a 4,000-foot depth in the ocean. Accuracy of fixes is within five miles at 2,000-mile range. Continuous monitoring equipment used to time arrival of impulse is described

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of minimum sound velocity. Sounds originating at this depth are refracted downward from above and upward from below. As a consequence, sounds are horizontally channeled.

Sounds originating at a depth of 4,000 ft spread horizontally within the sound channel in much the same way in which sounds in air go echoing down a canyon. This phenomenon has a number of rather interesting effects on the characteristic of the sound wave as it is received at some great distance from the source. For example, a sound ray leaving the source at an inclination to the horizontal has a tendency to cross and recross the horizontal layer indefinitely until it is finally attenuated below the ambient noise level.

As a consequence, sound may theoretically travel by an infinite number of different paths between the source and the receiving pickup—particularly if the separation between sound source and pickup is very great, for example, of the order of several hundred miles. Furthermore, the most direct route, that is, the horizontal path from source to pickup, is also the slowest; because those ray paths inclined from the horizontal lead into strata of higher sound velocity which then bend back some of the rays and produce the phenomenon described above as a crossing and recrossing of the axis of the sound channel.

**Multipath Effect**

It was found rather early in the series of experiments to determine the nature of sound channel transmission that sounds arriving at the receiving element commence at a low intensity, gradually building up to a loud crescendo with a very sharp cutoff—an effect which has been described as the kettledrum. The cutoff occurs, it is believed, when the sounds which have traveled by the slowest route (and at the same time the route of most nearly constant depth) arrive. The cutoff is so sharp that there is practically no possibility of mistaking it, and the instant at which it occurs can be determined to within 0.1 second. The buildup time of the sound wave received after spreading is about 1.2 seconds per 100 miles. Furthermore, the character of a sound-channel explosion is so distinct that it cannot be confused with stray explosions at other depths.

**Design Considerations**

Experimental work demonstrated that the primary specifications for sofar monitoring equipment should include:

1. Sensitive response from 30 to 300 cycles;
2. Self-noise of the amplifiers at an absolute minimum;
3. Provision for switching quickly from one hydrophone to another, with, at the same time, some means for introducing a signal generator for equipment calibration and maintenance;
4. Suitable means for indexing actual arrival time of the signal.
(to 0.1 second) and means for obtaining chronometer correction by introducing WWV time signals.

In order to expedite delivery of the initial group of monitoring station equipment, it was decided to utilize readily available commercial equipment modified as required, supplementing this with those units which required special design or treatment. Figure 2 is a front view of the three racks which house all the apparatus for each station except the bass reflex speaker used for aural monitoring. This equipment provides integrated receiving, recording and timing units for each network station. The equipment is built to operate continuously, day after day, although the incident that it is designed to note and report to the operator takes only a few seconds and may not occur for months at a time.

Figure 3 is a block diagram of the receiving station. Several hydrophones located in the sound channel are connected by submarine cable (sometimes 12 to 15 miles long) to the hydrophone input receptacles at the top of Rack 1, center of Fig. 2. One hydrophone is patched into the operating amplifier channel.

The hydrophone amplifier circuits terminate in a system bus, contained in a unit identified as the Chronometer Time Control and Phone Monitor. The functions of this unit are: to act as a distribution center for the amplified signal from the hydrophone to the recording components; to distribute the time indexing pulses from the circuits controlled by the break-circuit chronometer; to separate the 3-kc tone pulses from the signal when the magnetic tape is reproduced; and to amplify and rectify these 3-kc pulses as a driving source for the paper tape time index relay on reproduction from the magnetic tape.

Recording Data

The recording units, which consist of a dual installation of a graphic sound level recorder and a magnetic tape recorder, are housed in separate cabinets, Rack 2 and Rack 3 (left and right in Fig. 2) cable-connected to the main rack. A time indexing and auto-start, as well as selective input control and monitoring position were added to the basic graphic recorder. In the magnetic tape recorders the speed was made adjustable from one minute normal to a maximum duration of 2.5 minutes without sacrificing the frequency response below 500 cycles.

The automatic switching unit also is housed in Rack 2. It is the function of this unit to switch on the supply circuit to the graphic level recorder motors and the time indexing control relay when a sound channel shot signal arrives at the monitoring station. Figure 4 shows the response of this unit. It is designed to trigger a 2050 thyatron at 175 cycles. Rack 3, in addition to its recording units, also contains the break-circuit chronometer which initiates the timing circuit pulses.

Figure 5 shows the response of a typical amplifier unit with a 500-cycle low-pass filter incorporated in the circuit. With input energy of the order of a microvolt over a narrow pass band from 30 to 300 cycles, the normal undistorted voltage gain is 107 db. At maximum gain with input terminated in 600 ohms, the overall noise is 27 db below that of a typical amplifier.
ohms the overall self-noise of a typical amplifier channel as measured on a vtm (terminated in 600 ohms) is 27 db below 1 volt.

In normal operation the equipment listens continuously. One of the magnetic tape recorder units continuously records the sounds picked up by the hydrophone and erases automatically two and a half minutes later.

With the arrival of energy from a sofar bomb, the visual recording equipment is triggered by the buildup of the amplitude of the received signal, and the station operator is alerted by means of a suitable warning device. Inasmuch as the signal comes in rather slowly, building up to a crescendo before the cutoff, the gating circuit is actuated with ample time for the operator to process the shot reception. First he must press the cue switch which breaks the chronometer control circuit, thus providing a secondary timing mark on the visual tape as well as a 3-kc tone pulse on the magnetic tape recorder. This cue mark, labeled "arrival code" in Fig. 6, enables ready identification of the time to the nearest minute and second.

The operator switches the operating magnetic tape recorder to an inoperative condition. He then turns on the stand-by magnetic tape recorder to record and switches it to the system bus. After restoring the automatic switching unit to stand-by the listening operation of the station continues, and the operator is free to observe the arrival time of the signal as received and recorded. Since this signal has also been recorded on the magnetic tape recorder, the operator can play back this recording and reproduce it on the stand-by graphic level recorder in order to obtain another trace of the received signal.

Normal visual tape speed is 5 mm per second. However, on playback from the magnetic recorder, the operator can adjust the paper tape speed of the recorder to 10 mm per sec to increase the resolving power by a factor of two.

Timing Circuit

A standard Navy break-circuit chronometer is connected to each of the d-c amplifiers which actuate recorder paper indexing stylus. This chronometer breaks the circuit once each second, except the 59th in every minute. The break-second mark appears clearly on the transcriptions shown in Fig. 6. One of the two amplifiers keys a 3-kc oscillator which feeds a signal into the magnetic tape recorders, allowing 3-kc pulses to be recorded on the tape in synchronism with the chronometer.

When the magnetic tape recording is played back to the sound level recorder, the 3-kc pulses are separated from the signal by a bandpass filter, are rectified and are switched to the sound level recorder paper indexing stylus. By the use of the code mark, the sound level recorder paper for a particular shot as originally recorded can be lined up with the sound level recorder paper of this same shot as recorded from the magnetic tape recorder. In this way is afforded an alternate graphic level record of the complete signal, showing the dynamic range. An accurate measure of the time of arrival can be obtained from it. The picture of the shot arrival time evaluator, Fig. 7, shows a typical trace lined up for measurement.

Plans are now well under way for the installation of the first permanent three-station network. The primary responsibility for completing the installation of this network, carrying out the operational tests, and conducting additional sofar research, is being prosecuted by the U. S. Navy Electronics Laboratory in San Diego. One station has been established in Hawaii and tested satisfactorily by means of bombs dropped off the California coast, 2,000 miles distant. The other two will be on the west coast, located in positions suitable for covering the California-Hawaii air routes.

Acknowledgement

Credit for experimental verification of the sound channel effect belongs to the Woods Hole Oceanographic Institution, at Woods Hole, Massachusetts, where Dr. Maurice Ewing was the principal scientist involved in the cooperative enterprise with the U. S. Navy Underwater Sound Laboratory. Among the many who contributed much to this task are J. L. Worzel, J. E. Peoples, R. J. McCurdy, W. S. Latham, W. B. Watkins, and R. E. Maxwell.

FIG. 7—Shot arrival time evaluator for two different recorder speeds. The long vertical line is placed over the maximum signal and tenths of seconds read off to the nearest chronometer time mark.

FIG. 8—Pacific Ocean Air-Sea Rescue network showing experimental stations in California and the Hawaiian Islands.
An Oscilloscope Camera

Continuous recordings of oscilloscope patterns are made on film or paper at speeds from one inch per minute to five feet per second, a range of 3,600 to 1, using electronic motor control. Either film motion or the oscilloscope sweep can be employed as the time base.

Most oscilloscope pictures are made with cameras designed for general photographic purposes and not particularly suited for recording oscilloscope patterns.

The camera to be described is designed for both still and continuously moving film photography. For still photography of stationary patterns, single transients or data records, a shutter with speeds of 1 second to 1/400 second, plus time and bulb, is provided. This shutter must be kept open when making continuous recordings, so an interlock is provided to prevent any possibility of running the film through with the shutter closed or inadvertently leaving it open while taking a series of still pictures.

For continuous recordings, a speed range of 3,600 to 1, from 1 inch per minute to 5 feet per second, is provided by means of a specially designed electronic control and a two-speed clutch. The electronic control provides smooth, uniform speed continuously variable by means of a single-dial control from 1 inch per minute to 60 inches per minute, or 1 inch per second to 60 inches per second, depending upon the position of the clutch.

The clutch is shifted by a simple push-pull knob which inserts or removes a 60-to-1 gear ratio. It may be operated while the camera is running, so that it is possible to set up for a recording on low speed and shift to high at the desired instant, giving extremely fast acceleration of less than 0.01 second to reach maximum speed.

Many types of mechanical drives were tried in the development of this camera, including change gears, cone pulleys and variable cone, but it was found that the electronic control not only gave better performance but was cheaper to produce. Furthermore, the electronic control gave a continuously variable speed control which maintains any set speed without fluctuation due to variations in load and line surges. Such precise control is absolutely essential to be sure that any variation in the recorded pattern is due to actual changes in the oscilloscope pattern and not due to fluctuations in film speed.

To give an accurate record of the exact rate of film movement, a small neon lamp is mounted so it will record along the edge of the film when fed suitable voltage.
When taking still pictures, the film is advanced manually by means of a lever provided with an adjustable stop which permits advance of 1/ to double a standard 35-mm frame height (5 to 39-mm). However, if it is desired to take a large number of stills in succession the continuous film drive can be used by adjusting it to a speed which will separate successive pictures by the desired amount and by blanking out the screen with Z-axis modulation except during the interval when recording is desired. The blanking signal can be removed by the transient to be recorded, or by a relay or snap-action switch.

The camera is mounted on top of the oscilloscope with a reflecting mirror system in a light-tight housing to bring the scope image up to it. This periscope type of mounting gets the camera out of the operator’s way, and provision for simultaneous viewing and recording is easily provided by a port over the lower mirror.

A filter excludes most extraneous light which would affect the film when the port is open for viewing, and a guillotine shutter closes the port entirely at other times. A rubber ring at the lower end of the periscope fits up against the cathode-ray tube to exclude all light and at the same time locates the mount accurately so that no focusing is required. The camera is pre-focused at the factory.

Data Record

An illuminated data card mounts on the front of the periscope by means of spring clips, when not in use. Handwritten data may be put on the finely ground Lucite surface with an ordinary pencil and removed with a pencil eraser.

The camera uses standard 35-mm film or paper, and has an internal capacity of 100 feet, with provision for mounting a 1,000-foot magazine externally. With the 100-foot reels, the camera will operate from 20 seconds at the maximum speed to 20 hours at the minimum speed; with a 1,000-foot magazine it will operate from 3 1/2 minutes to 81 days, respectively.

A footage indicator shows the number of feet exposed regardless of whether 100-foot reels or 1,000-foot magazines are used, or whether the film is advanced manually or by the motor. The camera may be loaded or film removed in daylight.

A coated f/2.8 lens is supplied as standard equipment but an f/1.5 lens is optional. With the f/2.8 lens and accelerating potentials of 3,000 volts on a type 5CP11A cathode-ray tube, writing rates up to 0.8 inch per microsecond can be recorded. With a type 5RP11A tube and 29,000 volts accelerating potential, rates up to 70 inches per microsecond can be recorded. The corresponding writing rates with the f/1.5 lens are 3 and 270 inches per microsecond respectively.

Electronic Control

The circuit used in the electronic speed control of the Oscillo-Record Camera is shown in Fig. 1. A type C1B thyratron supplies the armature voltage to the motor. The control voltage is obtained from a 117Z3 rectifier with an OB2 voltage regulator used to eliminate line-voltage fluctuation effects. Bias voltage is obtained from a selenium rectifier and two other selenium rectifiers supply the motor field. A second OB2 maintains constant bias voltage. Current in the field of the motor is maintained constant with a current-regulating tube. The 117Z3 also supplies a time-delay relay which prevents application of power to the thyatron until it has had sufficient time to warm up.

In addition to the d-c applied to the grid of the thyatron to control the speed of the motor, a small amount of a-c is superimposed on it. With the d-c alone, the smallest portion of a cycle during which the thyatron can fire, if it fires at all, is 1/ cycle, with a maximum of 1 cycle.

By superimposing a small amount of a-c properly phased it is possible to cause the firing to occur much later in the cycle so that current is passed during only a very
small fraction of a cycle when the power requirements are low. In this way, in place of the motor receiving a large slug of power followed by several cycles with no power, a small amount of power is supplied to it each cycle. This practically eliminates speed fluctuations which would otherwise cause uneven film speed. It also provides excellent speed control over a much wider range of speed and load conditions than would otherwise be possible.

Methods of Recording

The fundamental recording techniques possible with the camera are: single-frame exposure on stationary film, continuous-motion photography employing the film motion as a time base (which we shall refer to as the first method), and continuous-motion photography employing the oscilloscope sweep as a time base, transversal to the motion of the film (which we shall refer to as the second method).

A paper written in 1944 thoroughly discusses the various factors generally involved in oscilloscope photography. In this paper, the relationships between the luminescent-spot writing rate, the lens aperture and optical-magnification ratio were derived and methods of calculating exposure were given. A Du Mont camera specifically designed for single-frame exposure photography only has recently been placed on the market. The Oscillo-Record Camera also has provision for this type of recording in addition to its primary use as a continuously moving film camera.

This method of recording can be used for the photography of either highly repetitive phenomena or single-transient phenomena where the duration of the transient is not longer than the longest sweep of the oscilloscope used, unless one wishes to photograph only individual parts of the long transient.

In photographing repetitive phenomena, the camera shutter speed should be set so that it opens for at least the duration, and preferably longer, than the time of one complete cycle of the oscilloscope sweep. The exposure, of course, should be sufficient to obtain useful negative density for the highest writing-rate components of the signal.

To photograph single transients, the camera shutter is best set at bulb or time, opened before the transient occurs, and closed after the transient has disappeared. For this purpose, an oscilloscope having a triggered sweep and automatic beam control is preferred. With such an instrument, the screen of the cathode-ray tube is blank before the transient occurs. When the sweep is initiated by the transient, the trace is blanked in for the duration of the sweep, and there is no fogging of the film by a luminescent spot or line before or after the transient.

When very long exposures are to be used with high-speed panchromatic film, fogging of the film may result due to a very weak glow coming from the heater of the cathode-ray tube. The fogging can be prevented by the use of a blue filter in front of the cathode-ray tube screen.

Film Speed Time Base

An example of the method of recording that uses the film travel as a time base is shown at the top in Fig. 2. The two pulses which appear recurrently are seen to have constant spacing, indicating the constant speed of the film. To make such a recording, the signal must appear as a horizontal deflection of the spot on the cathode-ray tube screen since the motion of the film in the Oscillo-Record Camera is vertically upward. This is best accomplished by reversing the horizontal and vertical deflection plate connections to the tube or by rotating the cathode-ray tube clockwise through 90 degrees. By doing this, rather than just feeding the signal into the X amplifier, the signal may be observed before the recording is started, using the oscilloscope sweep. Then, when all adjustments are made, the sweep is switched off and the camera motor is started.

This method of recording is useful where the signal to be photographed occurs too slowly for an observer to study, even on a long-persistence screen, or when the signal consists of a non-uniform recurrent phenomenon, or if the signal occurs at random.

At the maximum camera speed (60 inches per second), the highest frequency which can be recorded is limited by the resolution of the film and the luminescent spot size. With high-speed film emulsions, such as Eastman Kodak Linograph Ortho and Linograph Pan, the limit frequency for this method of recording is about 10,000 cycles.

For a particular cathode-ray tube screen, the frequency limit due to persistence, for continuous motion recording, is known as the blurring limit. This limit is approximately 200 kilocycles for a P11 screen and is therefore well above the resolution limit at 60 inches per second. When a time reference is desired, a signal voltage of known frequency may be connected to the small neon bulb in the camera; a narrow time-marker track is then recorded at the edge of the film.

The second method of recording, that of recording the oscilloscope sweep across the width of the film, is illustrated by the bottom trace in Fig. 2. The pulses shown are the same as at the top and were obtained by differentiating a sawtooth wave. Both oscillograms were made on the same strip of film by running the film through the camera twice; recording once by the first method, with the beam positioned to one side of the cathode-ray tube screen, and then recording by the second method, with the beam positioned to the other side of the screen.
Although the film was run at the same speed in both cases, the distance between pulses at the bottom in Fig. 2 is much greater and, had the signals been more complex, this additional space would have been necessary. As stated previously, it is only necessary to run the film at a rate of speed sufficient to provide some separation of the successive sweeps and the signals imposed thereon. The angle at which the sweep base-line appears is determined by the ratio of the oscilloscope sweep speed and the film travel speed. When the film speed and sweep speed are equal, the base line records at a 45-degree angle, and when the sweep speed is much greater than the film speed, the base line is essentially perpendicular to the film length.

The film speed at which the successive sweeps, and the signals imposed on them, are just separated, can be calculated from the formula

\[ S = f_s h/6 \]

where \( S \) = the necessary film speed, \( f_s \) = the sweep frequency, \( h \) = the height of the signal peak appearing on the cathode-ray tube screen.

The factor, 1/6, is the optical-reduction-ratio of the camera lens. In many cases where the signals appear immediately below one another the film can be run slower than \( S \), so that one signal appears inside the other or interlaces without overlapping (as in Fig. 9).

When the signal being recorded is a sine wave or any other pattern having negative as well as positive amplitudes, and the peaks of the signals on the successive sweeps do not interlace, then \( h \) will have to be taken as the peak to peak amplitude. The highest frequency that may be recorded by this method is limited only by the maximum sweep speed available and the maximum photographic writing rate of the oscillograph. (Maximum photographic writing rate is defined as the maximum writing speed of the luminescent spot on the cathode-ray tube screen, which produces a recording density of 0.1 above film fog at an optical object: image ratio of \( M = 1 \) with a lens aperture of 1/1 and with a high sensitivity film emulsion processed in a high contrast developer.)

Occasionally, certain phenomena are observed which have extremely rapid variations at the beginning and then undergo a slow rate of change with a duration many times longer than the initial transient. To record such phenomena completely, with sufficient detail for analysis, it would be necessary to run the film at extremely high speeds. Besides being uneconomical, this procedure would make it difficult to study the latter part of the signal which, since it has a slow rate of change, would be spread over a great length of film.

It may be possible in a few cases, by watching the pattern through the camera's viewing eyepiece, to switch the film speed from high to low by means of the speed-change clutch but this is usually impractical. The second method of continuous-motion recording might then be used, but the continuity of important parts of the phenomenon may be lost due to the many successive sweeps.

**For Transients**

In a third method of continuous-motion recording, a single driven-sweep of the oscilloscope is used to rapidly deflect the spot vertically upward at the start of the phenomena, as the film in the camera moves slowly in the same direction. The signal is impressed horizontally on the spot; at the end of the single sweep the spot is not blanked out but remains in position. The effective speed of the time base during the sweep is equal to the vector sum of the optically-reduced sweep speed and the film speed and, after the sweep, is equal to the film speed alone. Sweep and film speeds should be chosen to provide optimum spread of the rapid transient and the slow rate of change part respectively.

Only one time-base discontinuity then exists at the end of the sweep travel. Even this discontinuity can be avoided by the use of an exponential sweep rather than a linear sweep. That is, the exponential curve of the sweep rate can be made asymptotic to the film speed. Where a number of high-speed transients occur at random during an otherwise slow rate-of-change phenomenon, the oscilloscope sweep could be made to trigger off only during the transients and rapidly fly back to the original position to record the slow part. The use of timing markers is mandatory to achieve the proper time perspective when studying the recording.

The effects of a heavy load on the performance of a synchronous motor is shown in Fig. 3 and 4. The oscillograms show the starting current in the motor from the in-
Timing markers are unnecessary since each current cycle represents 1/60 of a second. Figure 4 shows that the motor switches to the starting winding 4 times in ½ second because of the heavy load. After the last switching occurs, the motor armature hunts for approximately 3 more seconds before stability is reached. The total elapsed time from the instant of switching on the motor to the time of stability is approximately 4 seconds.

**Fluorescent Lamp Analysis**

Another application of the oscilloscope and continuous-motion camera in the electrical industry is illustrated in Fig. 5. This oscillogram shows the starting voltage and current characteristics of a fluorescent lamp fixture. The simultaneous recording of voltage and current was obtained by the use of a 5SP dual-beam cathode-ray tube. In Fig. 5, the upper trace represents the voltage across the fluorescent tube and the lower trace represents the total current drawn by the fixture. Again, film motion provides the time base.

The two luminescent spots on the tube screen were positioned in a horizontal line to obtain the proper time relationship between voltage and current in the recording. When the switch is turned on, a voltage immediately appears across the tube and a small amount of current is drawn by the entire fixture. The lamp fixture contains the fluorescent tube, a series-inductive ballast, a gas-filled starter containing a bimetal element, and a capacitor which is connected in parallel with the starter and tube. At first the current is limited by the resistance of the starter, the ballast, and the filaments at the end of the fluorescent tube. After approximately 1.4 seconds, (determined from number of 60-cycle peaks) the voltage across the tube suddenly drops, while the current drawn by the fixture rises to a high value. This is caused by the heated, bimetal starter short-circuiting the capacitor. The current is now limited only by the filaments and the inductive-ballast.

The filaments rapidly heat up as the bimetal in the starter cools.

The oscillogram of Fig. 4, made by the first method of continuous-motion recording, clearly shows the heavy starting current and the automatic switching from starter winding to running winding. This switching and subsequent hunting, visible as a modulation of the motor-current amplitude as the motor builds up enough torque to carry the load, can easily be timed.

constant the switch is turned on to the time that the motor has reached its synchronous speed.

Figure 3 is a single-frame photograph and, although the oscillogram provides some indication of the transients that occur, it is not possible to analyze the phenomenon unless a series of pictures of sections of the overall characteristic is taken.
After another 1/10 of a second, the bimetal cools sufficiently to contract and unshort the capacitor. This causes the current through the inductive ballast to drop, and the collapsing magnetic field causes a resonant voltage surge to appear across the capacitor and tube, as indicated by the first voltage surge-transient in the oscillogram.

During the next 1/2 second, about 5 more voltage transients occur, corresponding to flickers in the tube, until the fluorescent tube finally starts and remains on. The end of the recording shows a constant voltage being maintained across the tube, and the current, which is limited now by the ballast and the resistance of the gas in the tube. The slope of each peak of the voltage characteristic is the result of the charging and discharging of the capacitor during each cycle.

Such a recording provides the lamp manufacturer with an excellent means of evaluating the action of the gaseous starter, the tube characteristics and the optimum constants for the ballast and capacitor. Since the life of a starter and fluorescent tube depends to a great extent on the number of times that starting occurs, it is of advantage to be able to study these transients in detail.

Frequency Drift

A method of recording oscillator drift by time is shown in Fig. 6. The oscillogram was obtained by a variation of the second method of continuous-motion photography. The recurrent sweep of the oscilloscope was locked to a standard frequency and the output of a drifting oscillator was connected to the Z-amplifier input. The sweep appears as a line across the film with a portion blanked out by the drifting oscillator signal.

If the oscillator frequency and phase are constant with respect to the standard frequency, the blanking will occur at the same point and appear as a straight path along the length of the recording. Notice how the oscillator drifts rapidly at first and then becomes relatively stable. A frequency-drift record such as this can be extended to over eight days on a 1,000-ft. magazine.

The camera provides a means of obtaining voltage time curves of power lines, power supplies, voltage stabilizers and regulators. The output voltage of an OB2 gas regulator tube is shown in Fig. 7. This characteristic was obtained by rapidly varying the load on a regulated supply from 0 to 10 milliamperes. From a curve such as this, the voltage recovery time of a voltage regulator may be determined for either rapid or slow charges in load.

Nuclear Physics

One of the simplest applications of the camera and oscilloscope is to record the output of a particle counter tube. Figure 8 shows an oscillogram of the output pulses of a gamma-ray counter connected to an oscilloscope. The random nature of the pulses and the apparent showers of cosmic rays is recorded. By running the film faster or by using the oscilloscope-sweep recording method, the pulses can be further separated, and the number during any time interval can be counted by using a time-marker track.

Biology and Physiology

Figure 9 is a typical biological recording showing the action potential of a frog's sciatic nerve in response to electrical stimulation at a repetition rate of 100 per second. An electrical-pulse stimulator was used to stimulate the nerve and simultaneously initiate the driven sweep of an oscilloscope at a pulse repetition rate of 100 per second. The film was run at about 3 inches per second, each successive reaction occurring beneath the other. At the start of the recording a portion of the nerve had been dipped into a powerful nerve poison and the reaction of the nerve to the stimuli gradually diminished.

The bottom portion of the recording shows the diminished response caused by poisoning of the nerve. Actually, the entire recording occupied about 100 feet of film so only small portions of the beginning and end are shown. The trailing edge of the stimulating pulse can be seen at the left of each sweep. The recording was obtained at the Columbia Medical Center in New York City with the permission and kind assistance of Dr. H. Grundfest.

Applied Acoustics

Recently, methods have been tried to teach the deaf to see sounds by sight-reading of patterns on luminous screens. An extension of this method to record these patterns on photographic paper is an obvious consideration and perhaps this will some day lead to musical libraries for the deaf.

With an oscilloscope and continuous-motion camera, acoustics design engineers now have a new means of observing the location and measuring the duration of sound reflections from walls or objects in auditoriums or sound studios. Measurement of reverberation time is one of the difficult problems with which the acoustics designer must cope. Usually the reverberation time is calculated mathematically by measuring the absorption surfaces of every unit in a room and applying acoustical absorption coefficients to these measurements, including them all in a formula. Some designers make use of tables and nomographs to simplify these calculations.

A continuous recording showing the reverberations in a closed room caused by a sharp sound impulse is shown in Fig. 10. The complete sound decay is not shown because of lack of space. As applied to the problems of acoustic design the reverberations may be picked up by a very directional microphone, and the recording would then show the amplitude and location of the source of most echo. Proper placement of sound damping materials is then facilitated and an over-all reverberation time recording may be made.

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www.americanradiohistory.com
Electronic computer is adjusted to simulate an industrial operation and its control. Engineer then manipulates system to determine optimum design. To simplify computer construction and increase speed very fast time scales are used in computing circuits and synthesizes of idealized systems were made. Hydraulic analogs of thermal systems were built from which transient behavior could be studied readily by direct measurement.

Beginning in 1936 the writer developed a complete computational Automatic Control Analyzer based on interconnected high-speed models of both process equipment and its associated controller, which took the form shown in Fig. 2A. Different masks depicting the processes and controls being studied were superimposed on the panel to facilitate visualizing the system; the in-

**FIG. 1—Electrical analog (A) simplifies design of pneumatic controller (B)**

**Designing Controllers by Analogs**

As long as a process remains in the steady state its analysis is relatively simple. About two decades ago engineers in the process industries, particularly those concerned with instrumentation, became concerned with the dynamic nature of their processes and the equipment, especially under automatic operation. Owing to the complexity of such problems, early studies were empirical. Mathematical analyses and

tROLS, SERVOMECHANISMS OR POSITION FOLLOWERS, NAVIGATIONAL CONTROLS, AND STABILIZERS FOR POWER PLANTS.

**USE OF ANALOGS makes it possible to experiment readily with devices or phenomena under changes of scale or after transformation of their variables.** All models, whether they are the small-scale replicas used by civil engineers, model airplanes in the wind tunnels of aerodynamic engineers, miniature boat hulls in the towing tanks of naval architects, or the equivalent circuits used by acoustical engineers to study microphones, are analogs. Dynamic analogs can be highly complex assemblies such as differential analyzers, abstractions such as mathematics itself, or direct simulations of the process.

The great advantage of analogs as devices for solving engineering problems is that they are simple. Electrical analogs of mechanical, thermal, or other systems can be assembled and adjusted quickly and easily. For example, in designing a pneumatic control, the analogous electrical network of resistors and capacitors of Fig. 1A was built. As a suitable design evolved from experiment a more formal network was constructed. Finally, after experience in the laboratory under many control circumstances, the actual pneumatic control of Fig. 1B was built. Much time and costly machining were saved using the easily modified electrical analogy.

To facilitate making electrical analogies and to perform the broader functions of analog computers in problems dealing with automatic controllers, the Analaut has been developed. It is a flexible electronic instrument for study and demonstration of regulatory systems such as industrial process con-

**By GEORGE A. PHILBRICK**

CONTROLLERS By Analog

Instrument is still in use. The same basic technique, developed to a higher degree, is employed in the modern instrument shown in Fig. 2B. It is used for designing controls and also for predicting the necessary type of control for a proposed installation and the adjustment for optimum performance of complex systems.

Whereas controllers can be designed by mathematical analysis provided the system is not prohibitively complex or by testing in the completed plant if adjustments to the system can be made safely and economically, it is simpler to represent the closed control-process loop by an analog. The heavy lines of Fig. 3A show the loop whose properties are to be studied; the rest of the diagram shows the elements of the analog analyzer. The control manipulates the plant input \( m \) in recognition of the unbalance \( u \) so as to cause the regulated variable \( v \) to follow its desired value \( v^* \), thus reducing the absolute value of the unbalance \( u \) to a minimum near zero. All the variable and parameters in the analog are the counterparts of those in the actual plant.

In the analog computing system, the controller and the plant are represented by electronic model assemblies, a basic circuit of which is shown in Fig. 3B. The essential loop variables are transformed into measurable voltages, each of which can be related to the corresponding plant variable by an appropriate scale factor such as pounds per square inch per volt (to convert to pressure in a pneumatic control).

For representing the desired value there is a manually adjustable steady component and an optionally inserted variable component for disturbing the system. The flexibility of the instrument permits comparing controlled and uncontrolled responses of the simulated system, studying hysteresis and excursion limit effects, inserting conventional regulating functions with proportional, derivative, integral, and second integral effects, and inserting special features from external circuits. Response of the analog is determined by disturbing it with a recurrent pulse and observing the transient on an oscilloscope. The time scale of the analog is made short so that the loop will have returned to equilibrium before the next pulse and so that the computing elements, especially the capacitors, can be conveniently small. The disturbance can be inserted at any desirable point in the loop.

Usually the variations around the simulated loop are displayed as functions of time on the oscilloscope, with suitable timing markers if necessary. However, by plotting one variable against another parametric plots of great interest can be obtained. Figure 4 shows curves plotted against time, and a parametric curve (for a more complex system) by way of comparing the two types of displays. The parametric method shows the stability and phase relations among significant loop variables.

With such an analog of the process an analog of the appropriate controller can be developed and its suitability observed from the transient response obtained. By manipulating plant or control parameters that are likely to vary during operation, critical conditions can be found and evaluated. With this information the control is practically designed. The fast operating time of the analog permits observing the complete transient response as an adjustment is made, so that a com-

FIG. 2—Circuits of analog computer simulate plant and controller

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complete study of a system can be completed quickly.

**Basic Circuit**

For special purposes the analog might be arranged differently than the one described here, but the same basic circuit can be used. Most of the complete analog system is based on conventional electronic techniques and so need not be reviewed. However, it should be pointed out that, of the possible mediums for building analogs, the convenience and flexibility of electronic circuits makes them excellent for experimental purposes. If one stays well above the noise and drift thresholds, there is no practical limit to the precision that can be obtained if the needs justify the effort. At the opposite extreme, tube noise can be employed for random excitations where statistical evaluations are to be made.

Figure 3B shows a useful general-purpose circuit for use in electronic analogs. Considered as an amplifier, the circuit is directly coupled for handling direct current but can operate to frequencies that are high compared to the fundamental frequency employed in the disturbance. The input impedance as seen from $e_i$ is very high. The internal impedance of the circuit is also relatively high so that for reliable results substantially no current can be drawn from the output by the load. Thus, because no current can be drawn at the output $e_o$, the circuit is usually followed by another of the same kind.

A fixed source of screen excitation is provided, giving constant gain to zero frequency. The same voltage source provides a reverse current mode of operation in the computing portion of the circuit. Dropping-resistance $R$ is chosen near the average effective d-c plate resistance of the tube. A peculiarity of the circuit is that there are no paths from the tube electrodes to ground other than those through the elements $Z_1$ and $Z_2$, thus the currents through these elements are equal and opposite. As the grid voltage approaches cutoff, current circulates through $Z_1$ and $Z_2$, in that order, making the output $e_o$ positive. At the opposite extreme, the current circulates in the reverse direction making $e_o$ negative. Because the voltage across $Z_2$ follows $e_i$, the output $e_o$ is dynamically related to $e_i$ in a manner dependent almost entirely on the values of $Z_1$ and $Z_2$.

If $Z_1$ is purely resistive, the current in $Z_2$ corresponds to the input voltage $e_i$. This property is useful in various ways; for example, $Z_1$ can be the input terminals of a four-terminal filter, in which case the current into the filter is directly manipulable with no expenditure of input energy.

If $Z_1$ is also purely resistive and equal to $Z_2$, reversal of sign or 'minus one' operation results. With $Z_1$ and $Z_2$ replaced by a single linear potentiometer, a distortionless inverting amplifier having a useful adjustment is obtained. With the tap in the center, the gain or transfer function is nearly unity. Deflection of the tap in one direction gives a transfer or gain of $G$ and an equal deflection in the other direction gives a gain of $1/G$.

With $Z_1$ still purely resistive, if $Z_2$ is purely capacitive, the circuit is a reasonably good integrator with a time constant $R C_1$. In the control analog computer for which this circuit was developed, the computing interval is typically four milliseconds, so that the time constant of the integrator can be made long compared to the computing time using components of reasonable size. If the elements are reversed the circuit is a differentiator. In fact there are numerous dynamic characteristics that can be obtained using different combinations of impedances for $Z_1$ and $Z_2$.

The nominal equation for the circuit is given in Fig. 3B.

In operating the circuit, care must be taken to prevent saturation of the tube or components. For example, a typical fast integrator will integrate to a limit in a millisecond with one volt remaining on the input. However, such a device can be tested and calibrated by applying a square wave of about five volts amplitude to the input, with an additive adjustable d-c bias. The bias can be set to bring the effective input level to zero and will keep the output within the limits of saturation. Under these conditions a sharp and straight sawtooth will be produced in the output by a sharp square wave at the input; the amplitude of the output will be dependent on the input.

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**FIG. 4**—Reproduction from oscilloscope tracings show how optimum response of plant can be determined by systematic adjustment of various controller adjustments.

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**FIG. 3**—(A) Block diagram of automatic control computer, and (B) basic circuit of used in the analog computer elements.
on the amplitude of the input, its period, and the time constant of the integrator. Other types of computing networks require other techniques for calibration and adjustment, but this example illustrates the simplicity of the methods.

The combinations possible with this basic circuit provide a powerful general technique for constructing computers and control analogs. Most dynamic conditions can be reproduced with this circuit and combinations of passive networks. For a small project, or for initial experimentation, the basic circuit using batteries is especially appropriate because well-regulated power supplies are unnecessary. As used in the control analog computer, common power supplies and auxiliary switching and calibration circuits are necessarily added to the basic circuit.

Industrial Applications

The first step in using the analog computer for designing an automatic control for an industrial plant or process is to reduce the actual system to its electrical model. In many processes it is possible to recognize the electrical analogs from the equipment and to compute parameters from known data or by simple tests. Distributed parameters can usually be represented to useful accuracies with a few lumped sections.

As mentioned above, if a direct approach is not feasible the dynamic response of the plant can be determined by introducing a known disturbance at the input or manipulated variable and observing the disturbance produced at the output or regulated variable. The plant must remain in a sufficiently undisturbed condition, aside from the intentional disturbance, or the measurement must be repeated often enough to eliminate random effects. Where the response depends on the condition of the load or there are other nonlinearities, a series of tests may be necessary.

The record of plant response is then duplicated to a much faster time scale on the control computer, with special attention to duplicating delay and the initial portions of the response. Once the plant response has been provided in the analyzer, the appropriate control can be quickly determined.

Two typical problems illustrate more specifically how the analog method of designing controllers is carried out in practice. Figure 5 shows a portion of a high temperature pasteurizer; the main heat exchanger is at the right and the instrument panel in the near background. Several interlocking controls are included in the plant to assure holding every drop of milk at a maximum temperature for a minimum interval, avoiding over-heating. The crucial regulation problem is to control the hot water temperature in the final milk heater stage at a point chosen for its significant relation to the milk temperature by manipulating a steam valve elsewhere in the system. Under manual operation with water replacing the milk to avoid accidents, a record was made of the temperature variations resulting from a sudden known change of the steam valve. From this information the settings for a proportional derivative-integral control were determined on the analog computer. High performance was obtained from the predicted settings and further adjustments were unnecessary.

In another type of problem the crucial regulated variable was the surface temperature of the central roll of a plastic calender. The temperature was measured electronically by the floating head shown in Fig. 6 and recorded on a self-balancing capacitor bridge instrument. The manipulated variable was steam pressure under control of an auxiliary or cascaded regulator. By making a manual change in the steam pressure, the plant response was obtained on the temperature recorder. The analog of the plant was then set to duplicate this response and several control methods studied. The best type control mechanism thus determined was installed and set to the predicted dynamic adjustments, giving satisfactory control immediately.

Besides providing a design and operating tool in the field of automatic control, this type of analog has also proved useful in instructing plant personnel and as a college lecture room demonstrator and laboratory test set. Acknowledgement is made to the engineers of The Foxboro Company for whom the early developments of these techniques were made, and to Prof. J. A. Hrones of MIT for encouragement in their application to the pedagogy of automatic controls.
Electron Diffraction for Film and Surface Studies

Crystalline structures of thin films can be determined by diffraction patterns produced when electrons are directed through the material. Surfaces of materials are studied by patterns of reflected electrons. Applications and equipment for the technique are described.

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Although oxidation of a magnesium disc was not visible, this reflection electron pattern shows the surface presence of magnesium oxide.

The electron diffraction instrument is a research tool designed to aid physicists in observing and measuring conditions on surfaces, or in thin layers, of materials such as metals, ceramics, and plastics. In it a beam of electrons is directed at the material being studied and the resulting diffraction pattern is observed visually on a phosphorescent plate or photographic records are made. This pattern consists of rings, the diameters, intensities, and sharpnesses of which indicate composition, orientation, and atomic arrangement of crystalline material.

Types of Applications

The electron diffraction technique is used for investigating corrosion, catalysts, lubricants, surface deposits, pigments for paints, inks, dyes, graphite, and many phases of metallurgy. The diffraction patterns are similar to those produced by x-ray diffraction. The essential difference is that diffraction patterns resulting from reflecting electrons from the test samples indicate conditions only on surfaces of samples, while diffraction patterns from electrons projected through test samples indicate internal conditions of thin films. X-ray diffraction indicates the condition throughout the entire specimen.

Comparison may be made between electron diffraction patterns obtained by various users of electron diffraction equipment, or with the card index of x-ray diffraction patterns maintained by the American Society for Testing Materials.

The electron diffraction instrument is used in research developing better filaments. It is now generally known that primary and secondary electron emission is a function of the surface conditions. The instrument has been used in the General Electric Research Laboratory in the study of better material for secondary emission. In this case, a magnesium-silver alloy was heated, after which the surface was examined by the electron diffraction instrument and found to be magnesium oxide, which is good for secondary emission.

In studying the cause and prevention of corrosion, it is essential to determine its nature in very early stages. Electron diffraction will detect minute changes and thus will help to identify chemical changes before they are visible under a microscope. By studying corrosion resistance of alloys in different atmospheres, the instrument has aided in selecting the best material for gas-turbine buckets.
Catalytic action is a surface phenomenon. Electron diffraction photographs reveal the presence of the very thin layer of material responsible for this action. Lubrication is a function of the surface film. Hence the electron diffraction instrument is important in determining good lubricating films and in controlling processes for their production. In addition, it is useful for studying surface changes on bearings and engine cylinder walls.

Method of Operation

The instrument is mounted on a portable table. The major components are an electron gun that produces the electron beam, an apertured anode that accelerates and positions the beam, a magnetic lens for focusing and positioning the beam on the specimen, the specimen chamber with manipulator for adjusting the position of the specimen, a mechanical shutter for controlling exposures and provided with a fluorescent coating for visual indication of focus, a camera box with fluorescent screen for viewing the diffraction pattern and with space for five 4 by 5 inch photographic plates for recording the pattern, the evacuating system, and the power supply.

Either of two apertured anodes, which are grounded and thus maintained at a positive potential relative to the filament, can be brought into position and adjusted mechanically for proper positioning of the electron beam. One aperture admits a beam of 0.002-inch diameter, the other 0.008-inch diameter.

The specimen chamber is about 6.5 inches square by 8 inches deep. Samples are admitted through a door 6 inches in diameter. Three of the faces of the chamber are provided with glass ports 3.5 inches in diameter. These glass windows are interchangeable with metal plates or other accessories. One accessory, a specimen manipulator, is normally mounted on the top port. Another accessory that can be mounted on the front port when required, is an auxiliary electron gun for neutralizing charges that collect on certain specimens.

The specimen, the surface characteristics of which are to be studied, is mounted on the specimen holder. After vacuum has been established and electrons are passing through the apertured anode to form a beam, the operator focuses the beam on the shutter by means of the magnetic lens until, by adjustment of the apertured anode, the unfocused and focused beams coincide. Specimen adjustments are made with the manipulator until a diffraction pattern is obtained on the fluorescent screen. The distance of the specimen from the shutter is determined by an accessory telescope, which can be mounted on the specimen chamber. When a photograph of the pattern that has been focused on the fluorescent screen in the camera box is desired the beam is interrupted by the shutter. A photographic plate is lowered from the upper plate holder by actuating a push button. The shutter is then opened long enough for the exposure. Then the plate is dropped into the lower plate holder by operating another push button.

The evacuating system consists of a mechanical pump and an oil diffusion pump, separately mounted beneath the assembly. A valve seals the chamber from the pumps during specimen changes or loading and unloading of the camera. Vacuum is measured by a thermocouple gage. Time-delay relays prevent premature application of voltage.

The power supply, furnishing accelerating potential to the main electron beam, is adjustable from 20 to 50 kilovolts and is stabilized and ripple-free to better than 0.1 percent. A high-frequency supply furnishes current for the filament of the electron gun. A zero-center instrument indicates any variation of the high potential greater than 0.05 percent.

PATTERNS CAN BE OBSERVED VISUALLY OR PHOTOGRAPHIC RECORDS CAN BE MADE

Elements of electron diffraction instrument show its operating principle

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Technique for Distortion Analysis

Modification of clipped sine waves by circuits under observation is displayed on a cathode-ray oscilloscope for quick analysis of audio response. Typical patterns are given, and a simple equipment comprising biased crystal rectifiers is described.

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Distortion in a linear circuit can be separated into two general categories: nonlinear distortion; and frequency distortion. Nonlinear distortion is caused by impedances that are functions of current or voltage. A sine wave introduced in such an impedance will be distorted in waveform because of the harmonics generated. These nonlinear impedances are generally resistive, like those encountered in a tube or crystal.

A sine wave introduced in a circuit containing only reactance will not be distorted in waveform, but may be changed in phase and amplitude. This phase shift and amplitude change may also vary with frequency. Harmonics are not generated in this kind of a circuit, though they may be selectively diminished or accentuated.

Circuits in general have both nonlinear distortion and frequency distortion. The amount and kind of distortion that can be tolerated in a circuit depends on its use. Communication circuits, in which intelligibility is paramount, can have considerable distortion, whereas broadcast circuits should have negligible distortion.

Measurement of Distortion

There are various ways of determining distortion in a circuit in order to indicate its suitability for a particular application. One well-
known method utilizes the circuit response to a sine wave. Nonlinear distortion is measured by noting the percentage of harmonics generated in the circuit for various frequencies and amplitudes. The effect of reactance is measured by the variation in gain as the frequency is varied.

The interdependence of the two kinds of distortion is not always clearly stated. The harmonics generated by nonlinear distortion will be influenced by the frequency characteristic, so that the sine wave analysis is correct only if either the nonlinear, or the frequency distortion is found to be negligible.

The sine wave analysis is of great utility however, in that definite and reproducible quantities are obtained. In experimental, and developmental work it is sometimes tedious and time consuming.

**Standard Waveform Method**

A quick and simple qualitative analysis of a circuit can be made by noting the change in shape of certain standard waveforms. Waveforms with a high harmonic content are particularly suitable for...
investigating the effect of frequency distortion in wide-band circuits. One example is the square wave, which is of great utility in the investigation of video circuits. The square wave can be considered to simulate an extreme case of the kind of signal the circuits are required to handle.

Most signals encountered in audio circuits are complex in that they are composed of a fundamental and its harmonics. A test waveform that simulates such a signal, and that has been particularly useful in audio circuit analysis is shown in Fig. 1A. It is a portion of sine wave and is therefore called a clipped sine wave. Two such clipped sine waves can be placed back to back, as shown in Fig. 1B. This waveform has been termed a double clipped sine wave.

**Clipped Sine Wave**

One great advantage of the clipped sine wave is in the economy and simplicity of its generator for which the circuit diagram is given in Fig. 2. A sine wave of the proper amplitude, is fed into the unit and clipping is done by means of biased crystal rectifiers.

The frequency range of the driving voltage is determined by the kind of equipment being tested. For high quality circuits, the frequency range may be approximately 100 to 10,000 cycles. For communications circuits, it can be 300 to 3,000 cycles. The frequency range need not be continuously variable. For most purposes, the discrete frequencies of 100, 300, 1,000, 3,000, and 10,000 cycles will suffice.

From Fig. 1A it is seen that the clipped sine wave is composed of successive flat portions with sharp corners, interconnected by portions of a sine wave. Analysis of this wave shows it to be the fundamental plus an infinite series of harmonics with the even harmonics predominating.

The flat portion and the sharp corners of the clipped sine wave are similar in shape to a half square wave, and the effect of a circuit on this portion of a clipped sine wave is similar to the effect on the square wave. Square wave experience can therefore be transferred almost intact to analysis with the clipped sine wave.

The asymmetry of the clipped sine wave is of great help in avoiding mistaken analysis due to amplitude saturation. Amplitude saturation is easily noted by a flattening of the peaks of the sine wave portion. Asymmetrical amplitude saturation can be investigated by reversing the polarity of the clipped sine wave. This feature has been useful in the investigation of class-B amplifiers. For the analysis, it is sometimes advantageous to reduce the duration of the sine wave portion by decreasing the ratio of driving voltage to back bias.

**Double Clipped Sine Wave**

The double clipped sine wave is useful in determining phase shift at low frequencies. It is composed of the fundamental and an infinite number of harmonics, with the odd harmonics predominating. This waveform, (Fig. 1B), is seen to be a sine wave with a small step at the points of zero voltage. Phase shift in a circuit is indicated by a vertical displacement of these steps, as shown in Fig. 1C. The approximate phase shift can be calculated from the following formula

\[ \phi = \sin^{-1} \left( \frac{a}{b} \right) \]

where \( \phi \) is phase shift; \( a \) is the vertical displacement of step por-
It is possible of course, to formulate and plot the effect of various circuits on the clipped sine wave and the double clipped sine wave. For qualitative analysis, however, it is practical to illustrate the effect of several typical circuits on these test waveforms by means of oscilloscope displays.

Interstage Transformer

The frequency characteristic of an inexpensive interstage transformer is shown at the top of Fig. 3. This transformer is essentially flat from 30 to 3,000 cycles, but with a large peak in the response at 8,000 cycles. The effect of this transformer on the clipped sine wave is shown at the left. At 100 cycles, there is sufficient high-frequency response to keep the corners sharp. At 300 cycles, a transient has become evident, becoming larger at 1,000 cycles.

The flat portion of the clipped sine wave is slightly less than a half period. Estimating the number of half waves of the transient on the flat portion and multiplying by two gives the approximate ratio of the transient frequency to the driving frequency. In this case it is estimated to be seven half waves for a 1,000-cycle half period, giving an approximate frequency of 7,000 cycles for the transient. It is interesting to note the correspondence of the transient frequency to the point of high gain on the frequency characteristic. The 3,000 cycle clipped sine wave indicates that the transient frequency has been more closely approached.

In Fig. 3 at the right are shown the effects of the transformer on the double clipped sine wave. The transient is beginning to be evident on the flat portions at 300 cycles. The 1,000-cycle wave is appreciably distorted by the transient, and the steps are practically obliterated at 3,000 cycles owing to dropping high-frequency response.

High Quality Amplifier

The graph in Fig. 4 shows the frequency characteristic of a high quality, multistage, resistance-coupled amplifier. This amplifier is essentially flat between 20 and 50,000 cycles. The series of oscillograms at the left shows the effects of this amplifier on the clipped sine wave. At 30 cycles, the slope of the flat portion illustrates the effect of phase shift. The sharpness of the corners indicates the presence of higher order harmonics. At 100 cycles, the phase shift has decreased and the high-frequency response is still good. The oscillogram for 300 cycles is a good replica of the clipped sine wave, as it is at 1,000 cycles. At 3,000 cycles the effect of high-frequency attenuation is beginning to make itself felt, while at 10,000 cycles high-frequency cutoff has rounded the corners appreciably. The important feature in this analysis is the gradual change in shape of the clipped sine wave over the frequency range. There are no distinct resonant circuits or sharp discontinuities indicated, nor would they be expected in high-quality circuits.

The effect of this amplifier on the double clipped sine wave is shown in the oscillograms at the right. Phase shift, as indicated by the displaced flat portions, is evident at 30 cycles. This characteristic decreases with increasing frequency until it is negligible at 1,000 cycles. At 3,000 cycles the phase shift has reversed direction. Above 3,000 the lack of sufficient high-frequency response tends to obliterate the steps, as shown in the oscillogram for 10,000 cycles.

Figure 5 shows the frequency characteristics of an amplifier used for communication purposes. The response of this amplifier is maximum at approximately 700 cycles. It is down 1 db at 300 cycles, up 1 db at 700 cycles and down more than 7 db at 3,000 cycles. Zero level is taken at 1,000 cycles.

Communications Amplifier

The oscillograms of the effect of this amplifier on the clipped sine wave are shown at the left in Fig. 5. At 300 cycles, phase shift is indicated by the slope of the flat portion, and the lack of high-frequency response by the blunted corners. The oscillogram for 1,000 cycles shows a rise in gain at somewhat less than 1,000 cycles, and the corners are further obliterated. At 3,000 cycles, the effect of a poor high-frequency response is evident. It is interesting to note in this amplifier also, the lack of any tendency toward transients. The clipped sine wave analysis indicates a broadly resonant circuit, with maximum gain at less than 1,000 cycles, and no significant frequency discontinuities outside the pass band.

To the right are the oscillograms showing the effect of this amplifier on the double clipped sine wave. The large phase shift at 300 cycles is shown by the vertical displacement of the flat portions. These steps are increasingly obliterated by the lack of high-frequency response at 1,000 cycles and 3,000 cycles.

Tuned Circuit at Driving Frequency

The examples just given illustrate the ordinary use to which one may put the clipped and double clipped sine wave. The effect of a circuit tuned to the fundamental frequency of the clipped sine wave was not clearly exemplified, and is therefore illustrated. Fig. 6A shows the shape of the clipped sine wave with the fundamental partially suppressed, and (B) with the fundamental partially accentuated. The flat portions have now become concave in A and convex as in B.

When the driving frequency is shifted slightly from that of the tuned circuit these convex and concave portions will be displaced to one side. An example of this effect is shown in Fig. 5 (1,000 cycles, at the left) illustrating the effect of a communications circuit on the clipped sine wave.
Multivibrator Design by Graphic Methods

Simple graphic method permits accurate design of free-running multivibrator circuit, eliminating tedious and repeated calculations. Curves are given for commonly used tubes. All phenomena determining circuit operation are taken into account.

By A. E. Abbot

Federal Telecommunication Laboratories, Inc.
New York, N. Y.

The equation for the semiperiod of the free-running zero-bias multivibrator shown in Fig. 1, as derived from its equivalent circuit, is

\[ \tau_1 = \left( R_{al} + \frac{R_L t_p}{R_L + \tau_p} \right) C_1 \ln \left( \frac{E_a - E_m}{E_s} \right) \]  

where \( \tau_1 \) = semiperiod of multivibrator
\( R_{al} \) = grid resistance
\( R_L \) = load resistance
\( t_p \) = plate resistance
\( C_1 \) = coupling capacitance
\( E_a \) = plate-supply voltage

And \( a \) is plotted in this graph against various values of \( R_s \) and \( E_s \). Figure 4, therefore, gives a value of \( a \) that can be multiplied by the time constant to give the semiperiod. Therefore, Eq. 1 reduces to

\[ \tau = \tau_1 + \tau_2 \]  

(5)

where \( \tau_1 \) and \( \tau_2 \) are the fractional periods.

In Fig. 6 and 7, it is assumed that

\[ \beta = \frac{R_s t_p}{R_L + \tau_p} \]  

(6)

Therefore, Eq. 4 further reduces to

\[ \tau = (R_{al} + \beta) C_1 a \]  

(7)

In Fig. 6, it is also assumed that

\[ \gamma = \frac{R_{al}}{R_{al} + \beta} \]  

(8)

When plotted against \( R_s \), the factor \( \gamma \) permits an evaluation of the effect of the load and plate resistances on the grid resistance. For the value of \( R_s \) selected, if \( R_s \) is made so high that \( \gamma > 0.9 \), then it can be assumed that \( \beta = 0 \). When \( \gamma > 0.9 \), there is approximately a 10-percent error in the calculation of \( \tau_1 \); this falls to 5 percent when \( \gamma = 0.95 \).
Equation 7 reduces to a simple equation
\[
\tau_i = R_L C a \tag{9}
\]
The B scales of Fig. 3 are a plot of Eq. 9, and enable a simple calculation of the fractional period from the time constant and \(a\).

If the conditions of the problem are such that \(\gamma << 0.9\) it will be necessary to include the effect of \(\beta\) and use Eq. 7 rather than Eq. 9.

Figure 7 gives the value of \(\beta\) for different load resistances. The \(r_a\) selected in this calculation is an average value. With a given voltage swing, there will be a maximum deviation of 11 percent between any possible \(r_a\) and this average value.

**Example 1**

It is desired to design a multivibrator, using a 6SN7 tube, that will have a peak-to-peak output of 190 volts and will operate at a frequency of 30 kc. The pulse width required for triggering purposes is 10 microseconds. The plate supply is 250 volts.

Then \(E_s = 250\) volts, \(f = 30\) kc, \(E_v = 190\) volts peak to peak, and \(\tau_i = 10\) microseconds.

**Step 1 (see Fig. 2):** When \(E_s = 190\) volts and \(E_v = 250\) volts, \(R_L = 35\) kilohms.

**Step 2 (see Fig. 4):** When \(R_L = \ldots\)
when and microseconds, and $0.93$. Then $T_2 = 30$ microseconds. The conditions of the problem remain the same, except that a lower value of $R_s$ is selected.

**Example 2**

Let $R_s = 10$ kilohms. Then, by consulting the curves in the same order as in Example 1, it is found that $E_s = 132$ volts, $\alpha = 2.205$, $R_n = R_{sp} = 0.1$ megohm, $\gamma = 0.93$, $R_n, C_1 = 10/2.205 = 4.54$ microseconds, $R_n, C_2 = 24/2.205 = 10.88$ microseconds, $C_1 = 45.4 \mu \text{uf}$, $C_2 = 108.8 \mu \text{uf}$, and $\tau_a = 3.51$ microseconds.

The multivibrator was again constructed, using resistor and capacitor values accurate to within 2 percent; results again were in close agreement.

**Example 3**

It is desired to design a 25-kilohertz multivibrator with a buildup time of 2 microseconds and a pulse width of 15 microseconds.

Step 1 (see Fig. 3, scales A): When $C = 31 \mu \text{uf}$ and $R_s = 8$ kilohms, $\tau_2 = 2$ microseconds.

Step 2 (see Fig. 2): When $R_s = 8$ kilohms and $E_s = 250$ volts, $E_r = 119$ volts.

Step 3 (see Fig. 4): When $R_s = 8$ kilohms and $E_s = 250$ volts, $\alpha = 2.11$.

Step 4 (see Fig. 5): When $f = 25$ kc, $\tau = 40.1$ microseconds. Then $\tau_2 = 15$ microseconds and $T_2 = 25.1$ microseconds.

Step 5 (see Fig. 3, scales B): When $R_s, C_1 = 15/2.11 = 7.11$ microseconds, and $C_1 = 31 \mu \text{uf} R_s = 0.228$ megohm. Then $R_n, C_1 = 25.1/2.11 = 11.9$ microseconds and $R_n, C_r = 0.1$ megohm, $C_r = 120 \mu \text{uf}$.

**Limitations**

The results of tests on a multivibrator of this design, using resistors and capacitors accurate to within 2 percent, are interesting because they illustrate one of the limitations of the method. The calculated value of $\tau$ is 15 microseconds, while the measured value of $\tau$ is 13 microseconds. The discrepancy is caused by the low value of coupling capacitance used (31 $\mu \text{uf}$). At this value, the stray capacitance becomes an appreciable fraction of the total. For extremely accurate results, it would be necessary to subtract the tube and wiring capacitance from the calculated value.

Another solution to the problem would be to use a smaller value of grid resistance, thus permitting a correspondingly larger coupling capacitance. When a high value of coupling capacitance is used, as in the calculation for $\tau$, the experimental results are very close to the calculated one.

Another somewhat hidden cause for errors in predicting the semiperiods of a multivibrator is the permanent change in the value of a resistor with temperature. To determine the order of this change, each lead of a 1-watt resistor of 102,600 ohms was heated with a soldering iron for a half minute. The resistor was then cooled and the measured resistance was found to be 148,000 ohms, a change of 45 percent. Each lead of five 1-watt, 0.1-megohm resistors was then heated for fifteen seconds. The average resistance change, after they had cooled for a long period of time, was 17 percent. Thus, the process of soldering resistors into a circuit may change the value of the resistor permanently and, consequently, affect the semiperiod of the multivibrator.

To evaluate the cause of the discrepancy in Example 3, the following experiment was made: The 31 $\mu \text{uf}$ capacitor was replaced by a variable mica trimmer capacitor, which was adjusted until the semiperiod was exactly 10 microseconds. The capacitance value under these conditions was 27 $\mu \text{uf}$. Thus, a 4 $\mu \text{uf}$ error caused by wiring and tube capacitance is responsible for the 3-microsecond error in the pulse width.

The results obtained with the new value of capacitance were: $\tau = 10$ microseconds, $\tau_a = 26$ microseconds, $\tau_2 = 3$ microseconds, and $E_r = 110$ volts.

**June, 1948 — ELECTRONICS**
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SUB-MINIATURE SOCKET for "printed electronic circuit"

...insert contact tails through holes in insulation and bend over — socket is mounted, tube lies horizontal to chassis, soldering tails positioned on back of chassis for wiring. These newly designed "self attaching" sockets will revolutionize conventional wiring in chassis applications.

Sub Miniature Socket No. 54 A 13124 (Reproduced here twice size)

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THE accompanying chart, based on FCC data, provides a quick means of determining the approximate service areas of a transmitter operating on any channel between 88 and 108 mc. Distance to the 1-mv-per-meter contour (solid lines) is shown by the upper scale and distance to the 50 microvolt-per-meter contour (dashed lines) by the lower scale, for various effective radiated powers and transmitting antenna heights. Receiving antenna height is assumed to be 30 feet above average terrain.

Using the Chart

To determine the distance to the 1 millivolt-per-meter contour with a transmitting antenna height of 2,000 feet and 20-kw of effective radiated power, enter the chart at the left and, at the point where the 20-kw horizontal line intersects the solid diagonal line labelled 2,000', read on upper scale 57 miles. To determine distance to 50 microvolt-per-meter contour follow the same procedure but use the dashed diagonal line labelled 2,000' and read the lower scale.

If coverage is desired at a given distance, with a known transmitting antenna height, the effective radiated power required may be read to the left of the point of intersection of appropriate distance and height lines. Similarly, should it be necessary to determine the transmitting antenna height required to provide a certain contour with a given power the chart may be entered from the left and the bottom, and the height read from the appropriate solid or dashed line.
This Terminal Won’t Pull Off or Work Loose...

... IT'S ONLY ONE FEATURE OF THIS COMPACT LOW VOLTAGE MALLORY SWITCH

The inset at the top of this picture shows how the terminals of Mallory 3100 Switches are doubly fastened by a wrap-around method which holds them tight and secure against damage and at the same time provides them with a smoother contact surface.

What the picture cannot show is that the stator is made of low-loss XXX Phenolic especially selected for good insulation properties at high humidities... that a metal web spaced between the terminal contacts improves non-shorting construction... that terminals and stator together provide an excellent solder shield.

Small size, of course, is another distinguishing feature of these 3100 Switches, of which millions have been sold to manufacturers of radios, inter-communication systems and test equipment. The larger model, shown above, is 1½" in diameter and has 18 position 20° indexing, embracing one to six circuits. The smaller model, with 12 position 30° indexing, embracing one to four circuits, is only 1¾" in diameter.

For more details, send for Mallory 3100 SWITCH Engineering Data Folder. A wide range of standard stock types is available through convenient Mallory Distributors.
**Flying-Spot Video Generator**

A NEW cathode-ray tube allows television stations to construct a video-signal generator which permits transmission of station call letters and test patterns from interchangeable slide transparencies or opaque surfaces.

The tube, RCA5WP15, furnishes a small, rapidly moving spot of radiant energy (hence the name) for scanning. It has an extremely short persistence phosphor having a large component of its energy emission in the near-ultraviolet region. The persistence of the ultraviolet radiation is so short that the amount of equalization needed in the video amplifier to minimize trailing in the reproduced picture is small and can be supplied by a single network. As a result, circuits and adjustments are relatively simple.

A video-signal generator using the tube would consist essentially of the Flying-Spot tube with associated power supplies, deflection yoke, and scanning circuits; a lens to project the raster on the subject to be scanned; the subject, a slide transparency, motion picture film, or opaque object; a multiplier phototube with associated power supply to intercept the radiation transmitted or reflected by the subject, and convert it into video signals; and a video amplifier.

The tube makes possible unusual video effects, such as double images—one produced by a slide, the other by modulating the beam of the tube. A block diagram of a video-signal generator arranged for use with a slide transparency is shown. For best results, the objective lens should be a high-quality enlarger type designed for low magnification and preferably corrected for use with ultraviolet radiation.

Suitable filters for absorbing the visible and passing the ultraviolet radiation of the screen are available. The choice of filter is affected by a compromise between the permissible loss of signal output through absorption by the filter and the amount of trailing which can be tolerated, or the extent of equalization needed.

Trailing results from the lag in buildup and decay of output from the screen. As the flying spot moves across a boundary from a light to a dark area of the subject being scanned, the persistence of energy output from the screen results in continued input to the phototube from the light area during the time the dark area is being scanned. Thus, the light area trails into the dark area in the reproduced picture.

Similarly, as the flying spot moves from a dark area to a light area, the lag in buildup of the screen output causes the dark area to trail over into the light area. As a result of these effects, the reproduced picture has an appearance similar to that produced by a signal deficient in high frequencies. It is, therefore, necessary to enhance the high-frequency response of the video amplifier by introducing equalizing networks with suitable time constants. Sufficient equalization should be provided to give the desired square-wave response.

The decay characteristics of most standard phosphors are such as to require considerable equalization provided by networks with different time constants in several stages of the video amplifier. Their relatively long decay generally results in appreciable reduction of the useful signal-to-noise ratio.

The persistence of the P15 phosphor is comparatively so short that less equalization is needed. If used without an ultraviolet filter, less equalization is required than for other standard phosphors but a complex network is nevertheless needed because the decay characteristic is not a simple exponential curve but a curve of a complex function. When used with a filter to pass only the ultraviolet radia-
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MULTIPLE BABY SITTING

Six children in adjoining student-veteran homes at Camp Shanks are monitored while their parents are out. Major Jean L. Wood and his wife use separate microphones, amplifiers and labeled loudspeakers for each baby channel, with a clock at each microphone to warn if any channel fails.

Versatile Power Supply

BY WILLIAM B. MILLER
Standards Engineer
Ballard & Medisfer, Inc.
Burbank, California

Both direct and alternating voltages for meter testing are provided by the circuit shown. The a-c output is continuously variable from 0 to 1,200 volts and the maximum d-c output is fixed and regulated at 500 volts. Lower d-c voltages are obtained by means of a variable voltage divider which allows smooth control down to zero volt.

Low ripple was not a factor in the design and only ordinary filtering was used. However, the action of the regulator section and a small amount of feedback resulted in a measured ripple of 0.4 millivolt. Regulation was important and is quite good. After the output was set at 500 volts, it held with no perceptible change, with a line variation from 90 to 125 volts and a load variation of from 0 to 200 milliamperes.

Four 6L6G's, triode connected, are used in parallel as the series regulators, and a 6S7J as the amplifier. Resistors in each plate lead of the 6L6's equalize the current distribution, and resistors in each grid lead help stabilize and limit the grid current. A total of 200 ma may be safely drawn from this combination.

The 6S7J control amplifier was considered as an r-f tube and care in wire placement was used to eliminate erratic operation and unwanted oscillations. Resistors R, and R, supply the screen voltage and also the keep-alive voltage for the VR150, the current through the latter being about 15 ma with no load on the supply. The divider network across the output supplies the control grid voltage for the 6S7J and also feeds the grid any fluctua-

(continued on p 146)
Western Electric announces a new line of Germanium Crystals! There are five types—all exceptionally compact and sturdy...all identical in mechanical dimensions...and all supplied with pigtails for soldering into circuits. Electrical characteristics have been standardized to meet the requirements of currently known applications.

**FOR THESE (and many other) APPLICATIONS**

**RECTIFIERS**

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Used to good advantage as second detectors at frequencies to over 60 mc. They have much lower impedance than vacuum tube diodes, and are particularly effective in low-impedance circuits. The 1N47 is tested for operation at 100 mc.

**SLICERS, LIMITERS AND CLIPPERS**

In the slicer circuit, biased units conduct current through R when critical voltages E, and E, are reached, preventing overshing. In limiters and clippers only one branch need be used, with addition of low-impedance d-c return path across output terminals or through signal generator.

**PULSE GENERATORS**

Unit damps out the oscillation after one-half cycle, producing a single pulse shaped similarly to half of a sine wave. This pulse may be clipped, provided clipper is isolated from pulse-producing tuned circuit to prevent damping out desired half cycle.

**D-C RESTORERS**

For complete specifications and application data sheets on Western Electric Germanium Crystals, call your local Graybar Broadcast Representative, or write Graybar Electric Company, 420 Lexington Avenue, New York 17, N. Y.
THE ELECTRON ART
Edited by FRANK ROCKETT

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Motion Picture Television Projected from Film

EXPERIMENTAL television pictures of boxing contests were projected onto the 18 by 24 foot screen of the New York City Paramount theater as the event took place. The technique will be used to provide practically simultaneous showings in theaters of local news events. When network facilities become available it may be extended to an intercity basis, independently of television broadcasting networks. The film from which the picture is projected can be stored, edited, and reused.

The experimental equipment with which the system was demonstrated in April consisted of a DuMont image orthicon pickup camera, two pairs of 7 kmc microwave RCA relays (to transmit the signal from the Brooklyn Navy Y.M.C.A. to the Manhattan Paramount building via the N. Y. Daily News building), and terminal equipment developed by Paramount engineers. The terminal equipment reproduces the television picture at 30 frames a second and electronically blanks it to permit recording on film at 24 frames a second. The film is completely processed (developed, fixed, washed, and dried—no trouble being encountered from grain or soft gelatin), and feed directly into the projector. The process can be operated so fast that a frame is projected 30 seconds after it is exposed. However, at such a rate, sludge tends to collect on the film; a 66 second processing interval has been found most satisfactory.

Because of the extreme sensitivity of the image orthicon (greater than that of film), this technique, in addition to offering quicker projection, is superior to that of using a motion picture camera to obtain news reels under adverse lighting conditions. Not only was the showing experimental in that the terminal equipment had only been completed 10 days before the showing (it was the first time the engineers had seen the picture projected onto the screen of the main theater), it was also experimental in that the audience was not apprised of the showing until it took place; they applauded at the conclusion of the 15 minute showing. The picture was as sharp as direct film news shots and had a remarkably long tonal range.

Crystal Diodes in Computers

LARGE scale digital computers using many electronic tubes dissipate a great deal of heat. To reduce the amount of heat that must be removed by the air conditioner for the computer, and to reduce the operating power and mechanical size of the computer, germanium

Television picture is recorded on 35 mm film, which is then completely processed in 66 seconds, by the equipment that Paramount's vice-president Paul Raiborn is inspecting.

Section of experimental film (not the one shown publicly) shows clarity of picture; note variable density sound track also recorded onto film from audio relayed over same uhf

June, 1948 — ELECTRONICS
**FM SIGNAL GENERATOR**

**Type 202-B** 54-216 mc.

Additional coverage from 0.4—25 mc. with accessory UNIVERTER Type 203-B

Designed to meet the exacting requirements set forth by leading FM and television engineers throughout the country, the 202-B FM Signal Generator has found widespread acceptance as the essential laboratory instrument for receiver development and research work.

Frequency coverage from 54 to 216 megacycles is provided in two ranges, 54 to 108 megacycles and 108 to 216 megacycles. A front panel modulation meter having two deviation scales, 0-80 kilocycles and 0-240 kilocycles, permits accurate modulation settings to be made.

Although fundamentally an FM instrument, amplitude modulation from zero to 50%, with meter calibrations at 30% and 50%, has been incorporated. This AM feature offers increased versatility and provides a means by which simultaneous frequency and amplitude modulation may be obtained through the use of an external audio oscillator.

The internal AF oscillator has eight modulation frequencies ranging from 90 cycles to 15 kilocycles, any one of which may be conveniently selected by a rotary type switch for either amplitude or frequency modulation.

The calibrated piston type attenuator has a voltage range of from 0.1 microvolt to 0.2 volt and is standardized by means of a front panel output monitor meter.

The output impedance of the instrument, at the terminals of the R.F. output cable, is 26.5 ohms.

**AVAILABLE AS AN ACCESSORY**

is the 203-B Univerter, a unity gain frequency converter which, in combination with the 202-B instrument, provides the additional coverage of commonly used intermediate and radio frequencies.

- **R.F. Range:** 0.4 mc. to 25 mc.
- **R.F. Increment Dial:** ±250 kc. in 10 kc. increments.
- **R.F. Output:** 0.1 microvolt to 0.1 volt. Also approximately 2 volts maximum (un-calibrated).

For further information write for Catalog E

**BOONTON RADIO Corporation**

BOONTON, N.J., U.S.A.

DESIGNERS AND MANUFACTURERS OF THE "Q" METER, DX-CHECKER, FREQUENCY MODULATED SIGNAL GENERATOR, BEAT FREQUENCY GENERATOR, AND OTHER DIRECT READING TEST INSTRUMENTS
crystal diodes can be used in the switching circuits. When the potential across a diode is negative, it presents a high impedance; when the voltage is positive, it presents a low impedance. Thus the diode constitutes a convenient voltage sensitive switch. Because it consumes power from the control or switching channel, that channel should have low internal impedance. Computers using such switching networks, like that illustrated here, have large capacity but are relatively compact.

High speed computer developed at the Servomechanisms Laboratory of M.I.T. uses germanium diodes, performs arithmetical operations using five-place binary numbers, and indicates solution by neon lamps

**Time Expansion of Periodic Waves**

**By Li-Yen Chen**  
*Transmission Engineer*  
*Ministry of Communication, China*

**Many Methods have been proposed for reducing bandwidth required to transmit a certain message. Preliminary tests conducted at Polytechnic Institute of Brooklyn with a wave-expanding system show that periodic waves can be transmitted over less bandwidth than is normally required.**

**Signal Sampling and Expanding**

A periodic wave consists of several identical cycles of a particular waveshape. To transmit this wave all that is needed is to transmit the characteristics of one cycle and knowledge of the rate at which the cycle repeats itself (waveform and frequency). Waveform can be transmitted by gating out a single cycle and elongating it in the time scale. The bandwidth required to transmit the elongated wave is reduced in proportion to the elongation. Furthermore, if the elongation has a predetermined fixed relation to the original wave, the system design incorporates knowledge of the number of cycles to be reproduced at the receiver for each transmitted cycle, and hence no additional bandwidth need be used to convey this information.

An experimental technique for expanding a wave has been developed and tested. Using a 1,000-cps frequency, the wavelength was doubled (frequency halved) and the signal transmitted as a 500-cps frequency. The wave reconstructed at the receiver of the original 1,000-cps frequency practically the waveform of the initial signal. Whereas a technique such as recording the signal at a fast rate and playing it into the transmitter at slow speed produces a similar increase in the time scale, this sampling and expanding method produces the increased time scale without changing the elapsed duration for transmitting the complete signal.

**Pulse Methods Perform Expansion**

Figure 1 shows the general principle of the expander. Information (continued on p. 170)

---

**Research Stimulates Electronic Applications in Science and Industry**

**Cathode-ray oscillograph equipment is used to study transients in the high-voltage and insulation research laboratory**

**Scientists working on vacuum tubes such as x-ray generators for therapy: an assembled synchrotron doughnut is in foreground**

Experiments leading toward physical, biological, medical, and industrial applications of electronics are being conducted at new and extensive laboratories in Staffordshire, England. Included in the equipment of the English Electric Company's Nelson Laboratories are a three million volt generator for testing transformers, a thirty million electron volt synchrotron that is being developed for the government's laboratory at Harwell, and a 140 million volt machine that is planned for cancer research. Electronic laboratories are developing television receivers, industrial controls and scientific instruments.
Lead-In Lines Play an Important Part in Television Reception

The effects of attenuation and impedance mismatch on FM and Television reception are minimized by Anaconda Type ATV lead-in lines.

The satin-smooth polyethylene insulation of Type ATV line sheds water readily, thus avoiding subsequent impedance discontinuities. This material also has exceptionally high resistance to corrosion. Count on Anaconda to solve your high-frequency transmission problems—with anything from a new-type lead-in line to the latest development in coaxial cables.

A Type ATV Lead-In for Every Need

Anaconda offers a complete selection of Type ATV lead-in lines for 75, 125, 150 and 300 ohms impedance unshielded and 150 ohms shielded. For an electrical and physical characteristics bulletin, write to Anaconda Wire and Cable Company, 25 Broadway, New York 4, N.Y.
NEW PRODUCTS
Edited by A. A. McKENZIE

New equipment, components, tubes, testing apparatus and products closely allied to the electronics field. A review of catalogs, handbooks, technical bulletins and other manufacturers’ literature

Frequency Standard
AMERICAN TIME PRODUCTS, INC., 580 Fifth Ave., New York 19, N. Y. Type 2121A frequency standard is designed to provide an accuracy of one part in 100,000. Power output is up to 110 volts, 10 watts, at 60 cycles; power input is 110 volts, 45 watts, at 50 to 400 cycles. Net weight of the unit with cabinet is 25 lb.

Wall Speaker Cabinet
JENSEN MFG. CO., Chicago 38, Ill. Two new wall mounting enclosures, model H-81 for 8-inch speakers and model J-61 for 6-inch speakers, have been announced. Pictured here is the model H-81, a bass reflex sector cabinet which may be mounted singly, in pairs, or in clusters of four around a post to obtain wide-angle distribution of sound.

Barretter Mounts
SPERRY GYROSCOPE CO., Great Neck, N. Y. These instruments are type-N holders for sensitive barretter elements used with suitable wattmeter bridges to measure absolute microwave power within ± 5 percent accuracy. Maximum average c-w power that can be measured directly is limited to 10 milliwatts. This range can be extended to 100 watts or higher by using a suitable directional coupler or attenuator. Four models are available.

Sideband Selector
JAMES MILLEN MFG. CO., INC., Malden, Mass. Type 92105 single sideband selector employs the McLaughlin circuit which has two crystals and four tubes. The unit provides advantages of single sideband reception on all signals rather than only to those with suppressed carrier. The unit is readily connected to any standard communications receiver.

Magnetic Tape Recorder
AMPLIFIER CORP. OF AMERICA, Magnetophone Division, 398-7 Broadway, New York 13, N. Y. Model SP850 high-fidelity magnetic tape recorder is a self-contained unit consisting of tape-pulling mechanism, recording amplifier with ultrasonic bias and erase oscillator, playback amplifier, monitor amplifier and speaker. Bias frequency range is adjustable from 30 to 80 ke with a total recording and playback distortion under 3 percent at 400 cycles.

Vacuum Capacitors
DOLINKO & WILKENS, INC., 101 Hazel St., Paterson 3, N. J., has a new line of high-current vacuum
Here's How It's Done — The words of the speaker (A) are transmitted to interpreters (B) who are working at microphones. As each interpreter hears the speech he immediately makes the translation in his particular language. All the translations are conveyed to the listeners (C) who select, by dial, the language they wish to hear.

This is the lightweight receiving set, with aerial in the shoulder strap for complete freedom of movement while listening. It contains three RAYTHEON Subminatures, two 2E42s and one 2E36. Two stages of radio amplification are provided, diode detector with automatic volume control, and a pentode output section connected to the headphones. The set measures 1⅛ x 4⅜ x 3½ inches and weighs only 1½ pounds. There is excellent speech tone with ample volume, sensitivity and selectivity between the channels that deliver any one up to seven languages.

Why International Business Machines Corporation and other manufacturers of high grade electronic equipment use RAYTHEON Subminiature Tubes.

1. Reduced Product Size... Increased Product Saliability. Raytheon filamentary Subminiatures are flat. Batteries can be tiny because of extremely low filament drain.
2. Plug Into Standard Sockets. All Raytheon Subminiatures can either be soldered in or plugged into readily available sockets.
3. Raytheon Reliability — the result of unique methods and nine years continuous production of long-life Subminiature Tubes.
4. Readily Available From Stock — over half a million on tap at all times. Over 30 types. Standard throughout the world.
5. At Your Local Distributor’s — over three hundred Raytheon Special Purpose Tube Distributors ready to serve you quickly and intelligently.

Write for Data Sheets on Raytheon Subminiature Tubes.
models, the new type features improved control circuits, extended frequency range, a continuous suppression control and more flexible remote control facilities.

Strip Selenium Rectifier

STANDARD ARCTURUS CORP., 54 Clark St., Newark 4, N. J. The Kotron strip selenium rectifiers were designed to replace thermionic rectifiers in many circuits. Available in 75, 100 and 200-ma units they mount easily and conserve chassis space. The units can be used in combinations as full-wave rectifiers or voltage doublers.

Ultrasonic Weld Tester

SPERRY PRODUCTS, INC., 1505 Willow Ave., Hoboken, N. J. The new angle-beam transmitter illustrated is used with the Supersonic Reflectoroscope to inspect welds. The weld itself will not constitute a reflecting interface, but any voids or inclusions will reflect a part of the energy.

Noise Suppressor

HERMAN HOSMER SCOTT, INC., 335 Putnam Ave., Cambridge, Mass. Type 910-C is the new and improved noise suppressor which functions on the exclusive dynamic-bandpass principle. Compared to previous models, the new type features improved control circuits, extended frequency range, a continuous suppression control and more flexible remote control facilities.

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The Voice of America gives to other nations a full and fair picture of American life, aims and policies, plus factual news of the world and the United States.

Broadcast in twenty-three languages, these programs blanket Europe, Latin America and the Far East, with a potential radio audience of more than 150,000,000 persons.

Of the thirty-two hours of daily broadcast, approximately one-fourth of the time is devoted to news, one-half to additional comment and informational programs, and the remainder to music and entertainment.

A substantial part of these daily programs is recorded and, due to the excellent quality of these transcriptions, such recorded portions cannot be distinguished from the live transmissions.

Today, as from the beginning, the recorded parts of these broadcasts are on AUDIODISCs.

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

Export Department: Rocke International Corp., 13 E. 40th Street, New York 16, N.Y.

Audiodiscs are manufactured in the U.S.A. under exclusive license from PYRAL, S.A.R.L., Paris
NEWS OF THE INDUSTRY

Edited by JOHN MARKUS

IRE plans for professional groups; Audio Engineering Society launched; new microwave relay chains; 19 new books reviewed

Broadcast Operator License Proposal Amended

In August 1947 the FCC proposed a change in rules applying to operator licenses for the broadcast service. After considering all available comments and information from interested parties the Commission recently modified its proposal as follows:

A new group of commercial operator licenses, to be known as the Broadcast Operator Group, will be established: (a) limited broadcast operator license; (b) broadcast-technician operator license; (c) broadcast-engineer operator license.

New examination elements will be added to presently existing elements 1 through 6, as follows:

(7) Practical Broadcast Operation. Provisions of law, rules and regulations governing the operation of standard and f-m broadcast stations, and procedures involved in normal operation (including minor transmitter adjustments) to insure compliance therewith.

(8) Technical Broadcast Theory and Practice. Intermediate electronics theory and practice as applied to the operation, adjustment and maintenance of standard and f-m broadcast stations, technical regulations, and standards of good engineering practice regarding the operation of all classes of broadcast stations and of the equipment permitted or required.

(9) Advanced Broadcast Theory and Practice. Advanced technical theory and practice applicable to the operation, adjustment and maintenance of a-m, f-m, television and other classes of broadcast stations and associated equipment, including special antenna systems.

Examination requirements for the licenses in the new broadcast operator group will include, in addition to satisfactory ability to understand the English language and to receive and transmit spoken messages in English, the following written examination elements:

Limited broadcast operator license—1, 2, and 7.

Broadcast technician-operator license—1, 2, 7 and 8.

Broadcast engineer-operator license—1, 2, 7, 8 and 9.

The scope of authority of licenses of the new broadcast operator group will be substantially as follows:

Limited broadcast operator license—Holders of this class of license may operate any standard broadcast station having a maximum licensed power of not more than 1 kw and not employing a directional antenna system, or any f-m broadcast station having a maximum licensed effective radiated power of not more than 1 kw, or any remote pickup or standard broadcast station, provided (1) that one or more holders of a radio-telephone first class operator license, broadcast technician-operator license, or broadcast engineer-operator license is regularly employed on a full-time basis by that station, and (2) that holders of the limited broadcast operator license are prohibited from making any repairs or adjustments beyond the protective interlocks of the radio station transmitter, except in the presence and under the direction of a person holding one of the higher classes of licenses.

Broadcast technician-operator license—Holders of this class of license may operate any class of broadcast station, provided that (1) in the case of a standard broadcast

BROADCASTERS SOLVE FLOOD PROBLEM

Radio station WXYW, Louisville, Ky., now has a water-borne transmitter near the Ohio River. In the path of frequent floods, it was installed on a barge and rises with the river. The barge is held by steel cables.
Ten years of research, development, design and manufacture of high-vacuum equipment have given DPI a rare technical background in the field.

The tangible result of this experience is DPI's wide variety of highly sensitive yet sturdy, trouble-free apparatus for making, measuring and controlling high vacuum.

DPI high-vacuum engineering is contributing to the production of television tubes and other electronic devices, to vacuum metallurgy and metal evaporation, hydration, vacuum distillation, atomic energy, and in scores of industries which are just beginning to see in high vacuum a new medium with untold potentialities.

To fit this wide range of applications, DPI has designed and produced more than 35 types and sizes of high-vacuum pumps, and also suitable controls, gauges, valves and accessories.

Seven fine gauges to provide accurate readings of high vacuum are shown on this page. Each has a different range of maximum sensitivity—thus each is best fitted for a particular range of operation.

The accompanying charts indicate the full range of each instrument. The Range of Maximum Sensitivity is indicated by the widest portions of that line.

For equipment to attain high vacuum, to measure it and to control it, look to DPI—a pioneer in the field of high vacuum. Your questions will be carefully and promptly answered. Write—

**Distillation Products, Inc.**

755 Ridge Road West, Rochester 13, N.Y.
570 Lexington Ave., New York 22, N.Y.
135 S. LaSalle St., Chicago 3, Ill.

Manufacturers of Molecular Stills and High-Vacuum Equipment; Distillers of Oil-Soluble Vitamins and Other Concentrates for Science and Industry.
How to cut manufacturing costs

Perhaps your manufacturing costs can be lowered by utilizing G-E Textolite 1834. This low-cost grade of laminated plastics may do your job just as well or maybe even better than more expensive materials you are now using.

And if grade 1834 doesn't meet your requirements, just remember that there are more than fifty other grades of G-E Textolite available. Each of these grades has an INDIVIDUAL COMBINATION of properties. None are exactly alike.

Why not investigate the varied grades of Textolite and the five forms in which it is produced. You'll profit. Plastics Division, Chemical Department, General Electric Company, One Plastics Avenue, Pittsfield, Mass.

GET THE COMPLETE STORY!
Send for the new bulletin G-E TEXTOLITE LAMINATED PLASTICS which lists grades, properties, fabricating instructions and detailed information about the five forms of Textolite. Fill in and mail the coupon below for your free copy.

TEXTOLITE LAMINATED IS SUPPLIED IN FIVE FORMS

SHEETS, TUBES, AND RODS—These standard shapes are available in thousands of sizes. Up-to-date manufacturing methods facilitate quick deliveries.

FABRICATED PARTS—G-E has modern fabricating equipment to machine Textolite laminated plastics parts to your own specifications.

MOLDED-LAMINATED PARTS—Textolite is custom molded directly to shape. Molded laminated products are among the strongest plastics parts produced.

LOW-PRESSURE MOLDED PARTS—Extremely large and irregular Textolite shapes are custom molded by the low-pressure laminating process.

POST-FORMED LAMINATES—Sheets of Textolite laminated plastics are custom formed into simple shapes by this very inexpensive method.
station having a maximum licensed power in excess of 1 kw or using a directional antenna system, or (2) in the case of an f-m broadcast station having a maximum licensed effective radiated power in excess of 1 kw, or (3) in the case of an international, facsimile, or television broadcast station, one or more holders of a broadcast engineer-operator license is regularly employed on a full-time basis by that station.

**Broadcast engineer-operator license**—Holders of this class of license may operate any class of broadcast station.

### Audio Society Launched

At a meeting April 13 in New York City attended by over 125 members, the constitution and bylaws of the Audio Engineering Society were formally adopted. C. J. Lebel, chairman of the meeting, announced that membership was already over 300 and growing steadily.

**MECHANICAL HANDS FOR RADIOACTIVE AREAS**

A remote-control manipulator using mechanical hands can perform chemical experiments or operate machine tools in radioactive areas. In actual use the hands would extend over a protective 8-ft wall into the area while operated from an outside room. General motion of the robot corresponds to that given the handles by the remote operator but wrists, rotated electrically by the use of synchros, can be twisted around completely any number of times. The device is used at the Knolls Atomic Power Laboratory near Schenectady, N. Y., and was developed by John Payne of the Atomic Power Division of the G. E. Research Laboratory

<table>
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<th>MEETINGS</th>
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Adoption of the constitution marks the launching of a new national technical society serving the field of electronics. Provisions are made for establishment of local or regional sections when authorized by the Board of Governors of the national society.

The committee entrusted with formulation of the constitution was headed by Harry N. Reizes and composed of Isabel Capps, R. J. Stier, C. R. Sawyer, A. A. Pulley, C. G. Brodhun, D. L. Richter, C. J. McProud, C. J. Lebel, A. Cezar and J. Daniels.

Classes of membership provided for are as follows:

1. **Honorary Members:** — A person of outstanding repute and eminence in the science of audio engineering or any of its allied arts, may be elected to honorary membership by the board of governors and thus become entitled to all the rights and privileges of the society.

2. **Fellows:** — A member who has rendered conspicuous service, or is recognized to have made valuable contribution to the advancement in or dissemination of knowledge of audio engineering, or the promotion of its application in practice, may be elected a fellow of the society.

3. **Members:** — Any person active in audio engineering who has an academic degree, or its equivalent in scientific or professional experience in audio engineering or in a closely related field or art, shall be eligible for election to membership in the society and upon election shall be entitled to all the

(continued on p 227)

ELECTRONICS — June, 1948

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EXACTLY THE RIGHT SELElCTOR SWITCH FOR YOUR APPLICATION

OTHER SHALLCROSS PRODUCTS
- Akra-Ohm Precision Resistors
- Combined Kelvin-Wheatstone Bridges
- Fault Location Bridges
- Kilovoltmeters
- Kilovoltmeter Multipliers
- Shallcross Varioten Attenuators
- Multi-Resistor Standards
- Portable Power Supplies
- Low Resistance Test Sets (Bond Testers) etc.

Tailoring a selector switch to a specific application economically is not a job for engineers who only produce a few types occasionally. Modern switch engineering calls for plenty of “know how.” It calls for a background of dozens of standard types from which adaptations can be made. Not the least important, it calls for highly specialized dies, equipment and trained assemblers. All of which Shallcross offers in fullest measure.

WRITE FOR SPECIFICATION SHEET
Let Shallcross quote on your Selector Switch requirements. Standard types, most of them subject to broad adaptations, cover switches for bridges, decade boxes, transformer tapping, resistor and capacitor paralleling, inductance tapping, television, and many other exacting uses. Ask for Form C-1.

TUBES AT WORK (continued from p 126)

...tions in the output voltage. The amplifying action of this tube provides the regulating effect. Any change on the grid of the 6SJ7 is amplified and transmitted as bias to the 6L6’s, which changes their series resistance in the proper direction to counteract the fluctuation.

By varying $P$, the output voltage is brought to the exact value desired. The divider was calculated to put the grid 5 volts above the cathode, or 155 volts; $P$ has a range of about 50 volts. Potentiometer $P$, helps in reducing ripple, as it feeds the unregulated voltage to the regulated side and any ripple will be partially cancelled due to the 180-degree phase difference between the two.

Resistor $R$, and capacitor $C$, aid considerably in ripple reduction. A 500,000-ohm potentiometer was used for $R$, and adjusted for minimum ripple voltage. If the supply is used where the load changes rapidly, a 4-uf 600-volt oil-filled capacitor across the output helps in maintaining regulation.

A-C Output

The change from d-c to a-c is accomplished by means of a 4-pole double-throw relay. When the relay is energized, it disconnects the high-voltage windings from the rectifier tube and makes them available by means of a switch. The Variac, connected to the primaries of one filament transformer and the plate transformer, controls the a-c output. When the switch selects the filament transformer, a-c from 0 to 7.5 volts is available at the terminals. With half of the plate winding switched in, up to 600 volts may be had. With the full winding, 1,200 volts are available; each range being continuously variable. The Variac is turned down whenever a change is made to prevent arcing at the relay contacts.

The resistance network across the output divides the 500 volts d-c into four ranges, each range being approximately a 125-volt step, depending on the current being drawn. Thus for the first range the voltage is 0 to 125, the second from 125 to 250, the third from 250 to 375 and the last from 375 to the full 500. The arrangement of the
AT YOUR SERVICE WITH OUR NEW FACTORY TO HELP YOU WITH YOUR SHEET METAL FABRICATION REQUIREMENTS.

Sheet Metal Products — such as:

INSTRUMENT PANELS, RADIO COMMUNICATION CASES and ENCLOSURES, OSCILLATOR BOXES, CHASSIS and CABINET ASSEMBLIES, RACKS and SPARE PARTS BOXES, WATER-PROOF CABINETS and BOXES, METAL STAMPINGS, FORMING and WELDING of FERROUS and NON-FERROUS METALS.

Thousands of varied Production Dies and Tools available at no extra charge—to speed production and reduce your costs. We specialize in "Whistler Die Setups" for economic and speedy production.

Our modern Finishing Dept. includes—Pickling — Degreasing — Bonderizing and Baked Enamel Painting of all types; thus assuring you of a fine quality product.

We can assure you of excellent workmanship and prompt deliveries. Send us your blueprints and specifications. We shall quote you immediately.

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ELECTRONICS — June, 1948
Phase Meter

By E. O. VanDeven
General Electric Co.
Schenectady, New York

The phase meter is a device that measures the phase angles of a low or high frequency polyphase voltage supply. Essentially this is accomplished by developing on the screen of a cathode-ray oscilloscope a circular sweep at the polyphase supply frequency. Each phase voltage of the polyphase supply is then separately amplified, clipped, differentiated and again amplified.

In the output of each phase amplifier are pulses which are established in time by their respective phase voltage. These pulses are mixed and applied to the Z-axis amplifier of the oscilloscope to intensity modulate the circular trace, causing a dark or bright spot to appear for each phase voltage. The angular displacement between the spots is then a measure of the angular displacement between corresponding phase voltages. The phase angles can be read by calibrating the oscilloscope screen radially in degrees.

A block diagram of the phase meter is shown in Fig. 1. One phase of the three-phase supply is applied to a device which shifts the phase by 90 degrees. This is done, since to obtain a circular sweep it is necessary to apply to the horizontal and vertical amplifiers voltages of the same frequency but separated in phase by 90 degrees. The pulse forming and mixing circuits are also indicated.

The phase meter was developed...
These Federal standard D-C Power Supplies are now available to meet a wide range of industrial and laboratory requirements for both filtered and unfiltered D-C power. All Federal D-C Power Supplies are powered by Federal long-life Selenium Rectifiers with no expendable parts that demand frequent replacement. Operation is dependable and economical. Federal D-C Power Supplies are conservatively rated. Heavy duty Selenium Rectifiers are able to withstand momentary overloads... provide D-C power immediately without heat-up period... operate quietly and efficiently with practically no maintenance. For prices and information on other Federal standard D-C Power Supplies, write Department E813.

**FILTERED**

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<td>2 FTR 3128-BS*</td>
<td>115 1 60 22-30</td>
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<td>5 FTR 3185-AS</td>
<td>115 1 60 12</td>
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*Filtered and regulated

**UN-FILTERED**

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**FILTERED RATINGS**

- Code Number
- A-C Input
- D-C Output

**UN-FILTERED RATINGS**

- Code Number
- A-C Input
- D-C Output

Federal Telephone and Radio Corporation

SELENIUM and INTELIN DIVISION, 900 Passaic Ave., East Newark, New Jersey

Export Distributors: International Standard Electric Corp. 67 Broad St., N. Y.
A few of the 125 permanently insulated wires, cables and cords developed by Rockbestos.

**ROCKBESTOS RANGE AND APPLIANCE LEAD WIRES**

Available in several types to fit the electrical and mechanical requirements of your product. Solid or stranded copper, nickel or monel conductors insulated with impregnated asbestos only, or a combination of high-dielectric tapes and impregnated asbestos.

**ROCKBESTOS A.V.C. 600 VOLT SWITCHBOARD WIRE**

This wire was designed to make complicated wiring jobs permanent. The impregnated felted asbestos wall beneath the flame-proofed cotton braid is heat, flame and moisture resistant and assures fine appearance of boards as it gives on bends to prevent hard-cracking. Sizes 18 to 4/0 AWG with solid or stranded conductors in black, gray and colors.

ROCKBESTOS A.V.C. Hinge and Bus Cables have the same characteristics.

**ROCKBESTOS A.V.C. 600 VOLT MOTOR LEAD CABLE**

Use this apparatus cable for coil connections, motor and transformer leads exposed to overloads or high ambient temperatures. It makes a permanent installation as it is resistant to heat, flame, oil, grease and moisture. Sizes No. 18 AWG to 1,000,000 CM insulated with two walls of impregnated asbestos and a high-dielectric varnished cambric insert, with a heavy asbestos braid covering.

Wire-Failure in Your Products Can Tie Your Salemen's Hands

The integrity of your company is at stake every time a switch is flicked on one of your products . . . protect your good name with **Permanently Insulated ROCKBESTOS WIRES, CABLES and CORDS**

Here's the protection you, as well as your customers, get when your products are Rockbestos-wired:

- Permanent insulation with impregnated felted asbestos.
- No rotting, blooming or swelling from oil, grease or corrosive fumes.
- No baking brittle from conductor-heating overloads.
- No destructive and expensive wire-fires.
- No deterioration from age or oxidation.
- Stepped-up current carrying capacity via high heat resistance.

These safety factors can mean the difference between stardom or obscurity for your brand — in terms of goodwill, reduced servicing or replacement. You'll find them in every one of the 125 different standard Rockbestos constructions.

Get your copy of the new No. 10-F Rockbestos Catalog, sectioned for easy reference . . . write —today—to our nearest district office or direct:

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460 NICOLL STREET, NEW HAVEN 4, CONN.

NEW YORK, PITTSBURGH, BUFFALO, CLEVELAND, LOS ANGELES, DETROIT, ST. LOUIS, CHICAGO, OAKLAND, CAL.

The Wire with Permanent Insulation

June, 1948 — ELECTRONICS
for work with the 2H21 phasitron tube, used to generate crystal-controlled f-m. The phasitron has three-phase r-f applied to the deflector electrodes. A crystal oscillator at approximately 230 kilocycles is the signal source. This single-phase voltage is transformed to three-phase by employing a modified Scott transformer connection.

The single- to three-phase transformation circuit, with the associated phase relationships, is shown in Fig. 2. Amplifier tube V supplies a transformer load, the secondary of which is center tapped. Secondary voltage, AF, is shown vectorially on the phase diagram. The OB vector, displaced 90 degrees from AF, is obtained by shifting the phase of the primary voltage DE by 90 degrees. Since DE and AF are in phase, vector OB is then 90 degrees from AF.

Resistor R is essentially connected from B to E which is part of a tuned circuit. Therefore by detuning the tuned circuit slightly from the resonant point the reactance from B to E can be made to appear inductive. This inductive reactance is in series with C, and by proper adjustment of these two parameters the voltage BE will be displaced from the supply voltage DE by 90 degrees. By properly establishing the ratio of C to C, the point E is selected along the OB vector. Point E is grounded providing a neutral point for the balanced three-phase system.

For the phasitron to operate with minimum distortion it is necessary that the exciter supply phase voltages of equal magnitude and angular displacement. The phase meter was developed to facilitate the adm...
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TUBES AT WORK
(continued)
justment of the exciter supply for perfect three-phase output.

Circular Sweep

Figure 3 shows the circuit used to obtain circular sweep. The single-phase, 230-kc signal feeds a pentode amplifier. The amplifier plate circuit has a tuned transformer which, when resonated, gives a 90-degree phase shift between primary and secondary. Proper adjustment of the secondary tuning capacitor is accomplished by observing the pattern on the c-r tube. When this capacitor, and the horizontal and vertical gains, are correctly set, the result will be a circular trace on the cro screen.

The pentode amplifier is run class A and with an unbypassed cathode resistor. This is to minimize distortion of the voltages applied to the vertical and horizontal amplifiers. The cro amplifiers must also have low distortion, or it will be impossible to obtain perfect circular sweep. Circle size is controlled by $R_c$.

One of the pulse-forming circuits is shown in Fig. 4. Phase voltage is applied to $V_{cm}$, a cathode follower. This tube transforms from high-impedance input to low-impedance output across $L_i$.

Operation

Accuracy of the meter depends more than anything else on the coupling circuit between $V_L$ and $V_n$ and the operation of $V_n$. The voltage developed across $L_i$ is at least 30 volts rms. Therefore the grid of $V_n$ swings from minus 50 volts to 50 volts plus, less the drop across $R_C$. The tube begins to conduct when the input voltage rises to approximately -4.5 volts. When it
GL-9C24 V-h-f Triode

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FIG. 4—Pulse generator for one phase

reaches zero volts, grid current begins to flow, resulting in a voltage drop across the grid resistor.

The output of $V_3$, therefore is a pulse whose leading edge is very steep. It is important that this leading edge be definitely established in time with respect to the phase input voltage.

Tube $V_4$ is directly coupled to $L_4$, since a blocking capacitor would have a discharge time constant which would develop grid bias on $V_4$ and change its operating point with respect to the phase input voltage. Filter $R_C$ has a time constant which is short compared to the period of one cycle. Thus, as the voltage across $L_4$ rises from its peak negative value, $V_4$ should begin to conduct at a point determined entirely by its cutoff potential.

If the magnitude of the phase voltage is varied, this point will shift slightly, which is part of the inherent error of the device. If all phase voltages are varied by the same amount however, no net error should result. All operating points will have shifted by the same amount and in the same direction.

$C$ and $R_L$ constitute a differentiating circuit, the voltage on $V_4$...
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TUBES AT WORK

(continued)

FIG. 5—Phase relations in pulse-forming circuit

gird consisting of narrow positive and negative pulses. Since $V_s$ is zero biased, its grid presents low impedance to the positive pulses and high impedance to the negative ones. In the output, positive pulses predominate.

Tube $V$, is an amplifier-inverter, biased beyond cutoff. The pulses are also narrowed in this stage. Output of $V$, is applied to $V_s$, a cathode follower. The negative pulses developed across the cathode-follower load impedance cannot be fed to the $Z$ axis input directly. If this were done the cathode-follower loads of all phase circuits would essentially be in parallel. When one cathode follower were pulsing the remaining two would present excessive loading. The result would be insufficient pulse output voltage.

Circuit Isolation

Therefore the second section of $V_s$, is diode connected. Under these circuit conditions, the cathode load impedances of the inoperative cathode followers are isolated from the load impedance of the one that is operating.

Tube $V_{in}$ is diode-connected to form part of a peak-reading volt-meter circuit. The meter is calibrated to read rms phase voltage.

Figure 5 shows the phase relationship between the sine wave input to the phase circuit and the output pulses appearing at the $Z$-axis input to the cro. The leading edge of each pulse is determined by the cutoff point of the first clipper tube in the corresponding phase circuit.

Other possible uses of the phase
THE RCA WV-84A ULTRA-SENSITIVE DC MICROAMMETER is a battery-operated vacuum-tube instrument capable of measuring currents from 0.001 to 1000 microamperes. The instrument has six ranges and can read currents in either direction by a simple switching operation. Accuracy is \(\pm 5\%\) of full-scale reading in the 0.01 range, \(\pm 4\%\) on all other ranges.

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TUBES AT WORK (continued)

The meter principle include the measurement of phase shift through amplifier circuits.

R-F Heating for Cabinets

By Charles Dusenbury
Engineering and Service Department
Westinghouse Electric Corp.
Atlanta, Georgia

When Gavan Woodcrafter Inc. began the manufacture of radio cabinets, a method was needed that would eliminate human error in gluing, holding and setting. In addition they were limited in time and floor space. The solution was found in radio-frequency heating.

The production line cabinet fabrication set up contains five Westinghouse generators, one 5 kw, 5-mc set, two 5 kw, 15-mc sets, and two 2 kw, 15-mc sets. Three of these units are equipped with two position switches to permit one jig to be heated while the other is loaded. The other two units are connected directly to the presses. The jigs and presses are constructed of plastic-impregnated wood and cost has been quite low.

With radio-frequency glue line heating and setting, cabinet construction does not rely on nails, cleats, or hand clamps to hold the cabinet together for a long glue-setting period. The various parts are coated with glue, placed in the jig and held for a few seconds during the r-f heating cycle, which sets the glue sufficiently so that they can be removed immediately for finishing. This gives a product without nails, and thus a finer finished cabinet.

The entire process consists of six steps: five gluing and heating operations and the final assembly. In forming the curved front section of the cabinet, two plys of birch or

In this jig, small blocks for the sides of the cabinet are glued and placed in slots having electrodes on each side so that r-f current passes through the glue line.
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TUBES AT WORK

(continued)

Two plys of birch or poplar and one of mahogany are glued together to form the cabinet front. A 5-kw, 5-mc Westinghouse generator is used.

poplar and one ply of mahogany are used to form a three-ply section. The middle ply is painted with glue and the section placed in the press. Approximately 200 lb per square inch pressure is applied to the ply section and the 5-kw, 5-mc generator is then applied for a period of 120 seconds.

After the heating cycle, the panel is split into quadrants to form four cabinet front panels. One man applies glue, operates the press, and splits the panels and turns out 100 sections or 400 front panels in an eight-hour day. Production can be increased in the future by the addition of a glue spreader.

Inside Gluing

After the front panels are cut by an automatic saw, stiffening or loudspeaker boards and six small blocks are glued to the inside. This is done by a 2-kw, 15-mc generator. This unit can be used for a second heating operation while the loading is going on. The second operation is the gluing of two small blocks and a strip on the record changer mounting board. These operations respectively require 30 and 20 seconds heating time and 20 to 30 seconds loading time. The generator is adjusted so that no change is necessary when changing jigs.

The next operation is the gluing of five blocks to each side of the cabinet. Glue is applied and the blocks placed in various slots which have electrodes on each side so that the r-f current passes through...
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ELECTRONICS — June, 1948
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Ask for Vacuum Pump Bulletin V45.

The glue line. When the blocks are in position, they are pushed under a press lowered by an air cylinder that applies pressure to the blocks during the heating cycle. A 5-kw, 15-mc generator with a time cycle of about 20 seconds completes the operation.

The fifth operation is heating the glue lines of the radio cabinet top. The two curved side pieces and the triangular strengthening pieces plus the front and back pieces are glued on in this case to form a top which is free from nails and is always square. The heating cycle for this operation with a 2-kw generator is about 45 seconds and the loading cycle is about the same.

**Transfer Switch**

The plant is laid out so that the parts flow from one operation to the next and eventually end up at the final assembly jigs. Dual presses are used for the final assembly, a transfer switch being mounted on top of the 5-kw, 15-mc generator. Two cabinets are heated at the same time in about 110 seconds. During this heating time the operators are loading the second two jigs and as soon as the first heating cycle is completed the power is transferred to the second set of jigs so that the generator is utilized about 90 percent of the time.

The cabinet must be kept square.

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(Tubes at Work)

(continued)
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TUBES AT WORK (continued)

Phonoradio cabinet glued together with r-f heating is free of nails and always square bulb type syringe with a small plastic nozzle. With this, glue can be applied without excess that might cause arcing and lost time in cleanup.

Advantages

When animal glue and nails are used the cabinets must be stacked for a period of probably twenty-four hours before sanding and finishing can be accomplished. This, of course, requires floor space and additional handling, eliminating the possibilities of a production line type of assembly. Furthermore, it requires a considerable outlay for clamps, and the possibility of nails alone not holding the cabinet tight enough during the...
COMPLETELY self-contained, portable and always set up for immediate use, this impedance bridge is indispensable in any laboratory where electrical equipment is used. No hastily putting together a circuit, finding an oscillator and a detector and then a power supply . . . they are all here permanently assembled in an accurate instrument . . . always ready to use at any time.

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The bridge includes built-in standards, batteries, a 1000-cycle tone source for a-c measurements, a zero-center galvanometer d-c null detector, and terminals for a headset for 1000-cycle detection. Provision is made for use of an external generator for measurements over a wide range from a few cycles to 10 kilocycles. Direct-reading dials add greatly to the ease and rapidity with which measurements can be made.

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THE HARVEY-WELLS Decade Units are created to save time and expense in the laboratory, school or workshop on DC or low-frequency AC electrical circuits, and are new and unique in both design and application. They use the Cannon Electric Laboratory and Switchboard fittings shown below.

Various parts of the cabinet are assembled into one unit in two minutes at this station served by a 5-kw, 5-mc generator.

glue setting period is always present.

The production line layout with radio-frequency heating saves handling and consequently gives a better product at lower cost. The fact that a man cannot apply a great deal of pressure when nailing a cabinet, unless it is in a jig, means that the parts have to be much more accurate when hand assembly and nails are used. However, the final assembly is arranged so that it draws up the material and takes up a great deal of misalignment which could only be tolerated under these conditions. Therefore, the labor required in the cutting operations need not be quite as highly skilled, nor the machines as accurate.

Carrier Shift Cheek Meter

BY J. W. WHITEHEAD
Central High School
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The center position of switch S is the normal position.

FIG. 2—Audio oscillator and mixer circuit. The center position of switch S is the normal position.

The oscillator is taken to the grid-filament circuit of the mixer tube, the cathode circuit of which is fed with the audio output from the oscillating frequency meter. This latter tone is generated by heterodyne action within the meter between the space frequency produced by the meter and the carrier shift transmitter on its mark frequency. The audio signal resulting in the plate circuit of the mixer is applied to phones, and the beats heard allow accurate setting of the transmitter mark frequency.

Mixer

For simplicity of construction it was considered desirable to use one tube for the two necessary circuits, and the double triode 6C8G was selected. Each section of this tube has its separate cathode, a fact which allows virtually complete isolation of the two circuits, thus making for enhanced frequency stability of the oscillator.

Referring to Fig. 2, the winding of transformer between terminal 4 and earth is tuned by means of fixed capacitors at C, strapped across it to produce the desired frequency. The precise values of these capacitors varies from unit to unit, and each must therefore be individually tuned. The scope of the instrument may be increased by providing switch S to bring in further capacitors C, in parallel with the first bank to secure a second audio frequency. (The two frequencies in use were 850 and 720 cps respectively). Terminal 3 on T, is a tap on the tuned winding taken directly to the cathode of V, and terminal 4 connects with the grid of this tube via a parallel r-c combination.

Output from the a-f oscillator is
"The use of Truarc Retaining Rings permits centerless grinding of pins instead of plunge-grinding. This eliminates the problem of taper and reduces the required tensinal tolerances of these parts," reports Acme Steel Company of Chicago. "Furthermore, use of Truarc rings gives the Steelstrapper smoother lines by eliminating unsightly projections. This results in a more streamlined housing, a definite sales advantage."

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Tubes at Work

taken from $T$, and applied to the other section of the 6C8G, $V_2$. The audio output from the frequency meter is applied across the cathode resistor via the capacitance. Across the plate load, therefore, appears the beat note resulting from the superposition of the two audio frequencies, and it is reproduced in the phones which are plugged in at $J_1$.

It was found convenient to tune the frequency meter to zero beat on space without switching off the a-f oscillator, and for this purpose a second jack $J_1$ is provided. This jack is connected across the audio input from the frequency meter, and has an additional contact which is arranged to short the grid of the audio oscillator to ground when the jack is in use, thus stopping that tube from oscillating and avoiding the complication of having a continuous additional note in the phones while tuning to zero beat.

It may be possible for an inexperienced operator to obtain an apparent tuning point when the two tones are harmonically related. A three-position nonlocking key is therefore provided to enable the two tones to be heard independently, thus ensuring that they are of exactly the same frequency.

The original prototype was calibrated against a standard tone generator to an accuracy of ± 1 cycle, and this was used as a standard against which further models were checked. During a long period of use the stability of all the models has been good and the results have been eminently satisfactory.

The particular model illustrated in the photographs was designed to fit beneath frequency meters of the U. S. Army type BC-221. This accounts for its somewhat unusual shape.

Radiation indicators are used by Australian Customs authorities to detect thorium in bags of mineral-bearing sand exported from the east coast of Australia. The thorium occurs in monazite sands, and exports of mineral sands containing more than a certain proportion of monazite are banned by the Commonwealth Government.

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FIG. 1—Basic wave-expanding technique of the waveshape of the input periodic wave (A) is stored in the modulated pulses (B). Because of the periodicity of the wave, the pulses in group T₁ are identical to those in group T₂. Only one group need be transmitted without reducing the information that will be conveyed (to a receiver adjusted to the system). Alternate pulse groups are therefore omitted (C) and the remaining pulses rearranged to occupy the entire time scale (D). Demodulation of these rearranged pulses gives the elongated wave (E). The bandwidth occupied by this wave (E) is half that occupied by the original one (A).

The system, comprising an arrangement of relatively common circuits, that accomplishes this novel result is shown in Fig. 2. Pulse position modulation is used to store information of the incoming wave. The repetition rate of the pulses is 10,000-cps so the system is capable of faithfully transmitting frequencies up to 3,500-cps.

A square wave of half the frequency of the input wave is obtained by a divider. This square wave gates the pulse-selecting circuit for passing pulses of alternate cycles of the signal wave, giving an intermediate signal of the general form shown in Fig. 1C.

A number of delay circuits are used to convert the pulses to the expanded time scale. The first delay circuit delays its pulse for 150 microseconds, the second circuit delays its pulse for 250 microsec-
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THE ELECTRON ART (continued)

microseconds instead of the initial 100 microseconds. The modulation displacements of the individual pulses are unaffected.

Because the number of pulses in each group may differ from the norm by ±1, the time interval between each delayed pulse group may be 200 ± 100 microseconds, and a special method of demodulation is required. The position-modulated pulses are converted to amplitude-modulated pulses by superimposing them on a 10,000-cps triangular wave. A capacitor charging circuit is used to gate and hold a charge corresponding to the amplitude of each pulse. Two charging circuits are used to avoid the gap created by discharging the capacitor. Switching actions of the charging circuits are actuated by two cathode followers controlled by a counter. Each incoming pulse trips the counter, which routes it to one capacitor and discharges the other. The expanded wave is obtained from the output of a low-pass filter.

Special Circuit Techniques

Because most of the circuit elements are conventional, it is unnecessary to describe their details. However, some of the design and adjustment techniques that are peculiar to this particular application should be mentioned.

In the pulse modulator, which is essentially a one-shot multivibrator tripped by the negative pulse from a 10,000-cps source, the position of the tail edge of the pulse is position-modulated by the incoming signal, giving a ±6-microsecond displacement for a ±2-volt input signal. A differentiating circuit and shaper circuit transform the modulated edge into the leading edge of a pulse. Push-pull output for the bridges of the delay circuits is obtained from a pulse transformer that delivers a 5-microsecond pulse with a peak amplitude of 40 volts.

The pulse delay circuit is also a one-shot multivibrator delivering a pulse a preset interval after being tripped by one. A bridge is connected between each pulse delay circuit and the pulse source. Normally the bridges are balanced so that no pulses can reach the delay
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THE ELECTRON ART (continued)

multivibrators. An incoming wave train initiates the action by producing a pulse that opens (unbalances) the first bridge circuit. The first pulse is thus received and delayed by the first circuit, and 10 microseconds later the bridge to the second delay is opened. The systematic switching continues routing successive pulses to delays in order. The unbalanced condition for each bridge exists for only 180 microseconds; the relay action stops when the incoming signal ceases.

Demodulation of the amplitude-modulated pulse train is compli-

Ten delay circuits with their input bridges and the pulse mixer are on the upper chassis. Coaxial cables connect to the lower chassis containing the rest of the experimental system for reducing bandwidth indicated by the variation of the interval between pulse groups. Two charging circuits are used alternately to hold a charge that is proportional to the pulse amplitude. The charging circuits are controlled by square waves 180 degrees out of phase so that only one circuit can operate at a time. The surge of charging current in one circuit ignites a gas tube that discharges the other circuit. The pulse that controls the charging is delayed 10 microseconds and then passed to a counter to cause the square wave to reverse. The two capacitors of the charging circuits are connected to the grids of two cathode followers having a common load, and thus the capacitor with the larger voltage will control the output. The cathode voltage thus follows the envelope of the amplitude-modulated pulse train; the demodulated signal is obtained from a low-pass filter.

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TUNE IN Du Pont's "Cavalcade of America"—Monday Evenings—NBC coast to coast.

CHECK THESE 7 BASIC FEATURES OF NYLON FOR ELECTRICAL USES

1. Good flexibility
2. High tensile strength
3. Extreme toughness
4. Abrasion resistance
5. Resistance to permanent set
6. Chemical resistance
7. Ability to be molded or extruded . . . colored or in natural color.
Small Single Pole
Open Blade

Yes, we repeat—these ACRO Open Blade Switches now carry Underwriters Laboratories, Inc., rating. The exceptionally fast Snap-Action of the patented ACRO Rolling Spring gives you freedom from burning contacts, more positive action and longer life. This switch, already used in hundreds of applications, has been designed to give the large volume user all the advantages of positive Snap-Action at low cost. Furnished with terminals at side or rear. Can be made with many variations in operating characteristics as well as form and length of blade.

Large Single Pole Open Blade

The larger single pole Open Blade Switch shown here, carries the same ratings as the small switch, but is of more rugged construction. Built with extra large contacts to assure extraordinary long life on applications where the continuous load is close to the rated load. Also built with the exclusive ACRO Rolling Spring principle for positive action and long, trouble-free life. Available with terminals at rear only, as illustrated.

Specifications for Both Models—Main blades of tempered spring steel. Rolling spring of beryllium copper. Contacts of fine silver. Switch locked together by two 6-32 screws. Furnished with either return type or set type action. For quick response, send operating details of your applications.

THE ACRO ELECTRIC COMPANY
1316 SUPERIOR AVENUE • CLEVELAND, OHIO

THE ELECTRON ART (continued)

Hoadley and W. R. MacLean for their advice during the project.

Reproducing Handwriting

BY HUGH LINEBACK
Assistant Professor
Oklahoma A. & M
Stillwater, Okla.

A novel application of the cathode-ray oscilloscope is the reproduction of handwriting. Inspiration for the device to be described came from a demonstration at the Naval School, Harvard University. Description of a similar device for writing “LORAN” (Radio News, Feb. 1946) attracted the attention of a dealer who asked for a unit that would reproduce his letterhead as a novelty display while giving demonstrations of electronic equipment.

To reproduce the letterhead, it was enlarged on rectangular graph paper, using a projector and pantograph. Two hundred and forty points in each word were plotted in polar coordinates on a thirteen-foot circle, using separate tracks for vertical and horizontal components; Fig. 1 shows the result. A photographic transparency of this pattern was made and mounted on a motor shaft. The tracks were scanned by light beams with phototubes receiving the modulated light. The voltages developed by the
Lock-In tubes in *Motorola* equipment maintain smooth flow of traffic on famous bridge

The famous San Francisco-Oakland Bay Bridge must be free of stalled cars at all times. A smooth flow of traffic is maintained with the aid of Motorola FM Radiotelephone equipment.

Tow cars, emergency roadside service trucks, electrician trucks, fire units and traffic engineer's sedan constitute the radio fleet. By means of this efficient system, a flow of 70,000 cars per day rolls with minimum delay over the great bridge.

Securely locked in position in the Motorola equipment are *Sylvania Lock-In Tubes*, depended upon day and night to give superlative service under all conditions!

For full information about *Sylvania Lock-Ins* see *Sylvania Distributors* or write *Sylvania Electric Products Inc., Radio Tube Division, Emporium, Pa.*

**SYLVANIA ELECTRIC**

Makers of Radio Tubes; Cathode Ray Tubes; Electronic Devices; Fluorescent Lamps, Fixtures, Wiring Devices; Electric Light Bulbs

Electronics — June, 1948

www.americanradiohistory.com
"Embarrassing is no word for it! The big boss wants prints in an hour. He won't understand that this old tracing is dry and brittle, and hit high C when I tried to pull it out of the cabinet in a hurry. All he'll see will be the patch marks. Wonder why he doesn't insist on Arkwright."

Arkwright has a world-wide reputation for staying clear, clean and pliable, year after year... no ghost-producing spots... no tear-causing britleness. Special mechanical all-the-way-through processing gives it this ability to laugh off the years. A perfect print was made recently from an 80-year-old tracing on cloth made by the same process now employed by Arkwright.

Why not try Arkwright? See for yourself what a difference there is. Generous working samples free upon request. Arkwright Finishing Company, Providence, R. I.

All Arkwright Tracing Cloths have these 6 important advantages
1. No surface oils, soaps or waxes to dry out, stain and cause brittleness.
2. Erasures re-ink without "feathering" or "creeping".
3. Prints are always sharp and clean.
4. No pinholes or thick threads.
5. Tracings never discolor or become brittle.
6. Mechanical processing creates permanent transparency.

Arkwright TRACING CLOTHS
AMERICA'S STANDARD FOR OVER 25 YEARS

THE ELECTRON ART (continued)
phototubes were applied to the two channels of the oscilloscope. Figure 2 shows the original letterhead and the reproduction produced on the oscilloscope. Actually only one word is reproduced at a time so that the letters can be as large as possible on the face of the cathode-ray tube. In use, either word can be selected or they can be made to alternate by an automatic relay.

Capacitor Counting Circuit

By Bradford Howland
U. S. Naval Research Laboratory
Author now at the Graduate School of Arts and Sciences, Harvard University, Cambridge, Massachusetts

Conventional capacitor counting circuits represent the count by a voltage stored on a capacitor. The circuit to be described operates on this principle but has in addition N stable states of electrical equilibrium and can store the count indefinitely. Because of this property of long time stability the circuit is well adapted to counting random events or at a low rate. A simple form of the circuit using crystal diodes is described.

Basically the circuit consists of (A) a network of diodes and resistors, the complexity of which determines the number of equilibrium voltages, (B) an impedance sensitive feedback circuit that stabilizes the voltage across the capacitor at any one of the equilibrium voltages determined by the diode network, (C) means for stepping the capacitor voltage up or down one increment for each count, and (D) means for resetting the circuit to zero each time it has counted N events.

Basic Diode Charging Network

Figure 1 shows the basic two-terminal counting circuit composed of diodes, resistors, and batteries arranged for an N of 5. The resistances are large. Normally current flows from the high bias voltage through them and the bottom row of diodes. When a voltage of the polarity indicated is applied to the terminals of the network, the currents through the resistors will switch successively to the top row of diodes as the applied voltage exceeds the individual voltages to which the lower diodes are connected. This action results in the
This one has Regulation Accuracy to
3.5% of 0.1 Milliamperes Load

LOW-CURRENT, HIGH-VOLTAGE D-C POWER SUPPLY IS COMPACT,
LIGHT IN WEIGHT—HAS PREVIOUSLY UNOBTAINABLE FEATURES

These new small, light-weight a-c to d-c power supply units are especially built for precision work. They have a number of highly desirable features which make them suitable for supplying the high potential necessary for cathode-ray tubes, television camera tubes and radar indicator scopes, electron microscopes, and other jobs where unusually low regulation, light weight, and small size are primary considerations.

The unit shown here (Cat. 8317502) will supply 7 kv at 0.1 milliamperes d-c output. The regulation does not exceed 3.5% per 0.1 milliamperes load, and 15% at 0.5 milliamperes maximum load. The ripple on the output voltage is less than 1%. This unit is manufactured for 215 volts, 10,000 cycles, a-c input. An additional pair of terminals is provided to supply 45 volts a-c when 215 volts are applied to the input terminal.

This completely self-contained hermetically sealed rectifier will meet Army and Navy specifications both in the matter of design, and as to its ability to withstand mechanical shock and operate continuously for long periods of time. It is designed to operate in ambient temperatures ranging from -40°C to +60°C.

Has these Features

- Precision stability
- Light weight (8 lb)
- Small size (6 by 6 by 7 in.)
- Selenium elements
- Only one high-voltage terminal exposed
- Filter has low energy storage
- Readily mounted
- Oil filled for strength
- Hermetically sealed
- Can be used as tank circuit of an audio oscillator*

*An unusual feature of this unit is that it may be used as the tank circuit of an audio oscillator. The input terminals are connected to the plate circuit. The 45-volt output terminals are connected as the grid feedback. The oscillator tube normally used is a 6V6. The operating frequency is 10,000 cycles.

GENERAL ELECTRIC COMPANY
Power Transformer Sales Division, Pittsfield, Mass.

Gentlemen:

1. Please submit quotation on Cat. No. 8317502 rectifiers, as illustrated.

2. Please submit quotation on rectifier units, similar to Cat. No. 8317502, designed to meet the attached specifications.

Name
Organization
Address
City State

ELECTRONICS — June, 1948
Given: An accurately scaled model of an aircraft—

Find: The radiation pattern of that antenna on that aircraft in any plane and for either vertical or horizontal polarization.

Solution: With a three-man crew to operate it, our Type 105 Aircraft Antenna Pattern Plotting System can measure and record more than 100 such radiation patterns in a routine working day.

This System — with its
TRANSMITTERS (500 to 10,300 Mc)
RADIATORS
RECEIVER SYSTEM
RECORDING SYSTEM
SERVOS and MOTOR CONTROLS
MECHANICAL STRUCTURES
is an excellent example of the kind of SYSTEMS DEVELOPMENT WORK we are staffed, experienced, and equipped to perform for you.

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Airborne Instruments Laboratory INCORPORATED
160 OLD COUNTRY ROAD - MINEOLA, N.Y.
Tel. Garden City 6880

FIG. 1—Basic diode stepping circuit

The stabilizing circuit responds to changes in dynamic resistance of the network and controls the voltage across a capacitor at or near the value for which the network presents low impedance. One such circuit is shown in Fig. 2. A small r-f voltage is applied to the grid of an amplifier. The cathode of the amplifier tube is connected to ground through a high a-c impedance in parallel with the network. If the network presents a low a-c impedance, the cathode will be bypassed to ground and a large r-f output will be produced at the plate of the tube. If the network presents a high a-c impedance, the cathode degeneration will produce a small r-f output at the plate. In general this action is obtained only if the peak-to-peak r-f voltage is small enough to limit the voltage swings in the network within one current-voltage characteristic also shown in Fig. 1. This curve is based on measurements made with 1N34 crystal diodes, 470,000-ohm resistors, and a bias of -150 volts.

The characteristic of the network, as shown by its response curve, is such that its dynamic or a-c resistance, which is the reciprocal of the slope of the characteristic curve, is low near points of transition and high between them. At the transitions the resistance is about 700 ohms, between them it is approximately 50,000 ohms depending on the applied voltage and the back resistance of the diodes. It is this marked variation in a-c resistance of the network that is used by auxiliary circuits to stabilize the voltage across the capacitor.

Impedance Sensitive Circuit

The stabilizing circuit responds to changes in dynamic resistance of the network and controls the voltage across a capacitor at or near the value for which the network presents low impedance. One such circuit is shown in Fig. 2. A small r-f voltage is applied to the grid of an amplifier. The cathode of the amplifier tube is connected to ground through a high a-c impedance in parallel with the network. If the network presents a low a-c impedance, the cathode will be bypassed to ground and a large r-f output will be produced at the plate of the tube. If the network presents a high a-c impedance, the cathode degeneration will produce a small r-f output at the plate. In general this action is obtained only if the peak-to-peak r-f voltage is small enough to limit the voltage swings in the network within one
presenting the NEW

"NOFLAME-COR"
the TELEVISION hookup wire

by

CORNISH

approved by Underwriters' Laboratories at 90° CENTIGRADE 600 VOLTS

This is IT! Tops in hookup wire for television, F-M, quality radio and all exacting electronic applications. Available for immediate delivery in all sizes, solid and stranded, in over 200 color combinations... ready to demonstrate anew the Efficiency and Economy of CORNISH WIRES AT WORK

- Flame Resistant
- Heat Resistant
- High Insulation Resistance
- High Dielectric
- Easy Stripping
- Facilitates Positive Soldering

COMPLETE ENGINEERING DATA AND SAMPLES ON REQUEST

RUBBER 75°
PLASTIC 80°
"NOFLAME-COR" 90°

"made by engineers for engineers"

CORNISH WIRE COMPANY, Inc.
605 North Michigan Avenue, Chicago 11
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1237 Public Ledger Bldg., Philadelphia 6

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

ELECTRONICS — June, 1948
step of its dynamic characteristic.

The r-f output at the amplifier plate can be calculated by means of the equivalent circuit also shown in Fig. 2. The cathode impedance is $Z_c$. The curve in Fig. 2 shows this variation of plate r-f voltage with voltage applied to the network. This r-f voltage is rectified (by a crystal diode) to give a positive potential that is amplified and fed back to the capacitor to maintain whatever voltage is across it.

To discuss specifically how the stabilization operates, assume that the capacitor is charged to 9.5 volts. Should this potential decrease, the output from the r-f amplifier will increase, the grid of the d-c amplifier will be driven positive, and the voltage across the capacitor will be restored to its initial value. The action is actually quite complex and a minimum capacitance is required to obtain stable equilibrium points. There is, in addition, a stable condition when the capacitor voltage is negative, in which case the d-c amplifier is cut off; this state is not usually used in counting circuits.

Stepping and Reset Circuits

To step the voltage across the capacitor in performing the counting operation, an increment of charge is either added or subtracted; the stabilizing circuit then brings the capacitor voltage to the next equilibrium point. The points of unstable equilibrium on the stabilizing circuit characteristic are the dividing voltages between stable states. To drop the voltage...
In Cathode-Ray Tubes, such as the one above, "dag" CRT Wall Coating—a colloidal graphite dispersion—serves as a conductor and as an accelerating electrode...excludes external light...and reduces light reflection from the filament.

Because of their unusual properties "dag" colloidal graphite dispersions are constantly finding new applications in the electronics industry.

Aqueous dispersions of colloidal electric-furnace graphite may be employed to form films which, in addition to being tenaciously adsorbed, possess low coefficients of expansion and friction. They are non-fusible, opaque, chemically inactive, electrically conductive; effective thermal radiators, good conductors of heat, low in photoelectric sensitivity, and capable of acting as gas adsorbers.

Give Acheson Colloids engineers the opportunity to talk with you about your specific problems. Check the coupon and mail.

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- electrostatic shielding
- corona prevention
- dry-film lubrication
- copper oxide rectifier disc coating
- electrical resistances
- filament cement

Acheson Colloids Corporation
PORT HURON, MICHIGAN

40th Anniversary Year

ELECTRONICS — June, 1948
Already in wide use by sonic-equipment manufacturers and research laboratories for such diversified applications as disintegration of bacteria, emulsification of unlike liquids, and pasteurization of milk, Reeves-Hoffman super-sonic and ultra-sonic crystals are available in ranges from 15 kc to 15 mc.

According to specification, these crystals can be provided with optically flat surfaces or with spherical or cylindrical contours. Plating in either gold or silver can be made to any specified degree or area. Designed for your particular application, sizes range from 3″x3″x3″ to thickness of .003″.

**REEVES-HOFFMAN CORPORATION**
CHERRY AND NORTH STREETS • CARLISLE, PA.

---

**THE ELECTRON ART** (continued)

across the capacitor to the next lower stable state the charge must be forcefully reduced to bring the voltage below the adjacent unstable point; to lift the voltage the charge must be increased to bring the voltage above the next unstable point before it will be driven into stability by the control circuit. The volt-

---

**FIG. 3—Complete decade counting circuit**

The output from the reset circuit is used to operate another counting circuit.

A complete decade counter using these elements is shown in Fig. 3. The network uses twenty 1N34
Where's the manufacturer these days who doesn't need all the competitive and cost advantages he can get? Maybe you have new electrical or mechanical equipment in mind—designs or re-designs that should employ permanent magnets for best results. Maybe you have existing applications that permanent magnets will do better—save you time and money in production, and step up the efficiency of your product.

In either case, let Arnold's engineering service help you to find the answers to your magnet problems. Arnold offers you a fully complete line of permanent magnet materials, produced under 100% quality-control in any size or shape you require, and supplied in any stage from rough shapes to finish-ground and tested units, ready for final assembly. Write direct, or to any Allegheny Ludlum branch office.
REDUCE "DOWN-TIME" LOWER WIRING COSTS, SAFEGUARD PERSONNEL

WITH

AMPHENOL

INDUSTRIAL SOCKETS

The advanced design of these sockets and the well known high integrity of Amphenol materials and production can save you thousands of dollars in "down-time." Another economy is the speed and simplicity of installation wiring. And these Amphenol sockets are safe—they guard highly trained workers and valuable tubes, so don't rely on make-shift equipment!

Included in the wide Amphenol industrial tube socket line is the Super Jumbo 4 pin socket for top or bottom mounting. The exclusive Cloverleaf contacts provide four full lines of contact with tube pins to carry heavy current loads. Outstanding in performance they are equally attractive in appearance—quality on all counts!

So insist on Amphenol when you buy. Write today for complete and well illustrated specifications.

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1830 South 54th Avenue, Chicago 50, Illinois
COAXIAL CABLES AND CONNECTORS • INDUSTRIAL CONNECTORS, FITTINGS AND CONDUIT • ANTENNAS • RADIO COMPONENTS • PLASTICS FOR ELECTRONICS

THE ELECTRON ART (continued)
crystal diodes, or 6AL5 vacuum diodes can be used equally well. Taps at 2-volt intervals along a low-impedance divider determine the ten equilibrium voltages. The number of steps that can be obtained in a single network is limited by the minimum voltage required per step (about 1 volt) and by the safe inverse voltage of the diodes. The control circuits require six triodes (three dual triode tubes). The r-f oscillator can be used in common by several other counting stages.

The oscillator frequency was chosen to make the plate circuit of the r-f amplifier resonate, and in this case is 600 kc. The inductance shunting the network was chosen to resonate with the stray capacitance to assure a high r-f impedance between stable states.

Positive pulses that are to be counted are applied to the storage capacitor through a trigger amplifier. The stored voltage is thus stepped down one 2-volt increment by each input pulse. The size of the coupling capacitor is not critical. The reset multivibrator is triggered each time the capacitor voltage goes negative. Upon being triggered the multivibrator passes a high current for a predetermined interval that restores the highest equilibrium voltage across the capacitor, limited at this value by the clipping diode. A positive output pulse from the multivibrator operates succeeding counting decades.

The count is indicated by a high-impedance voltmeter. A manual reset enables the circuit to be cleared. This circuit counts satisfactorily at any rate up to 1,500 events a second, the upper limit being determined by the reset time. The reset time, in turn, depends on the size of the storage capacitor and on the current that can be carried by the reset tube. The circuit of Fig. 3 does not represent an optimum design; it is believed that with further refinement the upper limit of counting speed can be considerably increased.

SURVEY OF NEW TECHNIQUES

Industrial and scientific problems dealing with the flow of heat are solved by a specialized calculat-
PLASTICON
Plastic Film Oil-Filled
CAPACITORS—

1. More Economical
2. Smaller—Lighter
3. Better Electrical Characteristics

1. MORE ECONOMICAL

<table>
<thead>
<tr>
<th>MFD</th>
<th>VOLTS DC</th>
<th>PAPER CAPACITOR</th>
<th>PLASTICON AOC</th>
<th>SAVING</th>
</tr>
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<tr>
<td>10</td>
<td>1000</td>
<td>$15.18</td>
<td>$10.67</td>
<td>$4.51</td>
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<tr>
<td>4</td>
<td>2000</td>
<td>13.67</td>
<td>9.24</td>
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<td>2</td>
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<td>1</td>
<td>4000</td>
<td>33.54</td>
<td>27.50</td>
<td>6.04</td>
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<tr>
<td>2</td>
<td>5000</td>
<td>48.73</td>
<td>41.25</td>
<td>7.48</td>
</tr>
</tbody>
</table>

Above are typical examples.

PLASTICONS are the result of technological advances...cost less to manufacture, give better performance.

2. SMALLER — LIGHTER

<table>
<thead>
<tr>
<th>MFD</th>
<th>VOLTS DC</th>
<th>Approx. Weight</th>
<th>Approx. Cubic Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PAPER CAPACITORS</td>
<td>PLASTICONS</td>
</tr>
<tr>
<td>10</td>
<td>1000</td>
<td>1.95 lbs.</td>
<td>1.7 lbs.</td>
</tr>
<tr>
<td>4</td>
<td>2000</td>
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<td>1.23</td>
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<tr>
<td>2</td>
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<td>.94</td>
</tr>
<tr>
<td>2</td>
<td>5000</td>
<td>5.2</td>
<td>2.9</td>
</tr>
</tbody>
</table>

3. BETTER ELECTRICAL CHARACTERISTICS

<table>
<thead>
<tr>
<th></th>
<th>Paper Capacitors</th>
<th>Plasticons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Factor at 85°C 60 cycles</td>
<td>0.3%</td>
<td>0.3%</td>
</tr>
<tr>
<td>Resistance at 85°C megohms per Mfd.</td>
<td>40</td>
<td>100</td>
</tr>
<tr>
<td>Capacitance/Temp. Coefficient 100% @ 25°C</td>
<td>-40°C=73%</td>
<td>-40°C=94%</td>
</tr>
<tr>
<td></td>
<td>+85°C=97%</td>
<td>+85°C=103%</td>
</tr>
</tbody>
</table>

PLASTICON CAPACITORS given are Type AOC, mineral oil-filled.
PLASTICON ASC silicone-filled have better characteristics.
Paper Capacitors given are chlorinated diphenyl impregnated.

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MANUFACTURERS of GLASSMIKE CAPACITORS and HIGH VOLTAGE POWER SUPPLIES.

ELECTRONICS — June, 1948
THE ELECTRON ART

(continued)

ing machine developed at the Columbia University School of Engineering. The heat and mass flow analyser laboratory consists of extensive resistance-capacitance networks and associated meters and power supplies. Thermal properties of materials are concentrated into individual electrical circuit elements by lumping their electrical analogs. Problems that would be impractically time consuming are solved readily by the machine, and accelerated action is obtained by changing the time scale of the analog. During the six years that the laboratory has been developing, problems dealing with solidification of metal and glass castings, heat losses in furnaces, deicing airplane wings at high altitudes, and heat generated by brakes on trains have been solved. The laboratory, headed by Dr. Victor Paschiks and Prof. C. F. Kayan, is operated as a consulting agency for industry and also engages in developing general physical data. It is sponsored by a number of industries concerned with heat transfer problems.

HIGH-VOLTAGE POWER SUPPLIES, for military infrared detectors, were developed by Dr. Carl Bosch, physicist for the Allgemeine Elektrizitäts-Gesellschaft, Germany. The rotary electrostatic generator patterned after the well-known Wimshurst machines used for classroom demonstration, weighs less than a pound and is 4.5 inches in diameter; it replaces a 20-pound transformer and vacuum tube power supply, and gives a d-c output of 12,000 volts. The basic design, illustrated in the May 1947 Science Progress (U. S. Dept. of Commerce), can be adapted to power supplies for x-ray, cathode-ray, and other high-voltage tubes.

PENCIL mark sensing method, developed by International Business Machine Corp., is replacing punched holes in cards for some applications. Conductance provided by a heavily drawn short pencil line across a particular box on a file card is sufficient to actuate the circuit between fine fingers under which the card passes. The pencil mark is simple to make and the sensing permits high speed operation of the accounting machine.

June, 1948 — ELECTRONICS
Micro-wave radar was made practical by operating magnetron tubes in the constant field of permanent magnets. For only with this unchanging magnetic field could frequency stability be obtained. Thus a whole new frequency spectrum was opened up—and a vast new electronic market developed.

Working with Raytheon Manufacturing Company, Waltham, Mass.—producer of more than half of the world's wartime supply of these tubes—our engineers helped design special permanent magnets for the major portion of Raytheon magnetrons. Some of these magnets weigh as much as 50 pounds—in other cases, total weight of the tube-magnet combination is less than two pounds.

OUR SPECIAL DESIGN SERVICE CAN HELP YOU
Every day, permanent magnets are supplying the answers to new and different problems in all branches of science and industry. A discussion with our permanent magnet specialists may assist you in new equipment designs—or bring higher efficiency and extra savings in your present products. Write today, Dept. E-6.

I-S-P Permanent Magnets offer these benefits
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- No wiring or electrical current needed.
- No shock hazard.
- No heat produced.
- No operating cost.
- Minimum installation cost.
- Easily installed in original equipment.
- Complete range of sizes and materials.

THE INDIANA STEEL PRODUCTS COMPANY

- Producers of "Packaged Energy"
- Specialists in Permanent Magnets since 1910

ELECTRONICS — June, 1948
**NEW PRODUCTS**
(continued from p 134)

transformer and test speaker which may be used separately. Two panel switches and chart establish any one of 30 desired transformer primary impedances from 325 through 70,000 ohms, single and push-pull.

**Television and F-M Receiver**

DUVAL RADIO & TELEVISION CORP.,
423 Grove Street, Jersey City 2,
N. J. Model 15C is a complete wired and tested unit, less cabinet. The receiver tunes continuously from 44 to 216 mc and a switch is provided to turn off sweep and high-voltage circuits when f-m reception alone is desired.

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THE ARNOLD CLOCK CO., 136 W.
52nd St., New York, N. Y. The new precision timer has a single-circuit double-throw switch with a capacity of 500 watts and can be used to turn any electrical unit either off or on. The electric switch has positive action that permits predetermined timing at any 15-minute interval.

**Audio Amplification**

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St., New York 23, N. Y. Type 122 is an audio amplifier unit featuring plug-in channel adaptors which

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by using these **NEW RACON SPEAKERS and HORN UNITS**

Right—NEW RADIAL RE-ENTRANT SPEAKER, excellent for all types of industrial sound installations, provides superlative excellence for all noise, tions, provides superlative intelligibility by efficiently over-riding factory high noise levels. Frequency response 300-6000 cps. Handling capacity 35 watts continuous, 35 w. peak. Has mounting bracket. Size 12” wide by 12 3/4” high.

Left—NEW SMALL RE-ENTRANT HORNS, extremely efficient for factory inter-com and paging systems, for sound trucks, R. R. yards and all other industrial installations where high noise levels are prevalent. Watertight, corrosion-proof, easily installed. Two new models—type RE-1 1/2, complete with Baby Unit, handles 25 watts, covers 300-6000 cps; type RE12, complete with Dwarf Unit, handles 10 watts, has freq. response of 400-800 cps.

Right—NEW SPECIAL PM HORN UNIT, having Almico V magnet ring completely watertight, housed in a heavy aluminum spinning. Provides extremely high efficiency reproduction with minimum input. Handling capacity 35 watts continuous, 60 w. peak.

To the more than 60 different type and size speakers and horn units that already comprise the RACON line—these new models have been added. There is a RACON speaker and horn unit ideal for every conceivable sound system application. RACON has not only the most complete line, but also has the most preferred line. For over 20 years leading Soundmen have recognized and specified them because of dependability, efficiency and low-cost, and because the reproducers are trouble proof.

RACON ELECTRIC CO., INC.
52 E. 19th St.,
New York 3, N. Y.

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Write for catalog describing RACON’S Line of Horns, Speakers, Units, Accessories, etc.
Remember the old days when you used to push your starter button, and hope? Or, maybe, you're still doing it—if you haven't heard about the small charger that helps keep batteries at their peak. But many a car owner is now enjoying new confidence in his car, simply by letting this handy rectifier revive the battery when the car is in the garage. This same rectifier, incidentally, has numerous other applications in recharging 6-volt batteries.

Designing this rectifier to do its job right—making it small enough to sell easily, large enough to function properly—were engineering problems that came within the scope of General Electric engineers. In fact, General Electric's experience covers all phases of rectification problems—from rectifiers the size of an aspirin, to ten-ton rectifiers as big as your garage.

Tell G. E. your problem of d-c supply

When rectification problems come up—unusual problems, or even the routine problem of deciding which type of rectifier to use for a job—call on General Electric. Because General Electric makes all three—selenium, copper-oxide, and Tungar®—General Electric engineers can give you an impartial solution. Because G-E engineers know rectifiers for every type of application, they can give you the kind of practical solution you want.

For information, write to Section A-11-631, General Electric Company, Bridgeport 2, Connecticut.

*SNADE-MARK REG. U. S. PAT. OFF.
Maybe We've Got the Combination to Your Moulded Plastic Job

There's no "Open Sesame" to a new moulding problem. It takes the same old patient hunt for the proper combination—in every function from design and engineering through mould-making, moulding, finishing and the rest.

But there's this bit of magic that still works. Knowing these problems . . . having solved similar puzzles before . . . experienced moulders are liable to get there quicker. And with methods that have been tried and proved.

So look a little deeper than the price tag on your moulder's bid. Experience like ours—a reputation like ours—experienced personnel and a complete, self-integrated plant like ours—these things mean we'll quote a fair price on a job you can depend on quality-wise, cost-wise and delivery-wise.

We're interested in your business, if either compression, transfer or plunger moulding will do the job. May we send a sales engineer?
I-T-E Oval Resistor Assemblies are especially designed to meet the exacting and changing needs of the fast-growing electronics industry.

They are distinguished by their high unit-area wattage ratio which is due in part to the heat dissipation qualities of the mounting brackets. An oval resistor, or assembly of oval units, has a much higher wattage rating than that of a conventional round resistor of comparable size. This quality enables them to meet the requirements of limited space, and makes them particularly suited to compact aviation, sound, radio, and other modern electronics applications.

Oval Resistor Assemblies are part of I-T-E's complete line of wire-wound Power Resistors. Only the highest grade materials are used in their manufacture, and they are given the same thought in design, the same care in fabrication that the most complicated unit of switchgear receives.

No matter what your resistor problem calls for—compactness, long life, dependability, or exact tolerances—be sure to investigate I-T-E Oval Resistor Assemblies, the modern wire-wound Power Resistors. Complete technical information, as well as valuable application data, is contained in the new I-T-E Resistor catalog. Send for it today.

**POWER RESISTORS**

*The Leader In Technical Excellence*

I-T-E CIRCUIT BREAKER CO., RESISTOR DIVISION, 15TH & HAMILTON STS., PHILADELPHIA 30, PA

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

ELECTRONICS — June, 1948

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**I-T-E OVAL RESISTORS**

<table>
<thead>
<tr>
<th>Type</th>
<th>Watts</th>
<th>Length</th>
<th>Maximum Recommended Resistance</th>
<th>Mounting Centers</th>
</tr>
</thead>
<tbody>
<tr>
<td>108 Oval</td>
<td>30</td>
<td>1 1/4&quot;</td>
<td>10000</td>
<td>2&quot;</td>
</tr>
<tr>
<td>200 Oval</td>
<td>40</td>
<td>2</td>
<td>15000</td>
<td>2 1/2&quot;</td>
</tr>
<tr>
<td>316 Oval</td>
<td>55</td>
<td>3 1/2&quot;</td>
<td>23000</td>
<td>4 1/4&quot;</td>
</tr>
<tr>
<td>424 Oval</td>
<td>65</td>
<td>4 1/2&quot;</td>
<td>35000</td>
<td>5 1/2&quot;</td>
</tr>
<tr>
<td>400 Oval</td>
<td>75</td>
<td>6</td>
<td>30000</td>
<td>6 1/2&quot;</td>
</tr>
</tbody>
</table>

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FOR THE HIGH-QUALITY PROFESSIONAL TYPE
Lear WIRE RECORDER

Portable Model in Convenient Carrying Case
Includes AM Radio • Lear High-Fidelity Wire Recorder • Leartronic Scratch Filter • Single Record Phonograph Turntable with Leartronic Pickup • Dynamic Speaker • Microphone.
One Full Hour Spool of Wire with Cue Disc • Index Pads • Connection Cable to attach Lear High-Fidelity Wire Recorder to any radio or loud speaker. Radio time clock, headphones, and additional spools available as accessories.

generous discount arrangements for qualified representatives
cHECK THESE IMPORTANT FEATURES

- A precision instrument
- Built by experienced engineers
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- Easy to operate and use
- Hours of uninterrupted performance
- Automatic timer
- Complete range of models and prices, with and without AM-FM Radio
- Super-fast rewind
- Wire can be used over and over
- Records direct, or from phonograph, radio
- Nationally advertised

Ideal for Radio Stations • Advertising Agencies • Auditions • Air Checks • Remote Broadcasts • Public Events • Schools & Colleges • Dramatic & Voice Teachers • Language Schools • Courts & Police, etc.

We have begun a nation-wide campaign of publicity and advertising that will create steady and profitable demand for the LEAR high-fidelity wire recorder. You can share in these sales and profits while calling on your present trade! If you are an independent radio supply salesman — or, if you operate a radio supply business with a live-wire sales staff — you can make money selling the LEAR High-Fidelity Wire Recorder. We have a most attractive deal for you now — if you are ready to do a REAL SELLING JOB! No middlemen or distributors — this is a direct factory deal where you get the full discounts!

For complete details, send information about yourself, your organization and your territory TODAY — to Dept. C.

NEW PRODUCTS (continued)
35-mm film. Equipped with an f/1.9 lens, the camera can be converted to a continuous film type.

Bidirectional Microphone
TURNER Co., Cedar Rapids, Iowa.
Model 87 velocity microphone uses a single element ribbon generator supported in an Alnio V magnet.
Response is within plus or minus 5 db from 80 to 10,000 cycles. Level is 62 db below 1 volt per dyne per square centimeter at high impedance. A switch allows use into 50, 200, or 500 ohms.

Timing Relay
WARD LEONARD ELECTRIC Co.,
Mount Vernon, N. Y., announces development of the Bulletin 362 mo-

tor driven time delay relay with composite connections. The unit is designed for use in control equipment or systems where an adjustable time delay is required for proper remote, automatic or sequential operation.

Lightning Arrester
RADIO CORP. OF AMERICA, Camden,
N. J., has developed a lightning
MONEY BACK GUARANTEE

We believe units offered for sale by mail order should be sold only on a "Money-Back-If-Not-Satisfied" basis. We carefully check the design, calibration and value of all items advertised by us and unhesitatingly offer all merchandise subject to a return for credit or refund. You, the customer, are the sole judge as to value of the item or items you have purchased.

The Model 88—A COMBINATION SIGNAL GENERATOR AND SIGNAL TRACER

We're prepared for the demand we know will be created by this long overdue combination of the two units which have always been used together. The ultimate in signal tracing procedure is achieved by the Model 88, for the use of this model, enables you to use either the broadcast signal itself or the signal injected by the Signal Generator. This is especially useful of course when servicing "dead" or "intermittent" receivers. The Model 88 you will find is the greatest time-saver ever provided for by combining a full range Signal Generator and Signal Tracer into one unit the set up time for interconnecting, etc., is entirely eliminated.

Signal Generator Specifications:

- Frequency Range: 150 Kilocycles to 50 Megacycles.
- The R.F. Signal Frequency is kept completely constant at all output levels. This is accomplished by use of a special grid loaded circuit which provides a constant load on the oscillatory circuit. A grounded plate oscillator is used for additional frequency stability.
- Modulation is accomplished by Grid-blocking action which has proven to be equally effective for alignment of amplitude and frequency modulation as well as for television receivers.
- Positive action attenuator provides effective output control at all times.
- R.F. is obtainable separately or modulated by the Audio Frequency.

Signal Tracer Specifications:

- Uses the new Sylvania 1N34 Germanium crystal Diode which combined with a resistance-capacity network provides a frequency range of 300 cycles to 50 Megacycles.
- Simple to Operate—Clips directly on to receiver chassis, no tuning controls.
- Provision is made for insertion of phones of any impedance, a standard Volt-Ohm Milliammeter or Oscilloscope.

The New Model 770—AN ACCURATE POCKET-SIZE VOLT-OHM-MILLIAMMETER

(Sensitivity 1000 Ohms per volt)

Features:
- Compact—measures 3-⅞" x 5-⅜" x 2-¼" 
- Uses latest design 2% accurate 1 Mil. D'Arsonval type meter. 
- Same zero adjustment holds for both resistance ranges. It is not necessary to readjust when switching from one resistance range to another. This is an important time-saving feature never before included in a V. O. M. in this price range. 
- Housed in round-cornered, molded case. 
- Beautiful black etched panel. Depressed letters filled with permanent white, insures long-life even with constant use.

Specifications:

6—A. C. VOLTAGE RANGES: 0—15/30/150/300/1500/3000 Volts
6—D. C. VOLTAGE RANGES: 0—7½/15/75/150/300/1500 Volts
4—D. C. CURRENT RANGES: 0—1½/15/150/300/750/1500/7500/15000 Amperes
2—RESISTANCE RANGES: 0—500 ohms 0—1 Megohm

The Model 770 comes complete with self-contained batteries, test leads and all operating instructions.

$13.90

ONLY

20% DEPOSIT REQUIRED ON ALL C.O.D. ORDERS

GENERAL ELECTRONIC DISTRIBUTING CO.
DEPT. 66 98 PARK PLACE, N. Y.
ELECTRONICS — June, 1948

199
Simple New Solderless Couplings
Maintain Constant 51.5 Ohm Impedance

ANDREW Flanged Coaxial Transmission Line for FM-TV

Offering the dual advantage of easy, solderless assembly and a constant impedance of 51.5 ohms, this new ANDREW FM-TV line is available in four diameters. Each line fully meets official RMA standards. It is also recommended for AM installations of 5 Kw or over.

Fabricated in twenty foot lengths with brass connector flanges silver brazed to the ends, sections are easily bolted together. A circular synthetic rubber "O" gasket effectively seals the line. Flux corrosion and pressure leaks are avoided. A bullet-shaped device positively connects inner conductors.

Close tolerances are maintained on characteristic impedance in both line and fittings, assuring an essentially "flat" transmission line system. Mechanically and electrically better than previous types, this new line has steatite insulators of exceptionally low loss factor. Both inner and outer conductors of all four sizes are of copper having very high conductivity. Flanged 45 and 90 degree elbow sections, and a complete line of accessories and fittings are available.

 Better be safe than sorry. Avoid costly post-installation line changes. Get complete technical data and engineering advice, from ANDREW now.

REGULATED DYNAMOTOR

BENDIX AVIATION CORP., Red Bank, N. J., introduces a regulated dynamotor which permits constant output with as much as 25-percent variation in input voltage. The unit is available in various sizes and voltage ratings.

Audio Frequency Meter

BARKER & WILLIAMSON, INC., 237 Fairfield Ave., Upper Darby, Pa. Model 300 audio frequency meter makes direct measurements of unknown audio frequencies up to 30,000 cycles per second.
RECEIVED HEAD SCREWS

OFFER DIMENSIONAL UNIFORMITY INSURED BY CLOSE ENGINEERING CONTROL

ESTABLISHED STANDARDS . . . Every manufacturer of Phillips Cross Recessed Head Screws is supplied with complete engineering and production data which prescribes precise dimensions and tolerances.

CENTRALIZED PRODUCTION TRAINING . . . And, before production is started on Phillips Screws, each plants' supervisory staff puts in an extended training period with Phillips engineers.

COMMON SOURCE OF RECESS FORMING TOOLS . . . Punches for forming the Phillips Cross Recess in all types and sizes of Phillips Screws are formed from master types at one plant. The manufacture of gauges for maintaining uniformity of Phillips Drivers and Bits are similarly centralized.

ENGINEERS' MEETINGS . . . Standards carefully established at the very beginning are rigorously maintained through meetings of “Phillips Recessed Head Standards Committee”. Engineers from all plants meet to exchange ideas, discuss problems and learn about recent developments.

All these precautions to secure absolute dimensional uniformity are just part of the care taken to produce Phillips Cross Recessed Head Screws that give users all the advantage of a cross recess engineered for practical production.

Speed and ease of driving in production assembly demands that the driver and recess fit smoothly, perfectly, the same way every time, all the time. With Phillips Screws, you can depend on it.

GET THIS NEW BOOKLET of facts that prove the top value, top economy of Phillips Recessed Head Screws. It’s free . . . use the coupon.

Phillips Screw Mfrs.,
c/o Norton-Noyes Co.
1800 Industrial Trust Bldg.
Providence, R. I.

Send me the new booklet—“How to Select Recessed Head Screws for Practical Production Driving”.

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Company .
Address .

E-29

ELECTRONICS — June, 1948

201
Imitated But Never Equaled
THE INTERNATIONALLY FAMOUS MECANITRON
HIGH SPEED INK TAPE RECORDER
Model MA-126 Series

The model MA-126 series recorder represents a complete, self-contained high speed ink tape recording system. The Mecanitron recording head represents a new departure in moving coil design. A lightweight, rugged coil of eight ohms impedance is driven by a special, pulse amplifier.

SPECIFICATIONS

MECHANICAL

Watch case construction—entire head may be removed by loosening one thumbscrew.
Tape guide arm provides straight line feed and floating action at the penpoint. This member is also instantly removable for cleaning.
Primary and secondary stops adjustable for any desired character width.
Pen and pen bearings instantly removable.
Pen may be cleaned quickly using straight piece of cleaning wire.
Plastifloat bearings used throughout requiring no lubrication.
Natural period of pen linkage well above 1,000.
Permanent magnet field requiring no excitation, resulting in cool operation.
Deep draft non-spilling ink well.
Micrometer barrel tape vernier adjustment.
Entire head dis-assembled in 30 seconds.
Completely tropicalized.

ELECTRICAL

Output power pulses instantly adjustable for any speed and independent of input signal voltages.
Phase reversing power output switch.
Power output tubes draw no current during signal standby periods.
Screen grid control trigger action in DC amplifier circuit.
Automatic noise limiting bias control in full wave rectifier circuit.
Complete automatic volume control.
All circuits voltage regulated.
Standby switch may be controlled by tape puller.
Built-in multi-contact relay switch controlled by tape tension allowing standby recorders and/or associated circuits to instantly function upon tape depletion.
Four separate and distinct inputs are available as follows:

a. Tone input: This input accepts any tone signal between 700 and 5,000 cycles at Zero DB or more.
b. Teletype: This input accepts the output from a teletype printer and prints teletype characters on inked tape suitable for retransmission at higher speeds by use of a Mecanitron Scanner.
c. Frequency shift: This input allows operation from the discriminator circuit of any standard F.M. receiver, or the detector circuit of any standard AM receiver.
d. Contact: This input allows operation of the recorder by means of any standard telegraph key, permitting the production of inked tape for retransmission.

Mecanitron high speed recorders can be obtained in either single or dual units. Dual units are sometimes required to permit operation of a second unit in standby position for instant use, as the tape in the first unit is used up. Instantaneous changeover makes operation possible without breaks. These units may be supplied for rack mounting if desired.

Write for additional information today!

MECANITRON CORPORATION

General Offices: 8 Irvington Street, Boston 16, Mass.
Phone: Commonwealth 6-2639
Branches: 101 New Hampshire Avenue, Washington 7, D. C., National 0310
142 Bank Street, Ottawa, Ont., Canada, Phone: Ottawa 5-5590

NEW PRODUCTS (continued)

000 cycles. Six ranges are required for the complete coverage of this spectrum. The meter will operate on any waveform with peak ratios of less than 8 to 1, and requires a minimum input of 0.5 volt.

Power Relays

MACK ELECTRIC DEVICES, INC., 30 Glenside Ave., Wyncote, Pa., has developed the Mercu-Trol power relays with 3-coil terminals and featuring a replaceable tube which is hermetically sealed with the contacts, having mercury-to-mercury make and break in inert gas. Contact ratings and coil data may be found in bulletin 410.

Molded Tubular Capacitors

SPRAUGE ELECTRIC CO., North Adams, Mass. Available in all popular capacitance values in 200 to 1,600-volt types, new phenolic molded tubular capacitors are rated for operation from minus 40 to plus 85 C. They are described in Bulletin 210.

Automatic Washing Unit

RAYTHEON MFG. Co., 60 E. 42nd St., New York 17, N. Y. The new automatic washing unit for use on industrial precipitators washes and
How 19,000 companies up take-home pay without upping payrolls

Can you deduct $18.75 from $60.00 and get $66.25? Yes. And the way you can do it is mighty important to your company—and to the nation!

You start with $60, representing someone's weekly take-home pay. You deduct $18.75 for the purchase of a U.S. Savings Bond. That leaves $41.25. But $41.25 isn't what the worker takes home. He takes home $41.25 plus a $25 Savings Bond. Total (assuming he holds the Bond till maturity): $66.25.

WHAT 19,000 COMPANIES HAVE LEARNED

In the 19,000 companies that are operating the Payroll Savings Plan for the regular purchase of Savings Bonds, employees have been more contented in their jobs—absenteeism has decreased—even accidents have been fewer!

Those are the "company" benefits the Plan provides, in addition to extra security for individual employees.

But the Plan has other, far-reaching benefits of basic importance to both your business and the national economy...

SPREADING THE NATIONAL DEBT HELPS SECURE YOUR FUTURE

The future of your business is closely dependent upon the future economy of your country. To a major extent, that future depends upon management of the public debt. Distribution of the debt as widely as possible among the people of the nation will result in the greatest good for all.

How that works is clearly and briefly described in the free brochure shown at the right. Request your copy—today—from your State Director of the U.S. Treasury Department's Savings Bonds Division.

ACTION BY TOP MANAGEMENT NEEDED

The benefits of regular Bond-buying are as important today as ever—but war-time emotional appeals are gone. Sponsorship of the Payroll Savings Plan by a responsible executive in your company is necessary to keep its benefits advertised to your employees.

Banks don't sell Savings Bonds on the "installment plan"—which is the way most workers prefer to buy them. Such workers want and need the Payroll Savings Plan.

Those are the reasons why it's important to make sure that the Plan is adequately maintained in your company. The State Director will gladly give you any assistance you wish.

"The National Debt and You,"
a 12-page pocket-size brochure, expresses the views of W. Randolph Burgess, Vice Chairman of the Board of the National City Bank of New York—and of Clarence Francis, Chairman of the Board, General Foods Corporation. Be sure to get your copy from the Treasury Department's State Director, Savings Bonds Division.

The Treasury Department acknowledges with appreciation the publication of this message by

ELECTRONICS

This is an official U.S. Treasury advertisement prepared under the auspices of the Treasury Department and the Advertising Council
Out on a limb because of shortages?

Call on Air Express. It's the best—and fastest—way to get supplies, parts and equipment. This super-speedy service is a round-the-clock proposition, speeding your shipment via Scheduled Airlines—offering you pick-up and delivery at no extra cost.

Air Express rates are surprisingly low. Use its speed regularly to clip whole days off shipping time, and keep your business running in high gear.

Specify Air Express—World's Fastest Shipping Service

- Low rates—special pick-up and delivery in principal U.S. towns and cities at no extra cost.
- Moves on all flights of all Scheduled Airlines.
- Air-rail between 22,000 off-airline offices.

True case history: Tulsa, Oklahoma, factory regularly gets machine replacement parts by Air Express. Keeps production moving. Typical shipment (35 lbs.) left Milwaukee at 10:10 A.M., delivered Tulsa 6:40 P.M. same day. 655 miles, Air Express charge 85.37. Any distance similarly inexpensive. Phone local Air Express Division, Railway Express Agency, for fast shipping action.

dries all ionizers and collector plates, reapplies the adhesive and shuts off automatically. Units are available in two sizes: 1,200 to 1,500 cfm and 1,800 to 2,250 cfm.

Battery Chargers

RICHARDSON-ALLEN CORP., 15 West 20th St., New York, N. Y., has introduced a new line of small, light, portable battery chargers. Each unit features a direct-reading meter, circuit-breaker protection and selenium rectification. They operate on 110 volts, 50 to 70 cycle a-c current.

Adjustable-Speed Control

RELIANCE ELECTRIC & ENGINEERING CO., Cleveland, Ohio. An electronic excitation control system has been designed for closely controlled speed regulation. Functionally it is comparable to a 2-circuit, motor operated rheostat with a servomechanism, preset speed device controlling the output voltage.

NEW PRODUCTS (continued)
These important books are the first 13 volumes of the Massachusetts Institute of Technology Radiation Laboratory Series, containing, in all 277 titles and indices, was written and edited principally by members of the Radiation Laboratory maintained during the war for electronic research. This outstanding addition to the literature of the field covers advances in radar work, makes these available to all fields concerned with the new electronics—communication, television, biological and physical sciences and the many industries in which electronics is becoming increasingly important.

TECHNIQUE OF MICROWAVE MEASUREMENTS
Vol. 11. Edited by C. G. Montgomery, Associate Professor of Physics, Yale University. 937 pages, illus. $10.00
This book describes in detail the procedures for measuring the properties of microwave and the circuits in which microwave power is used, giving a full description of the measurable quantities of microwave provides sound groundwork for the later chapters which deal with sources of power available for measuring purposes and the means for detecting energy at microwave frequencies. Methods for measuring wave lengths, impedance, frequency, and attenuation are fully described.

MICROWAVE DIPLEXERS
Vol. 14. Edited by L. D. Smulken and C. G. Montgomery, Professor of Physics, Yale University. 437 pages, illus., $6.50
An analysis of the problems of using a single antenna for receiving and transmitting microwave power, including descriptions of the principles of TR and ATB diplexers, with high-level operation explained in detail with diagrams. Several of the circuits used in the tubes. Circuits used for diplexers are fully described.

CRYSTAL RECTIFIERS
Vol. 15. Edited by H. C. Torrey and C. A. White. Rutgers University. 440 pages, illus., $6.00
The characteristics and use of the silicon and germanium rectifiers used as microwave converters and for other circuit applications. Treatment of the theory of semiconductors, of the semiconductor-metal contact, of frequency conversion by rectifiers, and of noise generation by crystals is followed by engineering information on the production and use of practical crystal types. Low-level detectors, high inverse voltage crystals and crystals with negative 1/C2 conductance are described in detail.

MICROWAVE MIXERS
A specialized treatise of the microwave properties of the special receiver to remote interferometers which is useful for studying the frequency of local oscillator and how to stabilize constant-frequency differences between transmitter and local oscillator.

MICROWAVE RECEIVERS
Vol. 23. Edited by S. A. Van Vories, Associate Professor of Physics, University of Rochester. 617 pages, illus., $6.00
This book treats together all the elements making up a wide-band receiver, describing various circuit types—the assembly, testing, and maintenance of microwave receivers. It includes analyses of actual receivers which contain examples of important circuit combinations.

THEORY OF SERVOMECHANISMS
Vol. 25. Edited by H. M. James, Purdue University; N. B. Nichols, Taylor Instrument Company; and R. A. Phillips, University of Southern California. 375 pages, illus., $5.50
Outlines the standard theory of servomechanisms, showing the design of servomechanisms, and providing an introduction to the practical aspect. It covers frequency response, loop gain considerations, drift, and the popular method which depends upon a minimum of rms error with the means for controlling noise and the presence of electrical noise and other disturbances.

COMPUTING MECHANISMS AND LINKAGES
Vol. 27. Edited by A. S. Vodbo, 379 pages, illus., $4.50
A discussion of computing mechanism and a detailed study of the design and operation of the computer. It includes a full account of novel methods for the design of computer and computer components.
These G-E Regulated Power Supplies provide a quick, reliable source of constant d-c voltage. Clean, economical and space-saving, they eliminate the need for expensive batteries that require continuous care, and will prove an indispensable aid in laboratory and production work.

POWER REQUIREMENTS: 105-125 volt, 60-cycle commercial power. Power input 350 watts maximum.

OUTPUT POWER: 250-450 volts d-c (either negative or positive terminal may be grounded as desired). 300 milliamperes maximum.

IMPEDANCE: Approximately 2 ohms at 30 cycles/sec. Decreases with increasing frequency.

ripples: Less than (.005) volts, peak to peak.

load regulation: Less than 1 percent change in output voltage from no load to full load.

POWER REQUIREMENTS: 105-125 volts, 60-cycle commercial power. Power input, approximately 375 watts.

OUTPUT POWER: 250-400 volts d-c, 200 milliamperes individually from two separate supplies, or 250-400 volts d-c, 400 milliamperes from both supplies when operated in parallel.

ripples and noise: Less than 0.020 volt rms.

load regulation: One percent or less change in output voltage from no load to full load, or for line voltage variation from 105 to 125 volts.

Light Soldering Iron

HEXACON ELECTRIC Co., 130 W. Clay Ave., Roselle Park, N. J. The new soldering iron weighs only 5 ounces less cord, and requires no transformer for operation. It works from any regular 110 or 220-volt line circuit a-c or d-c. Designated as catalog No. 30H, list price is $5.00.

Television Capacitors

CORNELL-DUBILIER ELECTRIC CORP., South Plainfield, N. J. The DSTH television capacitors are oil-impregn-
nated and wax-filled. Size range is from 1⁄8-inch diameter by 21⁄2-inch length up to 111⁄2 x 41⁄2 inches; d-c voltage from 3,000 to 6,000.

Sound Projector

ATLAS SOUND CORP., 1443 39th St., Brooklyn 18, N.Y. This stand and mounting fixture permit the illustrated sound projector to be easily directed in any vertical or horizontal angle and permanently locked in the desired position. A complete catalog description is available on request.

Portable Microammeter

RADIO CORP. OF AMERICA, Camden, N. J. Type WV-84A is an ultra-sensitive, portable, battery-operated

Your inquiry will receive immediate and intelligent attention.

Ask also about other Cosmalite types . . . #96 COSMALITE for coil forms in all standard broadcast receiving sets. SLF COSMALITE for permeability tuners. COSMALITE deflection yoke shells, cores and rings.

Spirally wound kraft and fish paper Coil Forms and Condenser Tubes.

Partial list of Radio and Television Receivers in which Cosmalite is used:

ADIMIRAL
ARVIN
BELMONT
BENDIX RADIO
COLONIAL
FARNSWORTH
GENERAL ELECTRIC
HOWARD
MAGNAVOX
MOTOROLA
SENTINEL
STEWART WARNER
WARWICK
WELLS GARDNER
ZENITH

Note: We also have available numerous stock punching dies.

New Products

(continued)
Kester dependability reduces soldering costs!

LAYOUT CONTROLLED

Watch the work flow when Kester Plastic Rosin-Core Solders are applied to your soldering operations. Kester Cored Solders are made to rigid specifications and can be depended upon to give uniform results every time. There is a Kester "Specialized" Flux-Core Solder in strand size, type of flux, and alloy to fit your needs. Consult our Technical Service Department on any soldering problem.

KESTER SOLDER COMPANY
4204 Wrightwood Avenue, Chicago 39, Illinois
Factories also at Nework, New Jersey - Bramford, Canada

KESTER SOLDER

NEW PRODUCTS (continued)

ated microammeter for measuring d-c currents ranging from 0.001 to 1,000 microamperes. The instrument can also be used as a high-range ohmmeter when connected to a suitable power supply.

Antenna Conversion
J. F. D. MANUFACTURING CO., INC., 4109-4123 Ft. Hamilton Parkway, Brooklyn 19, N. Y. A new line of f-m and television antennas with conversion kits has been assembled. In all there are 22 different types ranging from the single straight dipole to the double-stacked folded dipole with high-frequency lobes, as illustrated. The line covers the 44 to 216-mc range, channels 1 to 13 and f-m bands.

Tap Switch Rectifier
RICHARDSON-ALLEN CORP., 15 West 20th St., New York, N. Y., announces a new series of selenium
NEW PRODUCTS (continued)
rectifiers with 36-position tap switch controls. The units are standard up to 27-kw capacity.

Auto-Radio Vibrators
AMERICAN TELEVISION & RADIO Co., 300 E. Fourth St., St. Paul 1, Minn., announces a complete line of auto-radio vibrators designed for use in standard vibrator-operated auto and household radio receivers. The new line, featuring ceramic stack spacers, is covered in the recently released Vibrator Guide which is available free of charge.

Television Transformers
HILBURN ELECTRONIC PRODUCTS Co., 1 Worth St., New York 13, N. Y. Series ZV video and sound transformers are stagger tuned, have a 4-mc bandwidth, with sound rejection of 150 to 1 and adjacent channel rejection of 100 to 1.

Miniature Socket
CINCH MFG. CORP., 2335 W. Van Buren St., Chicago 12, Ill. A new type miniature socket features a contact construction which insures continuous and consistent mainte-
We undertake the Design, Development and Manufacture of any type of Optical—Mechanical—Electrical Instrument, Including Cameras for special purposes.

Avimo Limited, Taunton, England • Telephone Taunton 3634

KEEP POSTED ON ELECTRON TUBES

Use this convenient coupon for obtaining the RCA tube reference data you need.

RCA, Commercial Engineering, Section FW-40, Harrison, N. J.

Send me the RCA publications checked below. I am enclosing $... to cover cost of the books for which there is a charge.

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City ____________________________  Zone ______  State ______

☐ Quick-Reference Chart, Miniature Tubes (Free). [A]
☐ HB-3 Tube Handbook ($10.00)*. [B]
☐ RC-15 Receiving Tube Manual (35 cents). [C]
☐ Receiving Tubes for AM, FM, and Television Broadcast (10 cents). [D]
☐ Radiotron Designers Handbook ($1.25). [E]
☐ Quick Selection Guide, Non-Receiving Types (Free). [F]
☐ Power and Gas Tubes for Radio and Industry (10 cents). [G]
☐ Phototubes, Cathode-Ray and Special Types (10 cents). [H]
☐ RCA Preferred Types List (Free). [I]
☐ Headliners for Hams (Free). [J]

*Price applies to U.S. and possessions only.

TUBE DEPARTMENT

RADIO CORPORATION OF AMERICA

HARRISON, N. J.

June, 1948 — ELECTRONICS
nance of critical dimensions and holding tension of the contact. It is available in 1-inch and 1/8-inch mounting centers, plain or shielded, and in grounded types with seven or eight contacts.

Professional Recorder
ROBINSON RECORDING LABORATORIES, 2022 Sansom St., Philadelphia 3, Pa., introduce the new lathe type recorder for professional work in radio stations and recording studios. Wow factor is reduced to 0.01 percent by use of a new belt drive and dynamically balanced components. The unit also features a ground thread feed screw which eliminates the feed screw pattern.

Loudspeaker
RADIO-MUSIC CORP., Port Chester, N. Y. The new Hyper-Mag loudspeaker features a parabolic projector and frequency range from 50 to 15,000 Hz. It is designed for professional use in radio stations and recording studios.

Do you have complete data on the revolutionary new HELIPOT—the helical potentiometer-rheostat that provides many times greater control accuracy at no increase in panel space?... or on the equally unique DUODIAL that greatly simplifies turns-indicating applications? If you are designing or manufacturing any type of precision electronic equipment, you should have this helpful catalog in your reference files...

**It Explains** - the unique helical principle of the HELIPOT that compacts almost four feet of precision slide wire into a case only 1 3/4 inches in diameter—over thirty-one feet of precision slide wire into a case only 3 1/8 inches in diameter!

**It Details** - the precision construction features found in the HELIPOT... the centerless ground and polished stainless steel shafts—the double bearings that maintain rigid shaft alignment—the positive sliding contact assembly—and many other unique features.

**It Illustrates** - describes and gives full dimensional and electrical data on the many types of HELIPOTS that are available... from 3 turn, 1 3/4" diameter sizes to 40 turn, 3" diameter sizes... .5 ohms to 500,000 ohms... 3 watts to 20 watts. Also Dual and Drum Potentiometers.

**It Describes** - and illustrates the various special HELIPOT designs available—double shaft extensions, multiple assemblies, integral dual units, etc.

**It Gives** - full details on the DUODIAL—the new type turns-indicating dial that is ideal for use with the HELIPOT as well as with many other multiple-turn devices, both electrical and mechanical.

If you use precision electronic components in your equipment and do not have a copy of this helpful Helipot Bulletin in your files, write today for your free copy.

THE Helipot CORPORATION, 1011 MISSION ST. SOUTH PASADENA 2, CALIF.

NEW PRODUCTS (continued)
to over 10,000 cycles at low distortion. It is fully described in Bulletin HS-1.

**Sweep Signal Generator**

ELECTRONIC CORP. OF AMERICA, 170 53rd St., Brooklyn 32, N. Y. New York, N. Y. An f-m and television signal generator featuring a sweep width of 500 kc to approximately 10 mc with a 60-cycle horizontal sweep output, has a frequency range of 2 to 227 mc in three bands. Price is $34.95 complete.

**Testing Multimeter**

M. C. MILLER, 1142 Emerson Ave., W. Englewood, N. J. Model No. 5 is a multi-combination meter designed for electrolysis and corrodion investigations and cathodic protection testing both in field and laboratory. It provides all of the instrumentation required to cover the wide range of d-c current and potential measurements necessary in this field. The unit weighs about 23 pounds.

**Synchronizing Generator**

ALLEN B. DU MONT LABORATORIES, INC., 42 Harding Ave., Clifton, N. J. Type 5030-A is a portable
television synchronizing generator useful for testing transmitters, experimental development and laboratory work. Only a-c power is required. Half-line driving pulses are provided for using differential delay techniques necessary for long camera cable hookups. The instrument weighs about 50 lb.

Synchronizing Speed Control

RELIANCE ELECTRIC & ENGINEERING CO., Cleveland, Ohio. The Short Stroke Dancer Roll Control is designed for synchronizing the speed of independently driven machines used in paper finishing, rubber extrusion and other continuous process operations. The unit has been designed for 230 volt d-c service and a maximum current of 2 amperes.

Audio Amplifiers

SETCHELL CARLSON, INC., 2233 University Ave., Saint Paul 4, Minnesota. Model PA722 master amplifier and model B422 booster are illustrated. As many as ten boosters can be used, each one providing its own 25-watt output with separate gain control. The booster units are

$ Profit and Exquisite Record Reproduction...

JOBBERS ... SERVICEMEN ... turn service calls into profitable sales with ease. This new LEAR Reluctance Pick-Up transforms "flat" old-fashioned sound into full-toned modern reproduction!

This new, improved High-Fidelity Reluctance Pick-Up is LEAR engineered to excel in quality of performance ... and priced for your profit. Replaces millions of old style crystal pick-ups now in use! Jewel stylus eliminates needle changing — holds surface noise to a bare minimum. It performs a miracle of modernization — assures full tonal beauty of sound wherever installed.

List this "hot" seller in your catalog! Service men who feature the new LEAR Magnetic Pick-up will pick up extra profits every day! Cash-in now—write for complete discount price list today!

To complete your LEAR Sound Service:

New, Improved LEAR PRE-AMPLIFIER, List Price-$6.90

To provide additional amplification with use of MP-103 LEAR Magnetic Pick-up. Can be connected directly to old crystal cartridge unit. High voltage and filament wires provided for connection into existing equipment. Two-position switch permits high fidelity response to finest quality recordings.

No. PA-103 (not shown here)—LEAR Tone Arm Assembly with MP-103 Magnetic Variable Reluctance Pick-Up Cartridge, List Price $15.50.

Designed for high-fidelity reproduction of 10" and 12" recordings. Spring counter-balance provides "feather touch" operation — only 17 grams stylus pressure on record. This reduces record wear to a minimum. Handsomely finished in brown metallic.

Factory Representatives—Distributors: A few choice territories are still available for these and other fine LEAR Electronic Products. Write today giving full details.

110 Ionia Ave. N.W., Grand Rapids, Mich.
115 Volts
60 Cycles
Two Models
100 Watts
Single heat
100/135 Watts
Dual heat

See your radio parts distributor or electrical wholesaler. Or write direct for bulletin.

WELLER Mfg. Co.
806 Packer St. • Easton, Pa.

WHAT ARE LEAKS COSTING YOU IN PRODUCT PERFORMANCE OR EQUIPMENT FAILURE?

VEECO
MASS SPECTROMETER

LEAK DETECTOR
Makes BIG profits by finding small leaks

The Veeco finds small holes, locates them accurately. Highly sensitive vacuum and pressure testing finds small leaks in industrial equipment and finished products. Quick, dependable. Now successfully used for testing: electronic tubes, glass-to-metal seals, hermetically sealed systems, condensers, and scores of other products. Simple operation. Literature LD-35 upon request.

*Manufactured under license of the University of Minnesota

NEW PRODUCTS
(continued)

mechanically attached to the base of the amplifier by means of concealed tiebolts.

Gauss Meter

GENERAL ELECTRIC Co., Schenectady 5, N. Y. The new direct-reading gauss meter, with a probe diameter of 0.052 inch, permits measurement of flux in small-gap magnets of standard or irregular shape. Also available is a triple kit combining three meters of different ratings in a single carrying case. Ask for bulletin GEC-238.

Literature

Laboratory Instruments. Technology Instrument Corp., 1058 Main St., Waltham 54, Mass. A new bulletin describes and illustrates types 410-A r-f oscillator and 310-A Z-Angle meter. Specifications and simplified circuit diagrams are included.

Snap-Action Switches. Micro Switch, Freeport, Ill. Microtips, the first issue of a new publication, promises to tell in following
issues how plant engineers and electrical maintenance men are using snap-action switches. The pamphlet is punched for a standard 3-ring binder so that each copy may be filed for ready reference.

Magnetic Iron Powders. C. K. Williams & Co., Metallurgical and Electronic Division, 2001 Lynch St., East St. Louis, Ill., offers a brochure filled with data and a price list on a variety of IRN magnetic iron powders. Also available is the condensation of an article on the effective permeability of h-f iron cores.

Terminals. Shakeproof Inc., Division of Illinois Tool Works, 2501 North Keeler Ave., Chicago 39, Ill. Catalog A-S-51 contains dimensional data and general information to simplify selection and specification of proper wiring terminals for designers and draftsmen of radios and electrical devices. Working drawings of each part are included.

Crystal Units. Standard Piezo Co., P. O. Box 164, Carlisle, Pa. Eleven types of crystal units are pictured in a 4-page folder. Chief features are outlined and ordering information is given.

Miniature Speed Changers. Metron Instrument Co., 482 Lincoln St., Denver 9, Colorado. Bulletin No. 100 shows three types of miniature speed changers with a table giving all of the standard integral ratios. Power is transmitted either way for ratios below 230 to 1.

Coaxial Frequency Meter. Frequency Standards Corp., 237 Lafayette St., New York 12, N. Y. A loose-leaf perforated folder points out the prominent features of model 315A frequency meter which covers the 300 to 1500-mc range in four overlapping bands.

Portable Wire Recorder. Precision Audio Products, Inc., 1133 Broadway, New York 10, N. Y. Two sides of a single sheet show

Flexible Shaft Control Is As Good As You Require

You can get any degree of fidelity and sensitivity you need with S. S. White remote control flexible shafts.

Bear in mind, these shafts were developed specifically for control service. They have the necessary physical properties to provide a quality of control that satisfies the requirements of most applications. Its simply a matter of correct shaft selection and application.

Where vernier accuracy is essential, it is readily obtained by connecting the shaft to control and controlled members through simple gearing.

Get Full Details in This 260-Page Flexible Shaft Handbook

We'll gladly send you a copy, free, if you write for it on your business letterhead and mention your position.
Leakproof

ENAMELED MAGNET WIRE

A product, resulting from many years of research in the field of fine wire manufacture, that meets the most rigid requirements of radio and ignition coils.

A new coating method gives a smooth, permanently - adherent enameling, and mercury-process tests guarantee perfect uniformity. Great flexibility and tensile strength assure perfect laying, even at high winding speeds. If you want reduction in coil dimensions without sacrificing electrical values, or seek a uniform, leakproof wire that will deliver extra years of service, this Hudson Wire product is the answer.

Winsted HUDSON WIRE CO. Division
WINSTED • CONNECTICUT

Studio Quality AMPLIFIERS
WITH CUSTOM-BUILT FEATURES

Design of Bardwell & McAlister's New Commercial Amplifiers embodies the principles which have been proven in custom-built units developed in the Motion Picture Industry, where quality is requisite. Fully licensed.

12w. models operate up to 8 indoor speakers, effectively cover outdoor audience of 2500.
25w. models operate up to 16 indoor speakers, effectively cover outdoor audience of 8000.

2 to 4 high gain input channels and 2 to 4 high or low gain radio or phonograph input channels.

High fidelity reproduction at any setting of volume controls up to full rated output with less than 4% distortion.

Frequency response flat within ¼ db from 50 to 10,000 cycles.

Output impedances 500, 250, 16 & 8 ohms. Overall gain 105 db. Hum level 85 db below full output.

Designed & fabricated by manufacturers of high quality Sound & Recording Equipment for the Motion Picture Industry. Union made.

With or without professional "T" type bass and treble equalizers.

Write today for informative catalog & Technical data. Dealer inquiries invited.

ELECTRONIC DIVISION
BARDWELL & McALISTER, INC.
BOX 1310, HOLLYWOOD 28, CALIFORNIA

June, 1948 — ELECTRONICS
the outstanding features and technical specifications of the Wirer- master, a portable wire recorder. Frequency range is from 40 to 10,000 cps and the unit has separate listening and recording volume controls.

Laboratory Monitor. Tracerlab, Inc., 55 Oliver St., Boston 10, Mass. Model SU-3 was developed for use as a routine contamination monitor in radioactivity laboratories. Bulletin No. 9 gives a 12-page description of the instrument complete with diagrams.

Vacuum Melting. National Research Corp., 70 Memorial Drive, Cambridge 42, Mass. The new brochure on high-vacuum furnaces outlines equipment for metallurgical melting and casting in the micron pressure range. Components are sketched and described, and a bibliography is included.

Sound Reproduction. Terminal Radio Corp., 85 Cortlandt St., New York 7, N. Y. Amplifiers, microphones, loudspeakers, and wire recording equipment are described and illustrated in an eight-page catalog. Prices for individual items are listed.

Receiving Tube Reference. Radio Corp. of America, Harrison, N. J. The latest edition, form 1275-D, is a compact and informative booklet on receiving tubes for television, f-m and standard broadcast. Price is ten cents.

Sound Recorder. Sound Apparatus Co., 233 Broadway, New York 7, N. Y. Literature is now available on the newly designed model HPL high speed recorder and requests for the bulletin "Sound Advances" will be promptly filled.

Portable C-R Scope. Tektronix, Inc., 1516 S. E. Seventh Ave., Portland 14, Oregon. A recent 4-page folder on the type 511 cathode-ray oscilloscope gives a general description of the portable unit along with a thorough treatment of its vertical and horizontal de-

NEW PRODUCTS

NEW DEVELOPMENTS IN VACUUM CAPACITORS

By

United Electronics Company

When the older types of vacuum capacitors were designed, the sole conception of advantage was to attain a voltage breakdown characterized higher than could be accomplished with condensers of the same physical size with air or other substance as dielectric.

The limitations of the old types of vacuum capacitors resulted principally from high R.F. losses and a high temperature co-efficient. This caused considerable capacitance drift, and the added heat losses in the glass envelope led to external voltage breakdown or internal breakdown due to the liberation of gas. Actual seal puncture in these early type vacuum capacitors was also a frequent cause of failure. Extraneous inductance was caused by the use of conventional ferrous metal rod seals and copper strand leads soldered to the terminal caps, in the old type of construction. The higher the frequency and R.F. power, the more these limitations were accentuated.

Outstanding features of UNITED vacuum capacitors are the employment of large copper elements and large periphery glass to copper seals, and end caps as illustrated. This construction results in a low temperature co-efficient, low R.F. losses and low inherent inductance. End flanges as well as terminals are gold plated to prevent corrosion.

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UNIVERSAL vacuum capacitors have OFHC copper elements for high RF conductivity. Low temperature coefficients and noninductive characteristics make these units desirable for high power, high frequency applications where space, minimum drift and freedom from breakdown are important considerations.

Type designations of UNITED vacuum capacitors symbolize their capacitance ratings and their maximum current and voltage ratings—thus:

\[ C = \frac{A}{P} \]

Capacitance Amperes Potential

(50 uuf) (60) (35 KV)

The numerals are significant as shown in direct relation to the prefix letters.

The 5 types listed below are designed for peak working voltage of 35 KV.

<table>
<thead>
<tr>
<th>Type</th>
<th>Capacitance uuf</th>
<th>Maximum Current</th>
<th>R. F. Voltage</th>
<th>Length</th>
<th>Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAP-25/30/35</td>
<td>25</td>
<td>30 amps.</td>
<td>35 KV</td>
<td>6 1/2&quot;</td>
<td>2 3/4&quot;</td>
</tr>
<tr>
<td>CAP-50/60/35</td>
<td>50</td>
<td>60 amps.</td>
<td>35 KV</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CAP-75/60/35</td>
<td>75</td>
<td>60 amps.</td>
<td>35 KV</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CAP-100/60/35</td>
<td>100</td>
<td>60 amps.</td>
<td>35 KV</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CAP-250/60/35</td>
<td>250</td>
<td>60 amps.</td>
<td>35 KV</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Contact terminal diameter 13/16; length 23/32; standard capacitance tolerance ± 2%; can be furnished in precision tolerance ± 1% at increased cost.

Write for a copy of our latest catalog on Transmitting Tubes featuring the Patented Isolated Getter Trap and Complete data on Vacuum Capacitors.

UNITED ELECTRONICS CO.
42 Spring Street
Newark 2, New Jersey
The No. 92105 Single Sideband Selector

We announce the No. 92105 Single Sideband Selector, see April QST for technical details, which permits single sideband selection with your present receiver! Produced in co-operation and under exclusive U.S. patent license (2,364,863 and others) with the J.L.A. McLaughlin Research Laboratories.

JAMES MILLEN MFG. CO., INC.
MAIN OFFICE AND FACTORY
MALDEN MASSACHUSETTS

NEW PRODUCTS

(continued)

 Reception systems. Characteristics and other pertinent data are covered.

Components. Hugh H. Eby, Inc., 4741 Stenton Ave., Philadelphia, Pa., announces publication of a 48-page loose-leaf catalog showing a complete line of components. Pertinent dimensions of sockets, plugs, connectors, jacks, terminal strips and a wide variety of binding posts in many models and sizes are given.

Microwave Supplies. The Waveguide Mfg. & Equipment Co., Inc., 125 E. 23rd St., New York 10, N. Y. A recently issued catalog illustrates and describes a variety of microwave test equipment, assemblies and components.


Precision Switches. Micro Switch Corp., P. O. Box 561, Freeport, Ill. Temporary data sheet 41 gives characteristics, diagrams and prices of skeleton switches. Also available is a loose-leaf descriptive sheet showing a switch in actual operation.

Electronic Timers. Radio Corp. of America, Harrison, N. J. Application Note AN-131 describes the use of type 2D21 or 2050 thyatrons in electronic timer circuits.


Cathode-Ray Equipment. Allen B. DuMont Laboratories, Inc., Clifton, N. J. The Oscillographer is a bi-monthly loose-leaf perforated publication with information on different types of c-r tubes, polar-

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in quantities suitable to Volume Production...it may pay you to call upon the Design Engineers of United-Carr and its subsidiaries. They have helped many manufacturers

* CUT COSTS
* SPEED PRODUCTION
* TURN OUT FINER FINISHED PRODUCTS

UNITED-CARR FASTENER Corp.
CAMBRIDGE 42, MASSACHUSETTS

MAKERS OF DIRT FASTENERS

June, 1948 — ELECTRONICS

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FASTER, SIMPLER  
AUDIO ANALYSIS  
with Model AP-1

PANORAMIC SONIC ANALYZER
Reduce time, complexity and cost of making audio measurements with the unusual advantages offered by the Panoramic Sonic Analyzer. By resolving a complex audio wave into a spectrograph showing the frequency distribution and voltage amplitude of the components, Model AP-1...

- Eliminates slow point-by-point frequency checks
- Provides a quick overall view of the audio spectrum
- Enables determination of changes in waveform content while parameters are varied
- Furnishes simple presentations for production line testing.

Panoramic Sonic Spectrograph of 750 cps square wave.

Features...
- Continuous scanning from 40-20,000 cps in one second
- Wide input voltage range
- Linear and log voltage scale
- Closely logarithmic frequency scale
- Built-in voltage and frequency calibrator
- Simple operation.

WRITE for detailed specs, price and delivery.

AMPERITE MICROPHONES
The ultimate in microphone quality, the new Ampereite Velocity has proven in actual practice to give the highest type of reproduction in Broadcasting, Recording, and Public Address.

The major disadvantage of pre-war velocities has been eliminated—namely "booming" on close talking.

- Shout right into the new Ampereite Velocity—or stand 2 feet away—the quality of reproduction is always excellent.

- Harmonic distortion is less than 1% (Note: best studio diaphragm mikes is 500% higher).
- Practically no angle discrimination...120° front and back. (Best studio diaphragm microphones—discrimination 800% higher).
- One Ampereite Velocity Microphone will pick up an entire symphony orchestra.

STUDIO VELOCITY, finest in quality: Ideal for Broadcasting and Recording.
Models R6BH, R6DL. List $40.00
There is an Ampereite Microphone for every requirement.

WRITE FOR ILLUSTRATED 4-PAGE FOLDER giving full information and prices.

AMPERITE Company, Inc.
561 BROADWAY NEW YORK 12, N. Y.

HEAT RESISTANT WIRES FOR EVERY APPLICATION...

HAVE YOU A Wire Problem?

If it concerns heat and age resistance, we're specialists and have been for twenty years. Whether it is dropping excessive voltages—maintaining higher than ambient temperatures in equipment—high current conductors—heating element leads in crystal temperature control ovens—if it's got to be tough to continually withstand wear and tear...

Lewis can give you the answer

Send your electronic control, communications or appliance wiring specifications for a recommended solution by our engineers.

FOR A TRIAL ORDER OR A CARLOAD consult

THE LEWIS ENGINEERING CO.
Wire Division
NAUGATUCK, CONNECTICUT

AMPERITE Velocity Microphones for Public Address Models RBHG, RBLG List $42.00

AMPERITE Velocity Microphones

In Canada:
Ontario: Atlas Radio Corp., 250 King St. W.
Toronto, Ont.

Heat Resistant Wires

Heat Resistant Wires for Every Application

Resistance Line Cord
Thermocouple Wire
Asbestos Lead & Fixture Wire
Insulated Resistance Wire
Fiberglas Insulated Wire
Wire to Any Specifications

LEWIS can give you the answer

Send your electronic control, communications or appliance wiring specifications for a recommended solution by our engineers.

FOR A TRIAL ORDER OR A CARLOAD consult

THE LEWIS ENGINEERING CO.
Wire Division
NAUGATUCK, CONNECTICUT

WIRE DIVISION

219
Control of VIBRATION and IMPACT

... with special emphasis on the field of electronics

We offer a complete line of highly engineered Vibration and Impact isolators for commercial, industrial and military applications... also an Engineering consulting service on special problems.

A letter from you will give us the opportunity to demonstrate how we can help you.

Catalogue on request

IS YOUR PROBLEM COUNTING OR CONTROLLING ONE OF THESE?

- then COUNT on a POTTER High-Speed Predetermined ELECTRONIC COUNTER

For appraisal of your counting, timing or control problem, address inquiries to Dept. 6-J, Potter Instrument Company, 136-56 Roosevelt Ave., Flushing, New York.

NEW PRODUCTS (continued)

coordinate indicators, h-v power supplies, oscillographs and like equipment.

Speakers. Altec Lansing Corp., 250 W. 57th St., New York 19, N. Y., gives response curves and data on four of its outstanding speaker designs in a recently issued 6-page folder.

Synthetic Sapphire. Sapphire Products Division, Elgin National Watch Co., Aurora, Ill. An 8-page pamphlet explains the uses and properties of synthetic sapphire in industry.

Wire Recorder. Electronic Sound Engineering Co., 4344 Armitage Ave., Chicago 39, Ill., has a brochure describing the Polyphonic Sound recorder model PS179. Frequency range of the system is 30 to 15,000 cycles.

Metal-Backed Screen. General Electric Co., Syracuse, N. Y. A new 10-inch metal-backed direct-view television picture tube that gives better pictures at more normal ambient light levels has recently been announced.

Communications Equipment. Browning Laboratories, Inc., Winchester, Mass. A 4-page brochure describes the line of tuners, frequency meters, capacitance alarm, and other devices.


Carbon-Graphite. Stackpole Carbon Co., St. Marys, Pa. Tube anodes, battery carbons, ground rods, electrical contacts, and spectrographite are among the many carbon products discussed in a new 44-page booklet.

NEW PRODUCTS (continued)
describes the type 1141-A audio-frequency meter as well as the 1231-B amplifier and null detector. Illustrations, schematic diagrams and characteristic curves of both units are also shown.

Miniature Iron. Television, Inc., New Rochelle, N. Y. The Soldetron miniature soldering copper operates from a storage battery or 6-volt transformer and is described in a sheet recently issued.

Plastic Bulletin. Fabri-Form Co., 100 Seneca St., Byesville, Ohio. Some of the newest ways to use plastics are shown in a new 12-page bulletin. Over fifty drawings and photographs illustrate detailed parts in a manner that is simple to the layman.

H-F Conductor. Titeflex, Inc., 591 Frelinghuysen Ave., Newark 5, N. J. Water-cooled, flexible leads for use in conducting high-frequency currents are described in a folder just issued. List prices are included.

Timing Motors and Devices. Haydon Mfg. Co., Torrington, Conn. Of value to engineers and designers is the 16-page, 2-color catalog No. 320 on synchronous timing motors, timing devices and clock movements.

Miniature Tubes. Tung-Sol Lamp Works Inc., Newark 4, N. J. Actual sizes, advantages and applications of a line of miniature electron tubes are discussed in a six-page pamphlet.


Radio and Recorder Catalog. Hoffman Radio Corp., Los Angeles, Calif., has published a 16-page catalog of its 1948 line. The brochure, specially featuring the

For Unusual and Difficult Requirements

USE ADC TRANSFORMERS

- Research
- Models
- Testing

STEEL When a steel company engineer was presented with a problem of testing steel with an application of variable frequency, an oscillator output impedance as low as 0.01 ohms was required over a wide frequency range.

Through the aid of ADC engineers and the use of special ADC designed transformers a regular oscillator was equipped to perform the test satisfactorily with great savings in time and money to the steel company. Remember ADC as a transformer source for unusual and difficult assignments as well as for high quality and dependable production transformers.

COMMUNICATIONS Today a large utility company has a satisfactory communication system between its central location and its mobile units because ADC engineers worked out technical transformer applications for the maker of a power line carrier telephone. From model stage to production this company depended upon the skill of ADC transformer design and production. You, too, will find ADC helpful in all unusual model work as well as production.

ENGINEERING The development of a computer to check the muzzle velocity of a cannon with greater accuracy required many special transformer applications. This job is typical of scores of development tasks presented to ADC engineers from university laboratories, communication developments, guided missile programs and developmental engineers everywhere. ADC supplies transformer "know how" with excellent transformer production to assure you a reliable source of dependable transformers.

Have an ADC catalog in your file for ready reference. Write us about your special problems.

Foreign Inquiries Solicited, Cable address: AUDEVCO MINNEAPOLIS

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ZOPHAR
Waxes, Compounds and Emulsions

Materials for potting, dipping or impregnating all types of radio components or all kinds of electrical units. Tropicalized fungus proofing waxes. Waterproofing finishes for wire jackets. Rubber finishes. Inquiries and problems invited by our engineering and development laboratories.

ZOPHAR MILLS, Inc.
117 26th STREET, BROOKLYN, 32 N. Y.

ZOPHAR MILLS, Inc. has been known for its dependable service and uniformity of product since 1846.

Self-Contained to 6000 V
5 Mgs, 600 MA, +70 DB, with full size
3" Rectangular Meter

Net Price $247.5

In custom molded carrying case, Series 40 is ideally dimensioned and engineered as a portable, compact test set to withstand hard usage as imposed by the maintenance engineer, production inspector, trouble-shooter, etc. Series 40 offers features and components as incorporated in "Precision's" larger test sets, including: Rotary Selection - 1% shunts and multipliers - heavy duty insulated pin jacks - Large numeralled, easy reading meter.

ALL RANGES are SELF-CONTAINED.
NO EXTERNAL BATTERIES OR MULTIPLIERS ARE REQUIRED.

RANGE SPECIFICATIONS

* 6 A.C.-D.C. & Output Voltage Ranges: all at 1000 ohms per volt. 0-3-15-60-300-1200-6000 volts.
* 4 D.C. Current Ranges: 0-6-60-600 MA.
* 3 Resistance Ranges: self-contained batteries. 10-500-5000-100,000 ohms, and 0.5 megohms.
* 6 Decibel Ranges from -22 to +70
* Full Size 3" Rectangular Meter:
  200 microamperes 1% accuracy
  1% Wirewound & Metallized Resistors.
  Only 2 Pin Jacks serve all standard functions.
  Recessed 6000 volt safety jack.
  Anodized, etched aluminum panel. resistant to moisture and wear.

See the new "Precision" Test Set now on display at all leading radio parts and equipment distributors, or write directly for the Precision 1948 catalog describing the complete Precision line of quality Electronic Test Instruments for all phases of modern radio-electronics - A.M., F.M. and TV.

PRECISION
APPARATUS CO., Inc.
92-27 Horace Harding Blvd.
Elmhurst 10, N. Y.

Export Division: 458 Broadway, N. Y. City, U.S.A.
Cables: MORHANEX

June, 1948 - ELECTRONICS
NEW PRODUCTS

Wirecord and Musicord, is spiral bound, profusely illustrated and printed in three colors.

Pins and Leads. The Bead Chain Mfg. Co., Mountain Grove and State Streets, Bridgeport 5, Conn. Multiswage contact pins are constructed with a hole through the entire length to facilitate threading lead wires. The contact pins are used for radio tubes, panel-mounted terminals, jacks, and leads for miniature and other radio tubes.

Insulating Material. General Ceramics and Steatite Corp., Keasbey, N. J. Catalog 3000 shows various methods of producing steatite insulators. Different types and shapes are discussed with mechanical drawings given throughout.

Test Instruments. General Electronic Distributing Co., 98 Park Place, New York 7, N. Y. Several models of tube and set testers, volt-ohm-milliammeters, signal generators and tracers are described in an 8-page catalog. Specifications and price of each are given.

Phase-Shift Modulator. Radio Engineering Laboratories, Inc., 35-54 36th St., Long Island City 1, N. Y. Bulletin 5080 contains a description of characteristics, functions and technical specifications of the Serrasoid phase-shift modulator for f-m broadcasting.

Metered Variable Transformers. Standard Electrical Products Co., 400 Linden Ave., Dayton 5, Ohio. A four-page folder describes a new line of Adjust-A-Volt metered variable transformers, including isolated primary transformers with secondary voltages of 0 to 140 volts and autotransformers with the same output voltage.

Radio Service Encyclopedia. P. R. Mallory & Co., Inc., Indianapolis, Ind. The sixth edition of this reference book of useful service information contains 25 percent more listings than the fifth edi-

Sensitivity MULTIPLE ARM RELAYS

A. C. and D. C.

SIGNAL ENGINEERING offers a new series of small, rugged, general purpose Multiple Arm Relays adaptable to a wide variety of circuit arrangements.

OUTSTANDING FEATURES:

Mounting area minimized. Vertical balanced armature. Interchangeable unit contact pile-ups. Unusually high contact pressures. Shock and vibration resistant. Four styles of assemblies:

1. Relays only.
2. Octal base and removable dust cover.
3. Octal base and hermetically sealed cover.
4. Header type container, hermetically sealed.

Write for Bulletin 50-6 containing complete engineering data.

STANDARD SIGNAL GENERATOR

MODEL 65-B
RANGE 75 KC to 30 MC

Individually Calibrated Scale

OUTPUT: Continuously variable, .1 microvolt to 2.2 volts.
OUTPUT IMPEDANCE: 5 ohms to .2 volt, rising to 15 ohms at 2.2 volts.
MODULATION: From zero to 100%. 400 cycles, 1000 cycles and provision for external modulation. Built-in, low distortion modulating amplifier.
POWER SUPPLY: 117 volts, 60 cycles, A.C.
DIMENSIONS: 11" high, 20" long, 10½" deep, overall.
WEIGHT: Approximately 50 lbs.

Catalog on request

MANUFACTURERS OF

Standard Signal Generators
Pulse Generators
FM Signal Generators
Square Wave Generators
Vacuum Tube Voltmeters
UHF Radio Noise & Field Strength Meters
Capacity Bridges
Megohm Meters
Phase Sequence Indicators
Television and FM Test Equipment
A NEW OSCILLOSCOPE WITH EQUAL HIGH GAIN D.C. AMPLIFIERS ON BOTH X & Y DEFLECTION PLATES.

★ Frequency range on both plates from 0 to 3 Mc/s; 3 db loss at 3 Mc/s; sensitivity 17 mV per inch rms.

★ Application for industrial, radio, radar, television, medical and general use.

★ Delivery ex-stock; spares available.

THE NEW D. C.

FURZEHILL 1684D OSCILLOSCOPE

Among recent purchasers of the Furzehill 1684D 'scope are:

University of California—National Advisory Committee for Aeronautics—

British Broadcasting Corporation—Metropolitan Vickers Ltd.—National Physical Laboratory, Teddington—Phillips Petroleum Company—Standard

Telephones and Cables—St. Bartholomew's Hospital—University of New York.

Prices and all details on request from:

AMERICAN BRITISH TECHNOLOGY, INC.

57 Park Avenue, New York 16, N. Y.

Canadian Agents:

SHEPPARD LABORATORIES, LTD., 104 Sparks St., Ottawa, Canada

Do you need a DRY BATTERY you can't find?

There is a SPECIALTY DRY BATTERY for your special need

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SEND FOR THIS FREE CATALOG

SPECIALTY BATTERY COMPANY

A SUBSIDIARY OF THE RAY-O-VAC RAY-O-VAC COMPANY

MADISON 4, WISCONSIN

NEW PRODUCTS (continued)

Revolution Antenna. Kings Electronics, 372 Classon Ave., Brooklyn 5, N. Y. A looseleaf-perforated folder gives the chief features and prices of several models of Roto Beam dipole rotating antennas for the elimination of ghosts and weak stations in television reception. Typical installations are shown.

Loud Speakers. Magnavox Co., Fort Wayne 4, Ind., has just issued a complete compilation of all pertinent engineering data with illustrations and dimensional information covering all current models of loudspeakers available to manufacturers.

Oscillograph Photography. Fairchild Camera and Instrument Corp., 88-06 Van Wyck Blvd., Jamaica 1, N. Y. The Oscillo-Record camera is designed for recording cathode-ray oscillograph images. A complete description along with specifications, accessories and catalog listings can be found in a recent 12-page booklet.

Connecting Devices. Howard B. Jones Div., 2460 W. George St., Chicago 18, Ill. Catalog 16 lists various types of electrical connecting devices together with photographs and sketches of the products to facilitate ordering.

Resistors. Precision Resistor Co., 336 Badger Ave., Newark 8, N. J., has issued a 4-page bulletin setting forth a variety of inductive and noninductive resistors. The latest catalog covering wound resistors in full detail may be had on request.


June, 1948 — ELECTRONICS
When PLASTIC PARTS Must Be Precision - Fabricated

Depend on SILLCOCKS-MILLER

As pioneers in fabricating plastics to close tolerances since 1910, Sillcocks-Miller engineers offer complete facilities to improve products and develop new ideas.

This organization of specialists is recognized throughout the industry for skill in producing special parts or products from plastic sheet material. When specifications call for precision and uniform production, it will pay you to look to Sillcocks-Miller for quality and service at a price that’s right.

Write for illustrated booklet

The SILLCOCKS-MILLER CO.
10 West Parker Avenue • Maplewood, New Jersey

ELECTRONICS — June, 1948

Use LINDE Synthetic Sapphire At Points of Wear

LINDE synthetic sapphire offers definite advantages for small parts at points of wear. Sapphire is hard — takes and retains a high polish. These properties show why.

1. Hardness (Knoop) 1,525 to 2,000
2. Melting Point 2,030 deg. C.
3. Unicrystalline Structure
4. Chemical Resistance All acids
5. Coefficient of Friction 0.140 (ring bearing against high-carbon steel pivot)

Write for the LINDE Synthetic Sapphire Technical Data Sheet No. 3. It may suggest further uses where you have problems of small parts wear.

THE LINDE AIR PRODUCTS COMPANY
Unit of Union Carbide and Carbon Corporation
30 East 42nd Street ULC New York 17, N. Y.
In Canada: Dominion Oxygen Company, Limited, Toronto

The word “Linde” is a trade-mark of The Linde Air Products Company

SYNCHRON
TIMING MOTORS A N D TIME MACHINES

Motor Equipped With Patented Oil Reservoir
SYNCHRON motors never need oiling. All moving parts are bathed in a sealed-in, lifetime supply of oil.

Double Bearings Assure Smooth Operation!
Rotor shaft, reduction train, and output shaft—all have double bearings to reduce vibration and promote quiet operation.

Brass Gears Operate Against Steel Pinions—for Long Life!
There is no compromise for quality in the construction of SYNCHRON Timing Motors and Time Machines.

Write for catalog and complete engineering details.

HANSEN MANUFACTURING CO., INC.
Princeton 10, INDIANA

Established 1907 - a Pioneer in Synchronous Motors

225
FOR THE
FIRST TIME IN THE U.S.

GROUND Ball Bearings under 3/8" O. D.
New Hampshire MICRO Ball Bearings are ground, on all ten functional surfaces.
Radial
Radial-thrust
Self-aligning
Pivot
Chrome steel
Stainless steel
Beryllium copper

Bulletin on Request
NEW HAMPSHIRE BALL BEARINGS, INC.
Peterborough, N. H., U. S. A.

CRYSTAL CONTROLLED
AUDIO FREQUENCY STANDARDS

- Frequencies 1,0000 to 20,000 cycles per second.
- Sine wave outputs over 40 cycles.

Our Audio Frequency Standards possess all of the stability inherent to the quartz controlled oscillator plus special performance features exclusive to our patents and manufacturing skill developed in many years of experience. Unit illustrated is one of our many designs. Our service includes design and adaptation of special units for various applications...custom built in small quantities or produced for large orders on a production basis. Write for information.

GIBBS DIVISION
THE GEORGE W. BORG CORPORATION ≠ DELAVAN, WISCONSIN

"NOT ON MY PAYROLL... BUT WORKING FOR ME!"

Railway Express is part of everyone's business, always ready to go to work for you just where and when you need it, whether you use its nationwide shipping facilities daily or only occasionally.
Now available to Railway Express—and to your business—are 500 new, high-speed, passenger train-equipped cars. New motor vehicles, too, are part of the constructive Railway Express effort to offer you better service.
These and other improvements take time—and money. Add to them today's higher maintenance and operating costs and you will see the necessity for adequate rates which are helping to make Railway Express America's high standard shipping service.

RAILWAY EXPRESS

...Maintains 23,000 offices (there's one near your factory, office or home)...Uses 10,000 passenger trains daily...Has 18,000 motor vehicles in its pick-up and delivery services...Offers extra-fast Air Express with direct service to 1,076 cities and towns.

NATION-WIDE RAIL-AIR SERVICE

June, 1948 — ELECTRONICS
NEWS OF THE INDUSTRY
(continued from p 139)

rights and privileges of the society.

(4) Associates.—Any person interested in the objectives of the audio engineering society shall be eligible to election to associate membership in the society and shall upon election become entitled to all the rights and privileges of the society, except the right to vote or to hold office or chairmanship of standing committees. However, associates of record at the institution of the society shall have the right to vote as long as membership shall be continuous and maintained.

(5) Student Members.—A student interested in audio engineering and enrolled in a recognized school, college or university may apply for student membership in the society. Upon election, however, a student member shall not be eligible to vote or for membership on committees except in his local student chapter.

(6) Sustaining Members.—Any person, corporation or organization annually contributing substantially to the Society shall be eligible for election to sustaining membership in the society.

Regular meetings will be held on the second Tuesday of each month except during July and August, with an annual meeting in October. The annual dues shall be as follows: honorary member, none; fellow, $7.50; member, $7.50; associate member, $6.00; student, $3.00.

IRE Plans Group System

Two types of professional groups will soon be formed within the IRE: (1) vertical—illustrated by the broadcast engineering group and (2) horizontal—as in the audio, video and acoustic group. Each group will elect a chairman, vice-chairman and executive committee, to look after its own interests.

Other groups are anticipated to provide a further integration of the vasty expanded fields of communications and electronics into areas of special technical interests. An individual group can be instituted by petition from 25 or more members of the Institute. Each group may activate its own committees, special conferences, and meetings, and may expect to take charge of one or more programs at

IRE NEWS OF THE INDUSTRY
(continued from p 139)

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BUILT SPECIFICALLY
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Featuring Greater Accuracy
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Precise, Durable Movements

Peak performance—as planned by YOUR engineers—is assured when EDM meters are used. Our meters are custom engineered to your specifications—precisely built by craftsmen and carefully checked before being shipped.

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Just tell us what you want—EDM craftsmen will produce it quickly and at modest cost.

May we hear from you soon?

ELECTRIC DESIGN & MFG. CORP.
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COOLER OPERATION
KOTRON
STRIP-TYPE
SELENIUM RECTIFIERS

100 MA. UNIT
- Max. A. C. line input 130 volts rms
- Max. inst. peak current 1000 Ma.
- Max. inverse peak voltage 360
- Average operating temp. 105°F
- Dimensions: 4-1/16" x 1-1/16" x 5/32"
- Other Sizes: 75 Ma. and 200 Ma.

Kotron’s metallic rectifying elements are mounted in one plane. Plates cannot contribute heat to each other. Result—Cooler Operation... longer life... increased circuit efficiency. Wafer-thin Kotron saves space, mounts easier.

Write for Complete Technical Data, Prices and Delivery

June, 1948 — ELECTRONICS
These facilities, coupled with the characteristics mentioned for antennas, are simple polarization can assure optimum performance. Impedance data on high frequency components are obtained easily by a simple adjustment at the rear of the reflector. Special antennas — Parabola can be perforated to eliminate wind resistance or sectioned to produce a specified antenna pattern. Other antennas — I.M. and television receiving antennas. A complete line of amateur antenna equipment.

Prices on Request
The Workshop invites your inquiry on any type of high frequency antenna problem — no obligation. Write, or phone Boston, BRig 3330.

The Workshop Associates, Inc.
64 Needham Street
Newton Highlands, Massachusetts

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PRECISION POTENTIOMETERS
Toroidal and Sinusoidal

For use in computing and analyzing devices; generation of low frequency saw tooth and sine waves; controls for radio and radar equipment; position indicators; servo mechanisms; electro medical instruments, measuring devices—telemetering; gun fire control where 360° rotation, high precision and low noise levels are essential.

The type RL14MS sinusoidal potentiometer is illustrated. It is wound to a total resistance of 35,400 ohms and provides two voltages proportional to the sine and cosine of the shaft angle. It will generate a sine wave true within ±.6%. Overall dimensions are 4½" diameter x 4 11/32 long plus shaft extension ¾" diameter x 1¼" long.

Write for Bulletin F-68
THE GAMEWELL COMPANY
Newton Upper Falls 64, Massachusetts

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PARABOLIC ANTENNAS
FOR

- FM and AM Studio-to-Transmitter Link
- Television and Facsimile Relay Work
- Multi-channel Point-to-Point Relay
- Research and Development Laboratories

The Workshop can supply parabolic antennas in a wide range of types, sizes and focal lengths, plus a complete production and engineering service on this type of antenna.

Workshop test equipment and measurements for the determination of antenna characteristics is outstanding in the industry. These facilities, coupled with the wartime experience of its engineers on high frequency antennas, ensure exceptional performance.

Parabolas — Precision-formed aluminum reflectors. Can be supplied separately, if desired.

Mountings — Various types of aluminum reinforced mountings can be supplied with all antennas.


Pattern and Impedance Data — A series of calibratic measurements of both pattern and impedance are made to adjust the settings for optimum performance. Pattern and impedance data is supplied with each antenna.

Polarization — Either vertical or horizontal polarization can be obtained easily by a simple adjustment at the rear of the reflector.

Special Antennas — Parabolas can be perforated to eliminate wind resistance or sectioned to produce a specified antenna pattern.

Other Antennas — I.M. and television receiving antennas. A complete line of amateur antenna equipment.

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Large or Small
SQUARE, ROUND OR RECTANGULAR
PAPER TUBES
FOR COIL WINDING

Inside Perimeters from .592" to 19"

With specialized experience and automatic equipment, PARAMOUNT produces a wide range of spiral wound paper tubes to meet every need — from ¼" to 30' long, from .592" to 19" inside perimeter, including many odd sizes of square and rectangular tubes. Used by leading manufacturers. Hi-Dielectric, Hi-Strength. Kraft, Fish Paper, Red Rope, or any combination, wound on automatic machines. Tolerances plus or minus .002". Made to your specifications or engineered for YOU.

Paramount Paper Tube Corp.
616 Lafayette St., Fort Wayne 2, Ind.
Manufacturers of Paper Tubing for the Electrical Industry

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ELECTRONICS — June, 1948
From Milliwatts To Kilowatts

Selenium
Copper Sulphide

To simplify the solution of your AC-DC power requirements, Benwood-Linze offers you a quarter century of development and research experience in the field of metallic rectifiers and their application.

Tell us your problems. Consult us without obligation.

Manufacturers of Selenium and Copper Sulphide rectifiers, rectifier-transformer assemblies and AC-DC power supply units for every requirement.

THE BENWOOD-LINZE CO.
Division of the Sperry Corporation
1815 Locust St.
St. Louis 3, Mo.
Long Distance Telephone CEntral 5830

THE NEW JAMES KNIGHTS CRYSTAL CATALOG
You’ll want a copy of the new James Knights catalog of "Stabilized" crystals. It contains photos and specifications of many new crystals, crystal ovens, holders, including new filter crystals with standard RMA pigtauls. If your distributor cannot supply you, write for your free copy direct.

The JAMES KNIGHTS CO.
SANDWICH, ILLINOIS

For HEAVY DUTY WORK! Severest Electrical Services!

JONES PLUGS & SOCKETS
500 SERIES Proven Quality

For 5,000 Volts, 25 Amperes per Contact Alterable by circuit Characteristics.


Write for Jones BULLETIN 500 for full details on line.

N. S. BAER COMPANY
MONTGOMERY ST., HILLSIDE, N. J.

SEND BLUEPRINTS AND SPECIFICATIONS—NO OBLIGATION!
Check BAER FIBRE for accurate dimensioning, uniform surface, mechanical and electrical qualities, and low cost per piece. See how efficiently a BAER FIBRE terminal board, bushing, gasket, washer or other shape can simultaneously solve your electrical or mechanical problem...improve your product...and save you money! BAER FIBRE is precision fabricated to your specifications.

LITERATURE ON REQUEST

HOWARD B. JONES DIVISION
Cinch Mfg. Co.
2460 W. GEORGE ST.
CHICAGO 18, ILL.

June, 1948 — ELECTRONICS

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NEWS OF THE INDUSTRY (continued)

recognition of his invention of a new circuit system for communications equipment.

Robert P. Watson and F. M. Bailey of the tube division at Schenectady, N. Y., a joint award for work in developing the phasitron.

Kenneth C. DeWalt of the tube division, for transmitter-tube production accomplishments, especially in connection with the Manhattan District.

Marine VHF Service

The FCC has announced its decision to establish a vhf radiotelephone maritime mobile service on a regular basis for the operational and business needs of ships. In this connection, class 2 experimental applications have already been granted for certain land radiotelephone stations and associated stations aboard tugboats. These are of an interim character prior to the formulation of rules for the regular service. Further interim grants will be made to eligible applicants, but will not be for use on a common carrier basis. Common carrier experimentation can continue on the one duplex channel now being used.

New Technical Society

Formation of a new technical organization, the Standards Engineering Society, was recently announced. Its purpose is to remove barriers that tend to isolate various fields of engineering. Members may be any type of engineer—mechanical, industrial, electrical—so long as their work is concerned with standardization.


Due to present lack of office space, membership is now limited to the several thousand doing standards work in or near New York. A bulletin, to be published after each bi-monthly meeting, will be avail-

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**CATHODES**

Seamless and Lockseam*

“WITHIN THE ENVELOPE” TUBULAR STRUCTURES for all types of ELECTRON TUBES

TO STANDARD SPECIFICATIONS OR SPECIAL DESIGN

*Produced under Superior patents

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**Superior**

SUPERIOR TUBE COMPANY
ELECTRONICS DIVISION
2500 Germantown Ave.
NORRISTOWN, PA.

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**Red Streak Guaranteed Acid-Free Tapes**

Made with most exacting care Red Streak Acid-Free tapes and gummed flat sheets are made to conform to the most critical specifications and are uniform throughout. Tests for free acids and alkalines are made by P H method. Available in materials and thicknesses below. Write for your Red Streak samples.

- .005 Red Gummed Fish
- .005 Gummed White Flexible Holland
- .005 Gummed Red Rope
- .002 Gummed Glassine
- .005-.006-.008-.010 Kraft
- .005-.007-.010 Dark Grey Fish

The RIGHT Acid-Free tape for you

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**The Brown-Bridge Mills, Inc.**

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108 S. Dearborn St.

ST. LOUIS
605 Lindell Blvd.

NEW YORK
389 Fifth Ave.

SEATTLE
430 Market St.

SAN FRANCISCO
2416 First St.

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**ELECTRONICS — June, 1948**

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www.americanradiohistory.com
SINE WAVE CLIPPER

Net Price $10.00

Speeds Accurate Analysis of Audio Circuits! Simplifies Selection of Components! Saves Valuable Time!

Here's an instrument that will do most of the jobs usually assigned to a square wave generator costing about 10 times as much! The B&W Sine Wave Clipper provides a test signal particularly useful in examining the transient and frequency response of audio circuits. Designed to be driven by an audio oscillator, the clipper provides a clipped sine wave—hence the name "Sine Wave Clipper!" Used in engineering work, repair work, or with equipment under development, it will quickly pay for itself many times over.

Write for complete information

BARKER & WILLIAMSON, INC.
Dept. E-68—237 Fairfield Avenue
Upper Darby, Pa.

NEWS OF THE INDUSTRY (continued)

able to anyone interested, and the society's president anticipates formation of similar groups throughout the country.

New Microwave Chains

The FCC has authorized the American Telephone and Telegraph Co. to construct two experimental microwave relay chains—one between Chicago and Milwaukee and the other linking Detroit and Toledo—to provide common carrier service including television transmission. Equipment and services proposed are similar to those now in effect in the New York-Boston microwave chain. Construction is to be completed by June 15, 1949 at an estimated cost of $1,400,000.

Name NEC Officers

The National Electronics Conference, Inc., which will hold its annual technical forum Nov. 4, 5 and 6 at the Edgewater Beach Hotel, Chicago, Ill., has named W. C. White of General Electric Co., Schenectady, N. Y., as chairman of the board of directors for 1948.

Other officers elected are:

President—F. O. Neubauer of Illinois Bell Telephone Co.
Executive vice-president—G. H. Pett of the U. of Illinois.
Treasurer—O. D. Westberg of Commonwealth Edison Co.

Vice-president in charge of programs—H. A. Leedy of Armour Research Foundation.

Vice-president in charge of publicity—L. G. Killian of Cook Research Laboratories.
Vice-president in charge of publications—A. H. Wing of Northwestern Technological Institute.
Chairman of exhibits committee—J. A. M. Lyon of Northwestern Technological Institute.
Chairman of hotels committee—R. K. Metcalf of Illinois Bell Telephone Co.

Oak Ridge to Have Graduate School

A graduate engineering practice school for training in atomic energy plant work will be established in July at Oak Ridge, Tenn., by the Massachusetts Institute of Technology. The production plants of the Atomic Energy Commission at Oak Ridge will be utilized in the work. These include the gaseous diffusion and electromagnetic plants and the Oak Ridge National Laboratory.

Courses (five months each) will be open only to United States citi-
EISLER
ELECTRICAL & ELECTRONIC
EQUIPMENT
ELECTRONIC TUBE EQUIPMENT

36 HEAD RADIO TUBE EXHAUSTING MACHINE

We Make Complete Equipment For The
Manufacturers Of Incandescent Lamps Radio and Elec-
tronic Tubes.

TRANSFORMERS OF ALL TYPES

For LIGHTING POWER FURNACES PHASE CHANGING DISTRIBUTION ETC.

Air, Oil, or Water Cooled

SIZES 1/4 to 250 KVA SPOT WELDERS OF ALL TYPES FOR ALL PURPOSES SIZES 1/4 to 250 KVA Butt Welders - Gun Welders Arc Welders Neon Sign Units Fluorescent Tube Manufacturing Equipment

CHAS. EISLER
EISLER ENGINEERING CO., INC.
751 So. 13th St. (Near Avon Ave.), Newark 3, N. J.

BECAUSE...

Cost is a Factor

CONSIDER

BEST

SINCE 1922

"Controlled Performance" COILS TRANSFORMERS

Consistent high quality in Transformers and "Made-to-Specification" Windings for over a quarter of a century.

SPECIFICATION DATA INVITED FROM LARGE VOLUME USERS

BEST MANUFACTURING CO. INC.
1203 GROVE ST.
IRVINGTON 11, NEW JERSEY

Foreign Division
25 WARREN ST. • NEW YORK, U. S. A.
Cable Address SIMONTRICE, NEW YORK

ELECTRONICS — June, 1948

www.americanradiohistory.com
NEWS OF THE INDUSTRY (continued)

Dozens who are graduate students of the MIT engineering departments and who have been cleared by the Atomic Energy Commission. No compensation will be paid students, but academic credit will be given for work done. The major objective will be to help prepare graduate engineers for responsible posts in the atomic energy field.

BUSINESS NEWS

SUPREME, INC., Greenwood, Miss., a new corporation, has acquired the manufacturing rights, facilities and assets of the Supreme Instruments Corp., manufacturers of test equipment and meters, and will soon occupy its new air-conditioned plant.

YANKEE NETWORK'S new WNAC-TV-FM transmitter is under construction in Medford, Mass. Both the television and f-m antennas will

be mounted on the same pole atop a 467-ft tower. Effective radiated power of the television antenna will be 32.7 kw.

LOCKE INCORPORATED is the new name for the Locke Insulator Corporation of Baltimore, Md. Having enlarged its design and development engineering staffs, the company will produce all types of ceramics and hardware for the electronic field.

PHILCO CORP. will design and produce fixed-station and mobile radio-telephone facilities for 21 cities throughout New England and New York, for rental by the U-Dryvit Auto Rental Co., Inc., Cambridge, Mass. along with its vehicles. At present, U-Dryvit operates a 100-
News of the Industry (continued)

Unit system in the Boston area under FCC limited common carrier radiotelephone authorization.

Emeloid Co., Inc., makers of plastic products such as radio dials, electronic parts and name plates, recently moved to a new 40,000-sq ft plant in Hillside, N. J.

Lindberg Engineering Co. of Chicago, Ill., manufacturers of industrial heat treating and melting furnaces, has acquired the assets of the Electronics Division of Illinois Tool Works, and will continue to produce and sell h-f induction and dielectric heating equipment.

The Hays Corp., Michigan City, Ind., has added a new building to its manufacturing plant to provide for production of industrial electronic control instruments.

Standard Arcturus Corp. recently moved to a new plant in Newark, N. J., thus increasing plant capacity for tube development and production and providing expansion space for its affiliates.

Rowe Engineering Corp., Chicago, Ill., is the newly formed organization of the Rowe Radio Research Laboratory Co. Rowe Radio will continue to operate simultaneously until completion of several govern-
ALTEC LANSING INTERMODULATION ANALYZER
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Letters received by Altec Lansing demonstrate impressively that the Altec Lansing TI 402 Intermodulation Analyzer, used with the Altec Lansing TI 401 Signal Generator, has become an indispensable tool to:

(1) Broadening station engineers, for the measurement and correction of intermodulation distortion in radio transmitters; for analyzing distortion in speech input equipment; for routine checking of speech input equipment; for building special equipment for broadcast purposes, such as echo devices, filters, line equalizers, system equalizers, sound effects, etc.;

(2) Recording studio engineers, for checking cutter head performance and playback heads, amplifiers, compression devices, equalizers, etc.;

(3) Film recording engineers, for optimum film recording, processing, and reproducing; and

(4) Sound research laboratory engineers, for making progress checks in the design and development of new electronic apparatus.

The many-sided usefulness of Altec Lansing Intermodulation Test Equipment is evidenced by the fact that over 200 firms, in all branches of the electronic industry, have purchased this equipment. Among users are: U. S. Department of State, International Broadcasting Division, and other government departments; WOR Recording Studios; and other major recording companies; Rudolph Wurlitzer Company; radio stations throughout the U. S.; motion picture producing companies; leading manufacturers of radios, radio-phonographs, electrical instruments, sound reproducing equipment and motion picture theatre sound systems; and many others.

Complete engineering data on Altec Lansing Intermodulation Test Equipment are available, and will be sent on request. Use address nearest you:

Western Electric Co. will erect a new building covering an area equal to four entire city blocks in New York City to consolidate its headquarters organization.


Radio Corp. of America recently began construction of a new building at its Lancaster plant as part of a million-dollar expansion program to increase color television picture tube production.

Gray Research and Development Co., Inc., makers of recording and transcription equipment, have moved to a larger factory in Hartford, Conn., to expand manufacturing facilities.

Spellman Television Inc., manufacturers of 30-kv h-v power supplies and other projection television components, have moved to larger quarters at 150 W. 24th St., New York City.

United Television Mfg. Corp., Boston, Mass., has been established to build home, restaurant and hotel television receivers.

Arnold B. Bailey Corp., Scotch Plains, N. J., has announced the Bailey f-m transmitter which uses a highly stable f-m crystal operating at frequencies up to the limit...
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<table>
<thead>
<tr>
<th>Type</th>
<th>Input, 0-135 V.</th>
<th>Output @ 3.0 amps</th>
<th>Price</th>
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</thead>
<tbody>
<tr>
<td>TYPE 20</td>
<td>115V</td>
<td>0.4 kVA</td>
<td>$12.50</td>
</tr>
<tr>
<td>TYPE 116</td>
<td>Mounted; 115V</td>
<td>15.0 kVA</td>
<td>23.00</td>
</tr>
<tr>
<td>TYPE 116U</td>
<td>Unmounted; 115V</td>
<td>19.00 kVA</td>
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<tr>
<td>TYPE 1126</td>
<td>115V, 0-135 V.</td>
<td>46.00 kVA</td>
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</tr>
<tr>
<td>TYPE 1226</td>
<td>230V, 0-270 V.</td>
<td>118.00 kVA</td>
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</tbody>
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**NEWS OF THE INDUSTRY**

(continued)

of crystals now available. This newly formed concern will specialize in development of electronic communication equipment.

**GARSTANG-MAY Co., Indianapolis, Ind., representatives of radio and electrical manufacturers, was recently formed by the former president and general manager and the vice-president in charge of manufacturing, respectively, of Electronic Laboratories.**

**WESTINGHOUSE ELECTRIC CORP. has purchased additional manufacturing facilities at Hahntown, near Irwin, Pa. The new plant, with 125,000 sq ft of floor space, will be occupied by the mica-processing section of the transportation and generator division.**

**WESTERN SOCIETY OF ENGINEERS moved to new headquarters at 84 East Randolph St., Chicago, Ill.**

**PERSONNEL**

**MELVILLE EASTHAM, chief engineer of General Radio Co., Cambridge, Mass., recently received the New England Award for outstanding professional contributions to the industry, given annually by the Engineering Societies of New England, Inc. He founded General Radio in 1915, was its president until 1944, and was responsible for the development of Loran at MIT.**

J. Howard Dellinger, chief of the Central Radio Propagation Laboratory of the National Bureau of Standards, recently retired after 40 years of government service. He initiated radio research at the
NEWS OF THE INDUSTRY (continued)

Bureau in 1911 and discovered the simultaneous occurrence of solar eruptions and radio fadeouts, since called the Dellinger Effect. In the advisory field he organized the Interdepartmental Radio Advisory Committee which assigns all radio frequencies used by Federal agencies.

MARCUS A. ACHESON was appointed chief engineer for the radio tube division of Sylvania Electric Products Inc. He has been with the company since 1934 and during the war he directed the Sylvania development of proximity fuse tubes for the Navy Bureau of Ordnance.

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TECHNICAL DATA

NEW INSTRUMENTS
NEW TECHNICAL DATA

BULLETIN 100

"Resistance Standards and Resistance Bridges"

Included are complete descriptions of Rubicon Standard Resistors (Bureau of Standards and Reichsanstalt Types), Standard Shunts, Decade Resistors, Wheatstone Bridges (laboratory and portable), Mueller Resistance Thermometer Bridge, Kelvin Bridges (laboratory and portable), and Limit Bridges (for production testing).

BULLETIN 270

"Potentiometers"

Concise, factual information on Rubicon Type B High Precision Potentiometer, Type C Microvolt Potentiometers (single and double), Type D Microvolt Potentiometers, Portable Precision Potentiometers, Type S Students' Potentiometer, Temperature-Calibrated Potentiometers, Brooks Model 7 Deflection Potentiometer, and accessories including volt boxes, standard cells, keys and batteries.

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R. K. McClintock was named assistant to the chief engineer at Sylvania Electric's radio tube division. He has been with the company since 1956 and was instrumental in the development of the proximity fuze.

R. E. Mathes, previously associated with RCA Laboratories, with radar countermeasures in the Bureau of Ships, and until recently chief engineer of Finch Telecommunications, is now chief engineer at Gray Research and Development Co., Inc., Elmsford, New York.

Noel L. Keefer, for the last 12 years chief installation and service engineer on the Pacific Coast for General Electric Co., has been appointed chief engineer of KMGM, Metro-Goldwyn-Mayer's f-m station in Los Angeles.

William H. Lyon, former service engineer, has been appointed service manager at SoundSciber Corp. During the war he was an associate engineer in the Interior Communications Section of the Bureau of Ships.
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NEW BOOKS

Hearing Aids


This book describes work done at Harvard University during the war on the adaptation of hearing aids to individual users. The work had two original objectives: (1) the determination of frequency-response patterns in a hearing aid which would give best performance for people with various types of hearing loss and (2) the development of rapid and reliable methods for testing hard-of-hearing people.

The principal item of physical equipment used in the research was a "master hearing aid", which consisted of a laboratory-type microphone, amplifier, receiver, and controls.

The method of testing was concerned primarily with the intelligibility of speech as determined by the use of word lists. Tone quality and ease of listening were not considered in the merit rating.

The tests were conducted on a group of eighteen hard-of-hearing men and women with hearing losses ranging from moderate to severe.

The articulation tests on the word lists were conducted both to determine types of frequency patterns as related to hearing losses shown in audiograms for different individuals and also to determine desirable loudness and methods for limiting loudness.

The principal conclusion drawn on the first of these items is that practically all hard-of-hearing persons can be properly fitted with either a flat frequency response or with a response which has a simple and uniform rise with increasing frequency.

With regard to the second item it was concluded that it is desirable to limit maximum loudness for any individual and that this limiting may best be done by compression amplification, although peak clipping is also acceptable.

This report is a valuable summary of specific work done in the hearing aid field by a group of scientists. The validity of its general conclusions is impaired by the
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These compact, efficient, cost-saving units remove all metals such as sodium, potassium, calcium, magnesium, iron, copper, etc., as well as sulfates, carbonates, bicarbonates, chlorides, etc. Constructed of Stainless Steel. Flow rates from 3 to 100 Gallons per hour. Other Barnstead demineralizers up to 1,000 gallons per hour.

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NEW BOOKS (continued)

be patented, how to keep appropriate records of one's technical work that may lead to a patent application, the preparation of the application, its amendments, the whole question of interference, and finally, the ownership, use, and licensing of patents.

Copious examples from the patent literature point up the discussion, making the book more effective as a working tool and more interesting, even to one who may never make an invention. The entire technique of carrying matters through from the original concept to the use of an issued patent is covered.—K. H.

Radio Engineering

BY FREDERICK EMMONS TERMAN.

"ELECTRICAL circuits and vacuum tubes behave according to exact laws, which in the main are simple and easily understood, and which can be used to predict the performance of radio circuits and radio apparatus with the same certainty and accuracy that the performance of other types of electrical equipment, such as transformers, motors, and transmission lines, is analyzed. It is this ability to reduce a problem to quantitative relations that predict with accuracy the performance to be expected or explain the results already obtained that represents a real mastery of the subject such as the radio engineer is expected to possess." So reads a portion of the Preface to the First Edition. That it appears some fifteen years later in a much expanded Third Edition may be a hoary tradition of the publisher's routine, but it is none the less alive and, one suspects, a reaffirmation of the author's creed.

For all his uncompromising approach to the fact that there can be no royal road, nor primrose path either, to engineering, Professor Terman has managed to keep the presentation of information in his books clear and simple, so that "Terman says . . ." has become a natural preambule in classroom or laboratory. Although his scholastic attainments have brought him the title of Dean of the School of Engineering at Stanford University, he is probably better known as past
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NEW PRODUCTS (continued)

president of the Institute of Radio Engineers. No mere pedant, he served his country with distinction at the MIT Radiation Laboratory, from whence he moved his group to found the Radio Research Laboratory at Harvard.

We are dealing here with a college text that will not necessarily please everyone. It is not a handbook with a quick answer for the man who suddenly wishes to know all about a new electronic aid to navigation, nor is it a loose-leaf booklet into which one slips dope sheets on the latest equipment for the production of frequency modulation.

The text as a whole has been brought up-to-date by the inclusion at appropriate points of such information as that on klystrons, magnetrons, lighthouse and traveling wave tubes. In addition, a completely new chapter has been added that describes circuits with distributed constants and serves to orient the reader on microwave phenomena. It would be hopeless to attempt a complete catalog of contents and additions, particularly since there are already at least 105,000 readers who are familiar with the general philosophy and presentation of the original work.

Fifty-odd pages of questions from the separate chapters have been collected at the back of the volume where they are more conveniently found than in earlier editions.—A.A.M.C.

Microwave Mixers


The present state of the art in microwave mixer circuits and components is well covered in this volume. Although the microwave superheterodyne receiver and crystal rectifiers are themselves subjects of other volumes in the series, sufficient introductory material is presented here to permit the reader to study microwave mixers and their use without recourse to the other volumes.

Because of their wide usage, crystal mixers are the major topic of this text. Simple, multiple-function and balanced mixers are considered. The local oscillator is con-

www.americanradiohistory.com
NEW BOOKS (continued)

considered not only with regard to noise generation but to frequency control as well. A chapter by Eric Durand discusses various local oscillator frequency stabilization methods, including constant frequency difference and constant absolute frequency schemes.

The completeness of the text, its use of but lack of dependence on mathematics, the large number of practical design problems considered and the detailed drawings and data presented make this text very useful. Anyone desiring to know more about this field of microwave techniques would do well to read this book.—JOSEPH KAUFMAN, National Radio Institute, Washington, D. C.

Techniques in Experimental Electronics

BY C. H. BACHMAN, Associate Professor of Physics, Syracuse University, John Wiley & Sons, New York, 1948, 252 pages, $3.50.

In this short book the author, formerly with G-E, describes the equipment and methods used in laboratory vacuum systems, especially with electronic discharge devices. Liberal comparisons and evaluations of the methods discussed make the book a useful guide; practice is stressed rather than theory.

About the first two-thirds of the book is devoted to vacuum systems: pumps, traps, baffles, gauges, valves and controlled leaks, demountable joints, glass blowing, leak detection, glass systems, and metal systems. The last third of the book discusses electronics: cathodes and sources of charged particles, control, and assembly and processing in the laboratory. Two chapters, one on controls and gadgets and one on hints and techniques, contain many suggestions based on experience that can save others the need for learning the hard way.

As a comprehensive discussion of the subject, the book is especially valuable for the specific mentions of materials and equipment that have proved suitable under various conditions. The treatment is well adapted to the needs of the beginning experimenter concerned with simple vacuum and electronic problems, such as the graduate student. It should be supplemented with

ELECTRONICS — June, 1948
NEW BOOKS

works on the theory of gases and electronics, naturally. The book is a utilitarian manual.—F.H.R.

Crystal Rectifiers


EARLY in the development of microwave radar it was found that the old familiar crystal rectifier, in suitably modernized form, offered considerable promise as a high-sensitivity mixer crystal. With further development, improvement in sensitivity, stability and ruggedness resulted in a reliable component, superior in performance to any vacuum tube, which was universally used in microwave radar mixers. It is not surprising, therefore, that an appreciable percentage of the total research and development effort of the microwave radar program was devoted to crystal rectifiers.

The MIT Radiation Laboratory not only carried out a broad research program in all aspects of the crystal rectifier but also coordinated the simultaneous research programs of many university and industrial laboratories. The purpose of the book is "to present the fund of knowledge on crystal rectifiers that accumulated during the course of World War II."

Although the main application was that of mixer crystals, the low-level video rectifier for microwave beacon systems was of considerable importance. Crystals were also widely used in laboratory measurements, particularly for wavemeter resonance indication and relative power measurements.

After a discussion of the properties of semi-conductors from the present theories of the solid state, a summary is given of the most recent theories applicable to the semi-conductor point-contact rectifier. A major portion of the book is devoted to the crystal converter and includes thorough treatment of the crystal characteristics of conversion loss, noise, r-f and i-f, impedances and burnout properties. The remainder of the book is devoted to special types including the video detector crystals. Representative manufacturing techniques are given for the various
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PAMARCO tensions are the perfect answer to lower coil winding costs!
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Although its "paper performance" surpasses that of any other amplifier, the Brook must really be heard to be fully appreciated. When you hear the Brook alongside other amplifiers — any amplifiers — you are in for an experience that is both surprising and enlightening. Write today for copy of distortion analysis and Descriptive Bulletin AP-85.

NEW BOOKS (continued)

A crystal types as well as a discussion of the various measurement techniques. This includes both laboratory methods for comprehensive measurements and detailed descriptions of standardized test equipment for production testing of crystals for the most important frequency bands.

Probably the most outstanding development in this field was the discovery during the war by Benzer, of Purdue University, of the high-inverse-voltage germanium rectifier. Although developed too late for application during the war, this rectifier has already attained considerable commercial importance in communication and electronic equipment.

Summarizing as it does the entire field of crystal rectifier development during the war, this authoritative book may be highly recommended to physicists interested in the theory of semi-conductors and point-contact rectifiers and to microwave and communication engineers interested in the properties and applications of crystal rectifiers. — H. Hiens, Sylvania Electric Products Inc.

Books Received for Review

DICTIONARY OF GERMAN ELECTRICAL SYMBOLS. Office of Technical Services, Department of Commerce, Washington 25, D.C. 1949. 125 pages, $4.00. Approximately 1,200 symbols used to designate components of German communication systems, each identified according to conventional American designation. Includes symbols for switches, relays, tubes, radar components, etc.

MODERN COLLEGE PHYSICS. By Harvey E. White. D. Van Nostrand Co. Inc., New York, N. Y., 1948, 802 pages, $6.50. Designed for use as standard required one-year college physics course. The entire last quarter of the book is devoted to electronics as well as atomic and nuclear physics. The book is intentionally too big for a one-year course, and is divided into many chapters so instructors can pick and choose.


June, 1948 — ELECTRONICS

www.americanradiohistory.com
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FREQUENCY MODULATION, Volume I. Published by RCA. Review. New York, N. Y., 1948. 515 pages. $25.00. Reprints of papers by RCA authors covering the period 1936-1947, in four sections: General; Transmission; Reception; Miscellaneous. Additional papers are included in summary form or are listed in the bibliography at the end of the book. Cloth-bound.

ELECTRIC RESISTANCE WELDING. Published by Harold R. Caudill. 800 Euclid Ave. Cleveland 14, Ohio, 22 pages. $1.00. Nearly 350 articles published in 49 magazines from 1938 to June 1947 are listed chronologically by publication. An Index provides a subject key to the bibliography.

TABLES OF SPHERICAL BESSEL FUNCTIONS. Vol. II. Mathematical Tables Project, National Bureau of Standards, Columbus University Press, New York, 1947. 328 pages, $7.50. This volume extends the range for \( \pi r \) from 20/2 to 61/2, Vol. I having covered the range from 1/2 to 27/2.


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Backtalk

This department is operated as an open forum where our readers may discuss problems of the electronics industry or comment upon articles which ELECTRONICS has published.

Phantastron Decimal

DEAR SIRS:

In Table 2 of the article in the April issue of ELECTRONICS on phantastrons, all the values of delay in microseconds should be divided by ten; that is, 50 instead of 500, 250 instead of 2500, etc. This inadvertent misplacement of a decimal point would be somewhat embarrassing if a person built a phantastron using the values of the table and expected a delay ten times longer than they would get.

The values in the first column are for a circuit which worked. However, for circuits which have a small value of maximum delay time, the circuit is somewhat critical since the value of the grid condenser $C_v$ is beginning to approach the value which one might expect for stray capacitance in a badly laid-out circuit.

MATTHEW T. LEBENBAUM

Audio Noise Reduction

DEAR SIRS:

Harry F. Olson's statement (ELECTRONICS, Dec. 1947, p. 120) that he separates signal and noise on the basis of amplitude is misleading.

It is true that the system he describes will discriminate against any amplitude below a certain threshold level—but only when said amplitude is present alone (or with other sufficiently small amplitudes).

If a small noise voltage below the threshold level and a signal voltage of such a magnitude as to make the sum of the signal voltage plus the noise voltage greater than the
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**Backtalk**

(continued)

threshold level are simultaneously present, no separation of signal and noise will occur.

The statement that if the threshold level "corresponds to the maximum amplitude of the noise, the noise will not be reproduced" is accordingly incorrect, except under special conditions not usually attained.

There can be no improvement in signal-to-noise ratio by use of the system he describes except during intervals when the sum of the signal plus the noise is less than the threshold level—which is of course a trivial consideration.

Henry E. Singleton
New York, N. Y.

---

**Rebuttal**

Dear Sirs:

I am glad that Henry E. Singleton has called attention to some parts of my paper that were not clear because it provides me with an opportunity for additional explanation and clarification.

It is impossible in a discussion or in an article describing the system to present the complete theory of electronics involved and all the characteristics of speech and music which conspire to make the system effective in reducing noise. Since the elements of sound reproduction, such as, for example, time-frequency distribution of the components in speech and music, masking of noise by tones, threshold and ambient noise, integrating characteristics of the ear, are known to those interested in sound reproduction, it appeared superfluous to present these in the article. Rather I tried to present the physical action of the system.

Of the above characteristics, there is one outstanding one, namely, the transient nature of speech and music that makes it possible to reduce noise by threshold system. If the frequency range is divided into octave frequency bands, it will be found that, in general, there are relatively long intervals in which there is no signal amplitude. However, the noise is always present.

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when there is no signal, the noise will not be reproduced. Furthermore, when the noise and signal are of small amplitude there will be a reduction in noise. This is certainly separation of noise and signal on the basis of amplitude. Obviously, when the amplitude is several times the noise level the reduction is small. However, under the latter conditions, the signal masks the noise and noise reduction is not necessary. It may be mentioned in passing, that none of the existing noise-reducing systems are capable of reducing noise under full signal operation.

The effective noise reduction, in the frequency bands in which the nonlinear elements are employed, is 10 to 15 decibels depending upon the program material. With speech, piano and other impulsive sounds, the higher value is obtained, while in the case of popular music the lower value is obtained. All those who have developed or operated and heard this type of noise-reducing system are of the opinion that the noise reduction is quite outstanding rather than trivial.

Henry F. Olson  
Radio Corporation of America  
RCA Laboratories Division  
Princeton, N. J.

Stagger Tuning

Dear Sir:

I wish to disclaim responsibility for the captions accompanying the diagrams in my article "Stagger-Tuned Amplifier Design" in the May 1948 Electronics. In particular, Fig. 4 and 6 are interchanged, the numerical values in the caption of Fig. 2 are erroneous, and the word "flat" must be omitted in the phrase "flat staggered-pair" of the caption to Fig. 5.

Henry Wallman  
Massachusetts Institute of Technology  
Cambridge 48, Massachusetts

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  - Price: $15.75

- **20% DEPOSIT WITH ORDERS UNLESS RATED**
  - 160 GREENWICH STREET

- **LAST CHANCE**
  - Going Like “Hot Cakes”
  - Price: $48.50

- **SWEEP SIGNAL GENERATOR**
  - Price: $8.75

- **ADLAKE Type 1040-80**
  - Price: $9.05

- **MAGNETIC DEFLECTION YOKES**
  - Price: $14.75

- **SCOPE OR TELEVISION TRANSFORMER**
  - Price: $15.75

- **4 PIN GIANT SOCKET**
  - Price: $1.00

- **SEARCHLIGHT SECTION**

- **GENERAL ELEC. SOLENOID**
  - Price: $1.00

- **GENERAL ELEC. SOLENOID**
  - Price: $1.00

- **NIAGARA RADIO SUPPLY CORP.**
  - Phone: 911-3232
  - Address: 160 GREENWICH STREET
  - New York 6, N.Y.

- **June, 1948 — ELECTRONICS**

---

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(All Tube Types in Stock Now — Subject to Prior Sale)

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20% DEPOSIT WITH ORDERS UNLESS RATED

NIAGARA RADIO SUPPLY CORP.
160 GREENWICH STREET
NEW YORK 6, N. Y.

ELECTRONICS — June, 1948

Phone Digby 9-1132-3-4
All Prices F. O. B. N. Y. C.
"ELECTRONICS"
BIG SAVINGS at ELECTRO SALES CO.

General Electric Amplidyne

Winco Dynamotor
Brand New
$1


Western Electric Filter Assembly
#159988

Complete filter network contained in a single well-shielded unit measuring 6 1/2" long, 3 3/4" wide, 1 1/2" deep. A dual section low pass filter with high Q components. The response is flat from 175 - 1500 CPS. This network has a "Q" of 65 at 1000 CPS with 600 OHM output impedance. The DC resistance is 156 ohms.

Special Price $4.95

SPRAGUE PULSE FORMING NETWORK
Size of Case, Exclusive of High Tension Insulators, 8 x 4 x 4 inches.
Consists of Chokes & Condensers 15,000 Volts Oil-Filled 19 Micro-Sec.

$19.75 each to sell for $82.50.

New 112 Page Catalog -listing scores of bargains. Write for it on your company's letterhead.

ELECTRO SALES COMPANY
Dept. E-6, 110 PEARL STREET, BOSTON 10, MASS.

June, 1948 — ELECTRONICS
**SURPLUS SAVINGS at ELECTRO SALES CO.**

**MARATHON Motor and Generator**

Rebuilt like new. Two separate units coupled together on a common bed plate. MARINE TYPE with voltage regulator and frequency controller. Operable at 110 volts DC and supplying 110 volts AC. Single phase. 60 cycles. 500 va.

**SPECIAL PRICE**

- Same unit as above with 32 volt DMC motor and 300 va. output...$54

**Complete Motor and Pump Assembly**

Operating at 21 Volts, DC 70 amperes. Can be used on 32 Volt systems with resistance bank. Motor rated at 1/4 HP. Can be used for pumping water or oil. Original cost to government was over $100.00. We have a limited quantity of these units, sold on a money-back basis. Special...

**Motor Rated 21/2 HP**

Operative at 440 Volts, 3 phase, 60 cycles. Can be reconnected for operation on 220 v, 60 cy. 3 ph. 1750 RPM. Double Shaft. Ball Bearings. Marine Duty. 30 minutes. A sturdy motor for any application, at never before offered price. Brand New! Fully guaranteed. Original...

**Bosch Magnetos with Pump Assembly, completely enclosed. Brand New! Original cartons.**

**General Electric Motors**

Flange Mounted. Rated 1/20 HP operative at 60 volts. DC. Shaft is 3/16". 1" long. Model SP55806C. Special...

**G.E. Rebuilt Rotary Converters, Input: 110 Volts, DC; Output: 70 Volts, AC. Single phase, 60 cycles. 100 Watts.**

**NEW 112 Page Catalog**

Packed from cover to cover with thousands of amazing values in a $500,000 stock. Distribution must be limited to requests on company letterheads. Address Dept. E.6

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**"TRANSTATS"**

Amertran Voltage Regulator (Variable Transformer)

A truly remarkable value

**$75.**


**RAYTHEON Rectifier Charger**

The output voltage of the Raytheon Charger is 48 Volts at 3 amp. This charger has control for increasing or decreasing the trickle charge rate. Will charge up to 23 cells at one time. Can also be used as a battery eliminator and for operation of signaling equipment.

A Voltmeter—reading from 0 to 100 Volts, DC indicates the charging Voltage. Completely mounted and wired for operation in a gray finished sheet steel cabinet measuring 11" x 17" x 21 1/4". Each unit is brand new and packed for export in cases 16 x 18 x 30. Weight when packed 236 pounds. Spec. W-3828.

**NEW! Specifically Prized $23.**

**HELPOTS, Model A**

- Case diameter 1.8": Number of turns 10:
  - Slide Wire Length: 46½; Rotation: 3500 Degrees
  - Power rating: 5 Watts; Resistance rating: 20,000 ohms.

**SPECIAL PRICE**

- $4.50

**Resistor Assembly**

- National Brand Manufacturer. 150 amperes. 0.088 ohms. 13.2 volts. 25" long. 9" wide and 12" high.

**OUR SPECIAL PRICE**

- $3.89

**Janette Type CS13F Rotary Converters**

BRAND NEW! Input: 12 volts, DC Output 110 volts. Single phase, 60 cycles; 212 KVA. 85% P.F. Ball Bearings. With filter for use on radio equipment.

**SPECIAL**

- $51

---

**GENERAL ELECTRIC TRANSFORMERS**

Brand New! 1 KVA.

- 460-230...

- 230-115...

- $19

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**SEARCHLIGHT SECTION**

**ELECTRO SALES COMPANY**

Dept. E.-6, 110 PEARL STREET, BOSTON 10, MASS.

ELECTRONICS --- June, 1948

All prices F.O.B. Boston. Orders accepted from rated concerns on open account. Net 30 days.
SURPLUS BARGAINS!

WESTON MODEL 271
Large Fan Shaped Microammeter
Another of the famous Weston Fan shaped line. Very large scale 2.8" long. These units were made by Weston to General Radio specifications, with special mirrored scale and knife edge pointer. Accuracy 1%. 0–600 Microamps

Your Price $12.50
10 for $100.00

TRANSTATS—3 K. V. A.

Type HI Input: 115 V. 10%. Output: 115 V. Max. Amps: 24 A
Made as a line voltage corrector 10% of input voltage, or can be connected to give plus 20% or minus 10% of input. Can also be reconnected to be used as an isolated type. Double pole double throw. Input: 115 V. Output: 0–36 Volts at 10 Amps. No Shady.

A Real Buy at $18.00
(many sections.. K.Y.A. Input: 115-125 V. Output: 115 V.-2.17 A.)
Price $6.50

STEPDOWN TRANSFORMER

Made by General Electric. Heavy duty stepdown transformer with considerable overdesign. Ideal for home use, low voltage heating, general laboratory use, etc. Open frame type.

Input: 115 Volts—60 Cycles
Output: 15 Volts (at full load)
Capacity: 100 V.A.
Size: 5"x5"x5" V. A.
Your Cost $3.75
Quantity prices available

HEAVY DUTY STEPDOWN TRANSFORMERS


Your Cost $12.50
10 for $100.00

POWER TRANSFORMER

Pri-146/250 V 60 Cy Sec-115/110 V
Rating: 8 KVA RCA Open construction.
Bracket mounted, pin & screw terminal boards. Overall dimensions: 8 1/2" H x 11/2" W x 8" D.
Mounting dimensions: 5 1/2" H x 5 3/4" W. Price $12.50

STRUTHERS-DUNN RELAYS

D.P.D.T., Normally open, 15 amp, 250 Cycle, A.C. coil, 28 Amp contacts, fuse base with 4 holes for mounting. Dimensions: 1 1/2" L x 2 5/8" H.

A Real Buy At $2.50

OMHITE POWER TAP SWITCH

Non-Shorting, Model 353, Cat. No. 412-15, 60 Amps A.C., 30 amp continuous. Dimensions: 3/4" X 4 1/4" X 1 1/2" W.

Your Price $1.50

HEINEMANN CIRCUIT BREAKER

For use with low voltage transformers, with consideration of dimensions: 1/4" H x 4" D x 1 5/16" W.

Your Price $3.50


A. C. VOLT-AMMETER SET

Westinghouse RA-37—4th Br. 0-300 Volts AC
Scale: 390/390 Volts AC
With Potential Transformer for 300 Volts AC
Your Cost $10.00
Westinghouse RA-37—4th Br. 0-5 Amps AC
Scale: 60/60 Volts AC
With Donut Current Transformer for Double Range
Your Cost For ALL 4 PIECES $17.50

PORTABLE A. C. AMMETER

WESTON #528

Douglas type ammeter. 0–3 Amps and 0–15 V. A. Dimensions of the very useful ranges for your Lab. or shop. Complete with metal case with test leads.

Your Price $12.25

D. C. AMPS & MILLS

0-1 Ma 2" G.E. D.W. 110 A.
(30 scale)
0-1 Ma 2" Weston 506
0-1.5 Ma 2.25" Sun I.A.P. 365
0-2.5 Ma 2" Weston 306 with metal case
0-3 Ma 2" Dejar 810
0-5 Ma 2" G.E. D.W. (117)

For Price 0-10 Ma 3" Simpson 217
0-15 Ma 3" Weston 335

Your Cost $6.00

D. C. VOLTS

0-15 V. 2" Weston RX-33
(Black scale)
0-20 V. 2" Weston 506
0-40 V. 2" Weston 506
0-90 V. 3" G.E. DO 41

Your Cost $6.50

A. C. VOLS

0-15 V. 2" G.E. AD 110
0-19 V. 2" G.E. AD 25
0-180 V. 3" G.E. A-155

For Price 0-150 V. 3" G.E. AD 311

A. C. Amps

0-1.5 A. 2" Weston 57 (RF)
0-4 A 3" Weston RN 35

For Price 0-30 A. 3" Triplett (metal)
0-5 A 4" Triplett 1104

Your Cost $3.50

SEALED RECTIFIER STACK

New. Manufactured only 3 Months Ago
Full Wave Bridge. Approximate rating
Input Max. 35 VAC. Output Max. 24 V AC.

WORTH $1.50
(minimum order of 10 tubes)

RHEOSTAT, OHMITE MOD. N.

600 Watts, 150 Ohms, 11.1 Max. Amps, 4" Diameter. Weight 2 lbs. with knob.
Price $5.25

RHEOSTAT, OHMITE MOD. R.

500 Watts, 250 Ohms, Tapped, 15/30 Amps, 4" Diameter. Weight 6 lbs. without knob.
Price $7.50

SELENIUM RECTIFIERS

Full Wave Bridge

Price

FEDERAL OUTPUTS

Price

Capacitors

Cap. Volts

Weight Height Length Price

10 1000 VDC 7-1/2 1/4 4 1/2

1 1000 1/2 x 1/2 1/2

1 500 1/2 x 1/2 1/2

1 250 1/2 x 1/2 1/2

FREQUENCY METER

Range 50—150 Cycles, Weston 877, aircraft type, 3½' long.
Complete $4.95

All meters are white scale flush bake-lite case unless otherwise specified.

ALL PRICES INDICATED ARE FOB, OUR WAREHOUSE, NEW YORK, N. Y.

Shipsments Transportation Charges Collect Will Be Made Via Railway Express Unless Sufficient Postage Is Included, or Other Instructions Issued. We Will Refund Excess Postage In Stamps.

POWERTRON Electrical Equipment Co.
117 LAFAYETTE STREET
Phone: WORTH 4-8610
NEW YORK 13, N. Y.

June, 1948—ELECTRONICS

www.americanradiohistory.com
## TRANSTAT VOLTAGE REGULATORS

Manufactured by Amertran, three Models are available

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<td>Fixed Winding 200/110</td>
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<th>VALUE</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fixed Winding 115 Volts 4-600 cycles (Internal resistance 25 ohms)</td>
<td>$6.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Commutator range 150-1200 Volts, 25 Volts D.C.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fixed in Shielded case</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fixed in Shielded case</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## RELAYS

**Allied Control**

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
<th>VALUE</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>390D3</td>
<td>$3.95</td>
<td>D.P.T. (Electromagnetic)</td>
<td>$1.25</td>
</tr>
<tr>
<td>390D4</td>
<td>$4.15</td>
<td>D.P.T. (Electromagnetic)</td>
<td>$1.25</td>
</tr>
<tr>
<td>390D5</td>
<td>$4.35</td>
<td>D.P.T. (Electromagnetic)</td>
<td>$1.25</td>
</tr>
</tbody>
</table>

**Allied Control**

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
<th>VALUE</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>3911</td>
<td>$4.15</td>
<td>D.P.T. (Electromagnetic)</td>
<td>$1.25</td>
</tr>
<tr>
<td>3912</td>
<td>$4.35</td>
<td>D.P.T. (Electromagnetic)</td>
<td>$1.25</td>
</tr>
</tbody>
</table>

**Aircraft-type Starter Relay**

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
<th>VALUE</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1051</td>
<td>$2.75</td>
<td>D.C. Contacts 24 cycles, 36 Volts D.C.</td>
<td>$1.00</td>
</tr>
<tr>
<td>1052</td>
<td>$2.95</td>
<td>D.C. Contacts 24 cycles, 36 Volts D.C.</td>
<td>$1.00</td>
</tr>
</tbody>
</table>

**Isolating Relay D.P.T.**

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
<th>VALUE</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>$3.45</td>
<td>D.P.T.</td>
<td>$2.00</td>
</tr>
<tr>
<td>1001</td>
<td>$3.65</td>
<td>D.P.T.</td>
<td>$2.00</td>
</tr>
</tbody>
</table>

**Weston Model**

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
<th>VALUE</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2025</td>
<td>$2.95</td>
<td>D.C. Contacts 24 cycles, 36 Volts D.C.</td>
<td>$1.00</td>
</tr>
<tr>
<td>2026</td>
<td>$3.05</td>
<td>D.C. Contacts 24 cycles, 36 Volts D.C.</td>
<td>$1.00</td>
</tr>
</tbody>
</table>

**Tappan Type Relay**

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
<th>VALUE</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>21454</td>
<td>$4.85</td>
<td>D.P.T. (Electromagnetic)</td>
<td>$2.50</td>
</tr>
<tr>
<td>21455</td>
<td>$4.95</td>
<td>D.P.T. (Electromagnetic)</td>
<td>$2.50</td>
</tr>
</tbody>
</table>

**G.M. Relay D.P.T.**

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
<th>VALUE</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>21457</td>
<td>$6.45</td>
<td>D.P.T. (Electromagnetic)</td>
<td>$3.50</td>
</tr>
<tr>
<td>21458</td>
<td>$6.65</td>
<td>D.P.T. (Electromagnetic)</td>
<td>$3.50</td>
</tr>
</tbody>
</table>

**Tappan Type Relay**

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
<th>VALUE</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>21454</td>
<td>$4.85</td>
<td>D.P.T. (Electromagnetic)</td>
<td>$2.50</td>
</tr>
<tr>
<td>21455</td>
<td>$4.95</td>
<td>D.P.T. (Electromagnetic)</td>
<td>$2.50</td>
</tr>
</tbody>
</table>

**High Fidelity INPUT TRANSFORMERS**

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
<th>VALUE</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>21457</td>
<td>$6.45</td>
<td>D.P.T. (Electromagnetic)</td>
<td>$3.50</td>
</tr>
<tr>
<td>21458</td>
<td>$6.65</td>
<td>D.P.T. (Electromagnetic)</td>
<td>$3.50</td>
</tr>
</tbody>
</table>

**Searchlight Section**

**Specialized Electronic Material**

**High Quality Low Price Immediate Shipment**

**TUBES**

<table>
<thead>
<tr>
<th>Type</th>
<th>Price</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2AC6</td>
<td>$4.55</td>
<td>6S4</td>
</tr>
<tr>
<td>2A36</td>
<td>$4.55</td>
<td>6S4</td>
</tr>
<tr>
<td>2A37</td>
<td>$4.55</td>
<td>6S4</td>
</tr>
<tr>
<td>2A38</td>
<td>$4.55</td>
<td>6S4</td>
</tr>
<tr>
<td>2A39</td>
<td>$4.55</td>
<td>6S4</td>
</tr>
<tr>
<td>2A40</td>
<td>$4.55</td>
<td>6S4</td>
</tr>
<tr>
<td>2A41</td>
<td>$4.55</td>
<td>6S4</td>
</tr>
</tbody>
</table>

**Write for Descriptive Catalog Listing a Large Variety of Electronic Components**

**EDLIE ELECTRONICS, INC.**

**131 LIBERTY STREET**

**Telephone: Worth 4-1169**

**NEW YORK 6, N. Y.**
ELECTRONICS
Only home tubes required. This set...

**SELENIUM RECTIFIERS**

<table>
<thead>
<tr>
<th>Full Wave Bridge Type</th>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 15v AC</td>
<td>up to 12v DC</td>
<td>1 Amp</td>
</tr>
<tr>
<td>up to 18v AC</td>
<td>up to 12v DC</td>
<td>10 Amp</td>
</tr>
<tr>
<td>up to 24v AC</td>
<td>up to 12v DC</td>
<td>15 Amp</td>
</tr>
<tr>
<td>up to 30v AC</td>
<td>up to 12v DC</td>
<td>30 Amp</td>
</tr>
<tr>
<td>up to 50v AC</td>
<td>up to 12v DC</td>
<td>5 Amp</td>
</tr>
<tr>
<td>up to 60v AC</td>
<td>up to 12v DC</td>
<td>10 Amp</td>
</tr>
<tr>
<td>up to 80v AC</td>
<td>up to 12v DC</td>
<td>15 Amp</td>
</tr>
<tr>
<td>up to 115v AC</td>
<td>up to 10v DC</td>
<td>25 Amp</td>
</tr>
<tr>
<td>up to 115v AC</td>
<td>up to 9v DC</td>
<td>25 Amp</td>
</tr>
<tr>
<td>up to 115v AC</td>
<td>up to 8v DC</td>
<td>50 Amp</td>
</tr>
</tbody>
</table>

**PERMALLOY SHIELDS** for Cathode Ray Tubes

<table>
<thead>
<tr>
<th>Shield</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>3&quot;</td>
<td>$1.49</td>
</tr>
<tr>
<td>5&quot;</td>
<td>$1.98</td>
</tr>
</tbody>
</table>

**OIL CAPACITORS**

<table>
<thead>
<tr>
<th>All Ratings, D. C.</th>
<th>Indl.</th>
<th>200v</th>
<th>$0.85</th>
</tr>
</thead>
<tbody>
<tr>
<td>2x1-mfd.</td>
<td>600v</td>
<td>0.85</td>
<td></td>
</tr>
<tr>
<td>2x2-mfd.</td>
<td>600v</td>
<td>0.85</td>
<td></td>
</tr>
<tr>
<td>8x2-mfd.</td>
<td>600v</td>
<td>0.85</td>
<td></td>
</tr>
<tr>
<td>16x2-mfd.</td>
<td>600v</td>
<td>1.10</td>
<td></td>
</tr>
<tr>
<td>8x4-mfd.</td>
<td>600v</td>
<td>1.15</td>
<td></td>
</tr>
<tr>
<td>16x4-mfd.</td>
<td>600v</td>
<td>1.65</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HIGH CAPACITY CONDENSERS</th>
<th>2,300 mfd.</th>
<th>15 WDC</th>
<th>$0.45</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000 mfd.</td>
<td>15 WDC</td>
<td>$0.99</td>
<td></td>
</tr>
<tr>
<td>500 mfd.</td>
<td>15 WDC</td>
<td>$0.94</td>
<td></td>
</tr>
</tbody>
</table>

**CODE KEYER TG-10**

This practice Code Keyer contains a 7 tube 110 volt 6 cycle Amplifier plus an electric tube. It also contains a 110 volt 6 cycle motor with a 15 turn fly wheel through which a list of 5 to 25 words per minute. The amplifier would make an excellent P.A. system and the motor would turn a typewriter very nicely.

**NEW—$24.95** (Less Tubes)

**RS/ARN-7 RADIO COMPASS RECEIVER**

Three bands 200 to 1750 K.C. Complete with 17 tubes included. This set is ideal for converting to home broadcast Receiver, addition to ham shack, etc. A Receiver that would be hard to pick up at this price.

Only $31.95—NEW

**STEP DOWN TRANSFORMER**

PRIMARY 440/220 VOLS
SECONDARY 230/115 VOLS

400 KVA

$14.95

**TERMINAL—115 V, 60 CYC. HI-VOLTAGE INSULATION**

| 3710v | 10 ma; 2x25v @ 5A |
| 2500v | 15 ma; 3x15v @ 5A |
| 2000v | 25 ma; 4x15v @ 5A |
| 1500v | 40 ma; 5x15v | $31.95 |
| 1000v | 60 ma; 5x15v | $24.95 |
| 600v | 90 ma; 5x15v |
| 300v | 120 ma | $21.95 |

**FILTER CHOKES**

<table>
<thead>
<tr>
<th>HI-VOLTAGE INSULATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 kx @ 40 ma.</td>
</tr>
<tr>
<td>8 kx @ 30 ma.</td>
</tr>
<tr>
<td>250 kx @ 5 ma.</td>
</tr>
<tr>
<td>1250 kx @ 1 ma.</td>
</tr>
<tr>
<td>2500 kx @ 1 ma.</td>
</tr>
<tr>
<td>5000 kx @ 1 ma.</td>
</tr>
<tr>
<td>10000 kx @ 1 ma.</td>
</tr>
<tr>
<td>25 kx @ 1 ma.</td>
</tr>
</tbody>
</table>

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INDUSTRIALS — LABS — SCHOOLS — AMATEURS

Let us quote on components and equipment that you require. We have too many items to list on this page. Place your name on our mailing list now for new catalogs.

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ELECTRONICS — June, 1948
TACHOMETER MAGNETO
Model 44A
Weston
ONLY $37.50

SELSYSNS
ONLY
17.25 pair

SELSYN DIFFERENTIAL
#C79221
115 V., 60 Cycles.

President

NC WIRE
20 AWG
G"ODP
TUBULAR PAPER CONDENSERS

SPEACX
NEEDLE BEARINGS

TUBULAR PAPER CONDENSERS

OIL FILLED CAPACITORS

TUBES (brand new)

PRECISION RESISTORS

RELIANCE Merchandizing Company
Arch St. Cor. Croskey, Philadelphia 3, Pa.

PHONE R.I. tenhouse 6-4927

MINIMUM $3 ORDER

RELIANCE SPECIALS

UNIVERSAL JOINT
ALUMINUM
1 1/4" x 1/2" DD
1/4" 10 35c

BC 1072A IFF XMITTER
in MAPLE CHEST
130 to 200 Ws

POWER SUPPLY gives: 6,500 V.D.C., 600 V.A.C., 600 V.D.C.
5 KV meter, Blower, Condenser and many other electrical parts depending upon size and type. Shipping $15.00

Only
(used) $22.50

BC 1072A IFF XMITTER
in MAPLE CHEST
130 to 200 Ws

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POWER SUPPLY gives: 6,500 V.D.C., 600 V.A.C., 600 V.D.C.
5 KV meter, Blower, Condenser and many other electrical parts depending upon size and type. Shipping $15.00

Only
(used) $22.50
W.E. TYPE D-168479
MERCURY CONTACT RELAY
Brand New War Surplus
in Original Cartons
For application in all types of high speed switching devices. Long life service, high operating speed, lower contact fatigue and maintenance. No sparking, no arcing, continuous or momentary contacts. Operates in any position. Inclined and horizontal. Company, in enclosed, moisture and dustproof box, with 90 degree elbow. Unbreakable, adjustable to 0 to 90 degree. Complete with controls. Price, $7.50. Immediate delivery subject to prior sale.

PANORAMIC ADAPTER
TYPE AN/APA-10
Total 21 tubes including 3 scope tubes. Contained for operation 115 v., 60 cycle. Tested and guaranteed in perfect operating condition. $97.50.

VOLTAGE REGULATOR CHASSIS
AN/APA-10
Consists of 2 filter transformers, model 2-V-8100 tubes, etc. Can be used to regulate any 300 volt power supplies and provides 300 and 150 volt regulation. Complete as shown. $8.75.

AN/APA-10
POWER SUPPLY
Input: 30 or 115 volts, direct to 2600 volts
Output: 1200 volts D.C. at 1.5 MA., 140 volt D.C. at 150 MA., 1.4 C. V. C. (D.C. for 100 v. D.C. filtered tubes), 1.0-24V., 1.0-45, 1.0A, 500 volt power supply, resistance equalizing filter, two phase operation with intensity control and R.A.R. reference circuit. Complete as shown. $13.75.

AN/APA-10
400-2600 cycle
POWER TRANSFORMER
As used in Power Test Des, delivered alone. $1.75.

MOTOR GENERATORS
Brand New War Surplus Machines built by Allied Chalmers Co. to U. S. Navy Specifications.

All machines built for 230 V. D.C. input. Price $175.00. Same parts list with minor changes, brackets, field coils, bearings, etc., for either machine. $29.50.

All merchandise guaranteed. Immediate delivery, subject to prior sale.

ELECTRONICRAFT, INC.
PHONE—TUCKAHOE 3-0044
TUCKAHOE 7, NEW YORK

ELECTRONICS—June, 1948

273
3 METER BARGAINS FOR THIS MONTH
$2.95 EACH
10 FOR $24.75

- 2" GE 0-1 Amp RF (Internal Thermo)
- 2" GE 0-250 DC (Internal shunt)
- 2" Sun 0-1 MA Basic (Volt Scale)

METER SPECIALS
1 1/2" GE 0-1 MA Basic $3.95
2" GE 0-5 ma (amp scale) $1.95
2" GE 0-1.2 ma (0-100 scale) $2.49
2" Weston type 507 0-120 ma RF $4.95
2" GE 0-1 ma (volt scale) $2.95
2" Green 0-3V DC (1000 ohms per volt) $2.45
2" Weston 150-0-150 Microamps 3.49
3" Westinghouse 0.75 amp AC 4.95
3" Weston—10 to 14 DB 5.45
3" Weston—10 to 1+4 DB 5.95
3" Westinghouse 0-30 amps AC 4.95
3" Triplet 0.75-1 mV density AC 3.95
3" WE 0.8 mV DC 2.95
3" Westinghouse 0-200 microamps DC 3.95
3" McClointon 0-1 ma 3.95
3" Westinghouse 0.2 ma DC 3.95
3" Westinghouse 0-20 microamps DC 3.95
3" Westinghouse 0.15 ma DC (square) 3.95
3" Westinghouse 0-150 VAC 3.95
3" WE 0-5 microamps 9.95
3" GE Running Time Meter 7.95
3" GE 1-0-1 ma DC (Blank scale) 3.95

WIRE WOUND RESISTORS
Standard Make
5 Watt type A.A. 26-25-50-270-70-250 $1.00 ea.
10 Watt type AB. 25-10-40-140-725-1250 3.00 ea.
20 Watt type DC. 50-75-100-150-250-500-750-1000 8.00 ea.
30 Watt type 3D. 100-150-250-300-1000 15.00 ea.
50 Watt type 3D. 150-250-300-600-1000 25.00 ea.
80 Watt type 3D. 250-500-750-1000 40.00 ea.
100 Watt type 3D. 300-500-750-1000 50.00 ea.
1% PRECISION RESISTORS
Standard Make
200-2500-5000-8500-10000 ohms 39 ea.
3000-5000 ohms 49 ea.
10000-25000 ohms 69 ea.
S. C. TEST SET—1-114
In portable wood case 8" x 5" x 10" (including cover not shown). Has Weston 0-150 volt A.C. meter 60 cycles, 2-switching circuits, complete with binding post and A battery at only $3.95.

U. H. F. COAX. CONNECTORS
UG12U—43IR—631—UG21U—631P—611P Large stocks of Coax, and A/ Conectors.

VARIABLE CERAMIC TRIMMERS
1 5 to 7 MFM—24
2 5 to 20 MFM—24
3 20 to 50 MFM—24
4 75 to 150 MFM—24
10 to 110 MFM—39

DAVEN AUDIO FREQUENCY METER Model 837E

MEGOMH METER
Industrial use. Selects 100,000 volt input and/or 110/220 volts 60 cycle input. Direct reading from 0-30 KD in 4 separate ranges on 2" Weston Model A. 1.5 Volt battery. Built-in voltage regulated power supply operates from 115 volts 60 cycles. High input impedance, with pick-up can be used to determine frequency in vibration tester, with suitable meter can check deviation of R.F. carrier from standard deviation on 75kc/imp. cal. panel. Complete with tubes. Slightly used but perfect. Only $25.95.

MIDGET VARIABLE BARGAINS
Hamacarbide WC 2050 250 ohms 5.99
Hamacarbide WC 5502 525 ohms .79
Hamacarbide WC 1001 105 ohms .69
Hamacarbide WC 111 680 ohms 3.49
National EMS 150 ohm 0.39

"A CLOSEOUT" AMERICAN TRANSFER or Stepdown Transformer 110/220 volts 60 cycle input. Output variable from 0-250 volts. Also can be connected to different voltage connections. Brand new only $12.95 each.

AMERTRAN VOLTAGE REGULATOR
6000-20000 volt primaries. Input: Output variable from 2-250 volts. 1.3 kva. simple, heavy duty used but good. $9.90.

OIL CONDENSER
1 mfd 250 volt... $8.00 1 mfd 600 volt... $16.00
2 mfd 1000 volt... $8.00 2 mfd 5000 volt... $28.00
3 mfd 1000 volt... $11.00 3 mfd 5000 volt... $27.75
6 mfd 1000 volt... $17.00 6 mfd 5000 volt... $39.00
25 mfd 5000 volt... $65.00 25 mfd 600 volt... $0.55/mfd
50 mfd 5000 volt... $120.00 50 mfd 1000 volt... $1.39/mfd
100 mfd 5000 volt... $210.00 100 mfd 1000 volt... $2.25/mfd
200 mfd 5000 volt... $420.00 200 mfd 1500 volt... $4.62/mfd
300 mfd 5000 volt... $630.00 300 mfd 2500 volt... $9.69/mfd
350 mfd 5000 volt... $715.00 350 mfd 3000 volt... $12.56/mfd
1000 mfd 5000 volt... $3500.00 1000 mfd 5000 volt... $60.00/mfd

SPERTI RF VACUUM SWITCH
9200 volts peak, 8 Amps. Used in antennas switch in Catalin ART 13. BRAND new $1.75.

MISCELLANEOUS SPECIALS
2-1/2 mfd. Butterflies with ball bearings $5.99
G.E. S.P.T. Relay 10000 ohms coil... $3.99
Helenio Circuit Breaker 5 amp, 1000 volt A.C. $1.99
G.E. Sulzerlind W/Neutral. (Switches 21 V. D.C. $1.99
25 ohms 25 watt Rheostat $2.99
Microswitch with Glass Rectifier... $3.99
Corning Preamplifiers... $3.99
Vender Rod Counter... $1.95
Quantum Photocells... $1.95
Trim Commercial Phones (High Imp.) 4.50

Tremendous stocks on hand. Please send requests for specials. Special quantity discounts. Prices f.o.b. N.Y. 20% with order less rated, balance C.O.D. Minimum order $3.00.

Phone Cortlandt 7-6443

PEAK ELECTRONICS CO.
Industrials
Schools - Labs

274

June, 1948 — ELECTRONICS

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NEW GUARANTEED SURPLUS!!

SYNCHROS

NAVY TYPES
1G, 1CT, 5G, SCT, 5DG, 5G5, S5F, and others.
Pioneer Autosyns—AY-1, AY-14, AY-20, AY-30, AY-54, AY-101D, 851, etc.
Kalismann—77S-01
G.E. — 111F1, 111G1, 111H1, 113HA1, 113FB1, 116F3, etc.

Size 5 Synchro Generator

NULL TYPE SYNCHRO INDICATOR


Remote Position Indicating System
Idle for Ham Beam Position Indicator or industrial uses. 6-12 volt 60 cycles. 3-inch indicator with 0-360° dial. Heavy duty transmitter. Stock #SA-115. Price $9.95 per system.

SERVO MOTORS

Pioneer—CK-2 and 10047-2-A for 400 cycles.
Dickl—FP-25-3, FPE-25-11 (CD.1-211052) and ZP-105-8 (CD.1-211077) for 60 cycles.

400 Cycle Motors

Westinghouse Type FL Blower
115 V. 400 cy. 17 C.F.M. Includes capacitor.
Stock #SA-144. Price $6.75 ea.

DC MOTORS
Delco 5069370, 27 V., Alnico field. 10,000 rpm. Similar to S-65 but has straight shaft extension. Stock #SA-6. Price $4.75 ea.
DC Timing Motor—Haydon 1/2 rpm. 29 volts, 100 mls. Stock #SA-157. Price $3.75 each.

110 RPM Aircraft Motor
G.E. 5BA10J/18D. 27 V. @ 0.7 amps, 1 oz./ft torque. 12" diam. x 1½" Ig. Operates on AC or DC Stock #SA-98. Price $2.95 ea.
Include 15¢ for P.P. and handling.

ALL PRICES F. O. B. CLIFTON, N. J.

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Pioneer — 12116-5-A, 12117-2-A, 12123-1-A
Holtzer Cabot—MG-149F, MG-149H, MG-153F
General Electric—5D211J3A
Leland—10563, PE-218, Pioneer-CK-2 stock
Wincharger—PU-7/1AP

Magnesyn—Pioneer CL-3, 6 power. Transmitter or receiver. Stock #SA-6.
Price $3.75 ea.

ACUATOR
Foote Bros. 10801. 1/6th H.P. 24 V. @ 11.5 amps. 5 inch linear travel. Limit Switches. Stock #SA-161. Price $12.50 ea.

60 CYCLE AC Motors
Stock #SA-19. Similar to above but not split field. Price $2.75 ea.

AMPLIDYNES

G.E. Aircraft
5AM31-NJ18A
Input 27 V. D.C. @ 44 amps. Output 60 V. DC @ 88 amps. max. 530 watts.

SERVO-TEK PRODUCTS CO.

INCORPORATED
Surplus Division

247 CROOKS AVE.
ARMORY 4-2677

ELECTRONICS — June, 1948

CLIFTON, N. J.

Write or call for complete listing.

Open account shipments to rated concerns, others may order C.O.D.
1948 MODEL OUTBOARD MOTOR

AT DEALER WHOLESALE PRICE!

Powerful, durable two cylinder outboard motor with automatic carburetor (no turning, no choking). Standard engine is equipped with roller bearings, trolling quick release, frequency calibration charts. This unit is limited time only—sale ends July 1.

ULTRA45 An 11 tube crystal controlled superhet receiver for 20-24V DC operation. Beautiful chassis and cabinet. Use latest tube types including 7 miniature E42S tubes and schematic supplied. Only a few available at $11.95.

GENERAL ELECTRIC 150 WATT TRANSMITTER

Cost the Government $1800.00 • Cost to You—BRAND NEW—$67.50

This is the famous transmitter used in U.S. Army bombers and ground stations, during the war. Its design and alignment is as close as possible to that of a prototype which was used in the testing of the radio equipment carried aboard B-24s. A complete transmitter housed in a pass-through unit for receiving. All parts are covered by patents of the receiver units which are included. Each model has its maker's and power supply unit. Standard components are included, and additional components (one per unit) are designed to deliver at top efficiency within its frequency range. Transmitter and accessories are finished in black, and the radio tubes are used in the signal path. Here are the specifications: FREQUENCY RANGE: 1500-5500 kHz. With proper power supply, all tubes, transmitter power supply, tuners, etc., can be obtained from B. F. Goodrich's for less than $3.00 additional.
BRAND NEW EQUIPMENT

Available for Immediate Delivery

Pioneer Torque Units Types 12602-1-A, 12606-1-A and 12627-1-A.
Pioneer Torque Unit Amplifiers Type 12073-1-A.
Pioneer Autosyn Motors Types AY1, AY5, AY6, AY10, AY14, AY20, AY21, AY27, AY30, AY38 and AY 54.
Pioneer Precision Autosyn Type AY101D.
Pioneer Magnesyn Indicator Type 13318, dial graduated 0 to 360°, 26 volts 400 cycle.
Pioneer Autosyn Single Indicators Type 5907-17, dial graduated 0 to 360°, 26 volts 400 cycle.
Pioneer Autosyn Dual Indicators Type 6007, dial graduated 0 to 360° and other ranges, 26 volts 400 cycle.
Pioneer Two-Phase Low-Inertia Servo Motors Types CK1, CK2 and CK5, 400 cycle.
Diehl Two-Phase Low-Inertia Servo Motors Types CDA211052, 75 volts 60 cycle and FP.25-2 and FP.25-3, 20 volts 60 cycle. Will also operate on 115 volts 400 cycle.
Eastern Air Devices Permanent Magnet Generators Type J36A, 10 to 5000 RPM, .02 volts per revolution.
Eastern Air Devices Synchronous Motors Type J33, 115 volts 400 cycle, 3 phase.
Inverters—Three-Phase 400 cycle. Pioneer Type 12121 and 12123 and Holtzer Cabot Type 153F.
Inverters—Single-Phase 400 cycle. Pioneer Types 12116 and 12117. Holtzer Cabot Types 149F and 149H. General Electric Type 5D21-NJ3A. Wincharger Type MG750 PU/16 and Winco Type MG2500 PU-7.
Delco Permanent Magnet Field Motors Types 5069370, 5069466, 5069600, 5069230, 5067125 and Diehl Type SS-FD6-16.
Weston Frequency Meters Model No. 637, 350 to 450 cycle.
Synchros—Sizes 1F, 1CT, 5G and 5SG.
Pioneer and Kollsman Remote Indicating Magnesyn Compass Sets with or without 12 or 24 volt input 400 cycle inverters.
Gyros—Schwein Rate Types 45600D and 46800. Pioneer Servo Unit Type 12800-1-D, Sperry A4 and A5 units, Norden and Minneapolis Honeywell units.

WRITE FOR OUR COMPLETE LISTING!

INSTRUMENT ASSOCIATES

40-37 172nd STREET FLUSHING, L. I., N. Y.

Telephone Flushing 7-8718
Desirable Select Surplus Items of Electronic Equipment—New, Unused

<table>
<thead>
<tr>
<th>ITEM</th>
<th>QUANTITY</th>
<th>DESCRIPTION</th>
<th>UNIT PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>17</td>
<td>Link Radio Transmitter-Receiver Type 50-UFS, 50 watt frequency-modulated complete transmitting and receiving main station, frequency range 30–44 mcs. Includes transmitter, one 12-UF receiver, local control and deluxe desk cabinet, and Link Remote Control Unit. Primary power source 100–125 and 220 volts A.C. 50/60 cycles</td>
<td>$475.00</td>
</tr>
<tr>
<td>02</td>
<td>46</td>
<td>Radio transmitters-receivers for airport traffic control purposes, ship-to-shore communications, etc., type AN/FRC-1, output 150 watts, frequency range 1.5 mc to 12.5 mc (200–25 meters). Primary power source 90–120 volts or 200–230 volts 50/60 cycle AC, Emission A1, A2, A3</td>
<td>$575.00</td>
</tr>
<tr>
<td>03</td>
<td>6</td>
<td>Radar ships’ units Type SF, complete with all components</td>
<td>$1,480.00</td>
</tr>
<tr>
<td>04</td>
<td>1</td>
<td>QCT Sonar Unit</td>
<td>$2,400.00</td>
</tr>
<tr>
<td>05</td>
<td>1</td>
<td>Navy model transmitter for radio telegraphy, Type TAJ-19. Power output 500 watts—Emission CW and MCW. Frequency range 175–600 kcs. Manufactured by General Electric</td>
<td>$1,950.00</td>
</tr>
<tr>
<td>06</td>
<td>36</td>
<td>R5/ARN-7 Radio Compasses</td>
<td>$125.00</td>
</tr>
<tr>
<td>07</td>
<td>29</td>
<td>BD-72 Field Telephone Switchboards</td>
<td>$67.50</td>
</tr>
<tr>
<td>08</td>
<td>9</td>
<td>Army Type PE-197 Gasoline Engine Driven Electric Generator, output 5KW at 120 volts, 60 cycles, single phase. Engine: Hercules 4 cylinder water cooled automatic starting. Generator: manufactured by Hobart Bros. Complete with approximately 150 ft. of power cable, 150 ft. of remote control cable, spare parts and tools</td>
<td>$675.00</td>
</tr>
<tr>
<td>09</td>
<td>6</td>
<td>Army Type E-3 Gasoline Engine Driven Electric Generator, output 3KW at 110 volts, 60 cycles, single phase. Engine: Hercules 4 cylinder or Onan 2 cylinder water cooled with magneto ignition. Generator: manufactured by D. W. Onan &amp; Sons. Complete with spare parts and tools</td>
<td>$395.00</td>
</tr>
</tbody>
</table>

PRICE ARE F. O. B. OUR WAREHOUSE — QUOTATIONS SUBJECT TO PRIOR SALE

Export packing where necessary extra at cost

FRENCH-VAN BREEMS, Inc.

630 FIFTH AVENUE

NEW YORK 20, N. Y., U. S.A.

CABLE ADDRESS, FREXVAN, N. Y.

Electronic Engineering Experts

June, 1948 — ELECTRONICS
"ARROW" leads with Better Buys!

**BRAND NEW!**

- 2J32 .......... $19.95
- 869B .......... 19.95
- 872A .......... 95c
- 6G6 .......... 79c
- 1N5 GT .......... 95c
- 6G6 .......... 89c
- 869B .......... 2J32 $19.95
- 869B .......... 6G6 $19.95
- 872A .......... 869B
- 6G6 .......... 1N5 GT

**Write for lot prices!**

**BIAS METER**

Brand New

Originally used for measuring voltages and telephones and telephone equipment. Can be used for measuring DC voltages and bias voltages also checking polarity of DC voltages. Complete with aluminum fuses and schematics. Exclusively in metal carrying case. Includes no batteries for operation.

**GLIDE PATH RECEIVER**

R-89/ARN-5

Glide Path Receiver used in the Instrument Landing System covering the frequency range 320 to 335 mc; complete with the following tubes: T-6AJ6, 1-12SR7, 2-15NN, 1-8BY7, and including three crystals 6497KC, 6522KC.

**ANTENNA RELAY UNIT**

6-16 Meter Weston Thermocouple unit with 60 MMF, 6000V Vacuum Condenser, and heavy duty relay.

- Model A .......... $1.95

All Shipment F.O.B. Chicago. Minimum order $5.00. 20% deposit on all orders. DEPT. EL.

**ARROW SALES, INC.**

**MAIN OFFICE**

59 WEST HUBBARD ST., CHICAGO 10, ILL.

Telephone SUPERior 5575

**NORTH SIDE BRANCH**

1802 NORTH HUMBOLDT BLVD.
FREQUENCY METER

**TS-69/AP**

Frequency range 100 mc to 1,000 mc, continuous. Black-enameled aluminum case, dim: 8" x 6" x 3". Includes a 5 MHz crystal oscillator and test lead, and 2 batteries. Range is 1 to 1000 mc, depending upon battery voltage. Price, each $24.95.

**50 WATT RADIOTELEPHONE, MODEL ATD**

Ideal for mobile installation. Full 50 watts output. 4 channels. Prices quoted F.O.B. Watkin's, 1911 S. Senate Blvd., Los Angeles 24, Calif.

**XMTNG X'FORMERS, CHOKES, ETC.**

In stock Heavy Current Plate X'former, 4500V, 250A, for 5000 volts, $250.00; 2000 volts, $150.00. NEW.

**ELECTRO IMPULSE LABORATORY**

66 Mechanic St., Red Bank, N. J.

Red Bank 6-2427

June, 1948 — ELECTRONICS
WELLS

... the Immediate Source of Highest Quality Electronic Components at Less Than Market Prices

CO-AX CONNECTORS

You realize substantial savings on production runs when you specify Wells components. We maintain enormous stocks of a wide variety of parts of assured quality.

For specifications and prices, check the listings in which you are interested and mail the coupon. A wire or phone call will produce immediate information on any specific components.

VOLUME CONTROLS


MICRO-SWITCHES


WELLS
SALES, INC.

320 N. LA SALLE., DEPT. SL, CHICAGO 10, ILL.
"TWO-IN-ONE" CRYSTAL UNITS

TYPE MX-9E

BRAND NEW!

ACTUAL SIZE

COVER CUT AWAY TO SHOW INTERIOR

C R Y S T A L $1

C R Y S T A L $2

THESE UNITs ARE MARKED TO DETERMINE THE DIFFERENT TYPES ACTIVE IN EACH UNIT. TONE CONTROL FOR ANY SPECIFIC FREQUENCY IS ATTAINED. IMMEDIATE DELIVERY.

$1.95 EACH

NO CODE

PLEASE INCLUDE $1.00 FOR POSTAGE INS. AND HANDLING

WHEN ORDERED IN QUANTITIES OF $12.50 OR MORE, A 10% DISCOUNT IS ALLOWED.

Each unit contains two ¼" sq. crystals differing in frequency by 455 k.c.

The following combinations are available:

<table>
<thead>
<tr>
<th>Kilocycles</th>
<th>Kilocycles</th>
</tr>
</thead>
<tbody>
<tr>
<td>(118.3 and 1638.0)</td>
<td>(4242.5 and 4697.5)</td>
</tr>
<tr>
<td>(2030.0 and 2485.0)</td>
<td>(4287.5 and 4742.5)</td>
</tr>
<tr>
<td>(2172.0 and 2627.0)</td>
<td>(4310.0 and 4765.0)</td>
</tr>
<tr>
<td>(2407.0 and 2862.0)</td>
<td>(4360.0 and 4815.0)</td>
</tr>
<tr>
<td>(2457.0 and 2912.0)</td>
<td>(4435.0 and 4890.0)</td>
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<tr>
<td>(2481.0 and 2936.0)</td>
<td>(4472.5 and 5157.5)</td>
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<tr>
<td>(2530.0 and 2985.0)</td>
<td>(4713.0 and 5168.0)</td>
</tr>
<tr>
<td>(2539.0 and 2994.0)</td>
<td>(4730.0 and 5385.0)</td>
</tr>
<tr>
<td>(2560.0 and 3015.0)</td>
<td>(4535.0 and 5390.0)</td>
</tr>
<tr>
<td>(2585.0 and 3077.5)</td>
<td>(4975.0 and 5430.0)</td>
</tr>
<tr>
<td>(2915.0 and 3370.0)</td>
<td>(5080.0 and 5535.0)</td>
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<tr>
<td>(2945.0 and 3400.0)</td>
<td>(5217.0 and 5672.0)</td>
</tr>
<tr>
<td>(3280.0 and 4275.0)</td>
<td>(5235.0 and 5690.0)</td>
</tr>
<tr>
<td>(3360.0 and 4315.0)</td>
<td>(5490.0 and 5945.0)</td>
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<tr>
<td>(4002.5 and 4575.5)</td>
<td>(5835.0 and 6290.0)</td>
</tr>
<tr>
<td>(4175.0 and 4630.0)</td>
<td>(6485.0 and 6940.0)</td>
</tr>
<tr>
<td>(4205.0 and 4660.0)</td>
<td>(6515.0 and 6970.0)</td>
</tr>
</tbody>
</table>

All above units are brand new, individually packed with frequencies marked on containers and with manufacturer's inspection tags attached. Quantities available to large users.

All prices quoted are F.O.B. Tuckahoe, N. Y. (About 20 miles north of New York City). All merchandise warranted. Immediate delivery subject to prior sale.

ELECTRONICRAFT, INC.
5 Waverly Place, Tuckahoe, N. Y.
Phone Tuckahoe 3-0044
Selenium Rectifiers
FULL WAVE BRIDGE TYPES

Input | Output
--- | ---
0-15VAC | 0-13VDC

<table>
<thead>
<tr>
<th>Type</th>
<th>Current</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-250</td>
<td>50 MA.</td>
<td>$2.95</td>
</tr>
<tr>
<td>22-250</td>
<td>10 MA.</td>
<td>$2.95</td>
</tr>
<tr>
<td>32-250</td>
<td>3 MA.</td>
<td>$2.95</td>
</tr>
</tbody>
</table>

Input | Output
--- | ---
0-35VAC | 0-26VDC

<table>
<thead>
<tr>
<th>Type</th>
<th>Current</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-350</td>
<td>50 MA.</td>
<td>$2.95</td>
</tr>
<tr>
<td>22-350</td>
<td>10 MA.</td>
<td>$2.95</td>
</tr>
<tr>
<td>32-350</td>
<td>3 MA.</td>
<td>$2.95</td>
</tr>
</tbody>
</table>

Input | Output
--- | ---
0-45VAC | 0-32VDC

<table>
<thead>
<tr>
<th>Type</th>
<th>Current</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-450</td>
<td>50 MA.</td>
<td>$2.95</td>
</tr>
<tr>
<td>22-450</td>
<td>10 MA.</td>
<td>$2.95</td>
</tr>
<tr>
<td>32-450</td>
<td>3 MA.</td>
<td>$2.95</td>
</tr>
</tbody>
</table>

Input | Output
--- | ---
0-55VAC | 0-45VDC

<table>
<thead>
<tr>
<th>Type</th>
<th>Current</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-550</td>
<td>50 MA.</td>
<td>$2.95</td>
</tr>
<tr>
<td>22-550</td>
<td>10 MA.</td>
<td>$2.95</td>
</tr>
<tr>
<td>32-550</td>
<td>3 MA.</td>
<td>$2.95</td>
</tr>
</tbody>
</table>

13,000 NEW STORAGE BATTERIES
PORTABLE TYPE

Plastic and Hard Rubber Containers
waterproof, lead acid type terminals, 6 volts, 15 amp. hrs., 3 cells, 2 volts each, 114 amp. for 10 hrs., size 4½" width by 4½" length by 5½" height, manufactured by Willard and Gould, packed in wood boxes of 9, 12, and 18 each. At $2.00 each, f.o.b. Allentown, subject to prior sale.

SALES ALL PRICE SUBJECT TO CHANGE WITHOUT NOTICE
It would be impossible to give a complete listing of all our rectifier types. Our engineering staff is at your service to help you with applications of units to problems submitted to your satisfaction.

Minimum Order $3.00. 25% Deposit Required on All C.O.D. Shipments. No C.O.D. Orders Accepted Under $25.00. Add 4% for Parcel Post.

OPAD-GREEN COMPANY
71 Warren St. 
Dept. 3 
New York 7, N. Y.
Phone: BEEckman 3-7385

13,000 NEW STORAGE BATTERIES
PORTABLE TYPE

Plastic and Hard Rubber Containers
waterproof, lead acid type terminals, 6 volts, 15 amp. hrs., 3 cells, 2 volts each, 114 amp. for 10 hrs., size 4½" width by 4½" length by 5½" height, manufactured by Willard and Gould, packed in wood boxes of 9, 12, and 18 each. At $2.00 each, f.o.b. Allentown, subject to prior sale.

Sample orders upon request

PHONE 3-7387
214-222 HAMILTON STREET 
ALLENTOWN, PA.

OPAD-GREEN COMPANY
71 Warren St. 
Dept. 3 
New York 7, N. Y.
Phone: BEEckman 3-7385

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PORTABLE TYPE

Plastic and Hard Rubber Containers
waterproof, lead acid type terminals, 6 volts, 15 amp. hrs., 3 cells, 2 volts each, 114 amp. for 10 hrs., size 4½" width by 4½" length by 5½" height, manufactured by Willard and Gould, packed in wood boxes of 9, 12, and 18 each. At $2.00 each, f.o.b. Allentown, subject to prior sale.

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Sample orders upon request

PHONE 3-7387
214-222 HAMILTON STREET 
ALLENTOWN, PA.
**FOR SALE**

All or part

12 RCA 1608 C.R. Scopes, new, export packed

10 General Radio 724-A Precision

Wavemeters, new, export packed

Large quantities of Amphenol 80-1AP UHF right angle adapters, AN 3102-145.5P and 145.2 connectors and Cannon PL-81 connectors.

Centralab 50 mm threaded ceramic feed thru capacitors and 300 mm/2 silver button mica disc type feed thru capacitors.

1000 lengths of aluminum alloy conduit, flexible shielded with tinned copper braid, ID ¾", 88" long, male and female couplings

1600 lengths of stranded aluminum flexible shield conduit, ID ¾", 7 ft. long

7000 feet of stranded aluminum flexible shield conduit, ID ¾".

1000 meters, 0-350 volt, 1000 ohms/volt.

3½" round Westinghouse RX-35

**ELECTRO IMPULSE LABORATORY**

P. O. Box 250 Red Bank, New Jersey

JUST OPENED!

New FEDERATED Branch

ALLENTOWN, P.A.

With completely stocked warehouse and show room, featuring all standard brands in Radio, Electronic Parts & Equipment. IF YOU'RE AROUND—DROP IN AND SAY HELLO!

Federated Purchaser Inc.

113 Hamilton St. ALLENTOWN, Penna.

PHONE: Allentown 3-2411

---

**PORTABLE D. C. AMMETER**

**HOYT TYPE 515**

**RANGE 0—15 AMPS**

Mirrored scale 3½" long, knife-edge pointer. Molded bakelite case dimensions 4½" x 5½" x 2¼". Snaps in place in black wrinkle-finished steel case 5½" x 6" x 2¾". Furnished with 3 ft. color-coded rubber insulated clip leads.

Basic movement—approximately 12.5 ma. Shunt readily replaced permitting conversion to lower range scale

Individually packaged in moisture-vaporproof packing.

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**BOONTON 120A VHF CIRCUIT CHECKER**

This instrument was developed by the Boonton Radio Corporation for aligning an adjustable transist circuit to 2 unit frequencies (such as those used in a Television Tuner) and for testing individual units, check, frequency range habits, tracking at two frequencies. We have three models (215-75 Mc.) (75-160 Mc.) (200-210 Mc.). They are used in good operating conditions. Catalog price is $320.00—Our price is $240.00, f.o.b. New York City, subject to prior sale.

THE NATIONAL INSTRUMENT CO. FAR ROCKAWAY, N. Y.

---

**SIGNAL GENERATORS**

We are able to supply for immediate delivery two measurement model 84 Microwave Signal Generators (300-1000 Mc.). These units are fully guaranteed. 40% Discount. Subject prior sale.

VILLAGE RADIO EQUIPMENT CO.

201 West 16 St. N. Y. City

Juge, 1948 — ELECTRONICS
We specialize in ADF, ILS, Marker Beacons, and all Aircraft Radio Equipment, Components, Parts, and Accessories. All inquiries promptly and intelligently answered.

"Full many a gem of purest ray serene"

In ARICO'S warehouse can be seen.

DM-53-AZ Input 12-v, Output 220-v @ 80 ma.
Brand new in original cartons. Postpaid anywhere in the U.S. No C.O.D.'s
$7.00 ea.

For 12-volt Localizer operation use as is.
For 12-volt ARC-5 or 274-N Receiver operation merely change existing saddle on 24-v dynamotor. NO TAPPING OR DRILLING NECESSARY.

Aircraft Radio Industries, Inc.
101 Dixwell Ave. New Haven, Conn.

FOR SALE
HIGH FREQUENCY HEATERS—Induction and Dielectric
Limited Stock of surplus units immediately available at GREATLY REDUCED PRICES

Manufacturer's stock units—unused. Available in standard ratings of 1, 3, and 25 kw output. These are high quality dielectric and induction heaters, made by one of the country's leading manufacturers of electronic equipment. A real opportunity for big savings. Write for full particulars today specifying type of equipment desired—induction or dielectric.

Address:
FS-4743, Electronic
330 West 42nd Street, New York 18, N. Y.
SEARCHLIGHT SECTION ell

LABORATORI EQiJIPMLNrh
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Are you tired of standing in line, and waiting for delivery of New Equipment?
If so, why not try us. We have in stock for immediate delivery the following surplus
Laboratory Instruments. Fully tested and guaranteed. We number among our clients
many of the best known Colleges, Industrial Organizations, and Research Laboratories
in the U. S. A., and Canada.
Marker Generator); 151754, D 152213
General Radio: 10T11 Variable Inductors;
Modulator Oil Unit; TS9/APQ-5 Range
222, 722F, 722M, 722NQ Precision Variable
Calibrator Modulator; 157A Output TransGeneraSignal
Condensers; P522A Special
Wave - formers; Breakdown Testers, 500 volt;
tor 250-1000 Mc.; 224A, 724A, 758ACapaci716B,
740BG
VTVM;
meters; 726A
Weston: Model 1: 0-300 M.A.; 0-500 Volt
D.C., Model 45: 0-75 Volt; 0-300 Volt;
tance Bridges; 736A Wave Analyzer; 619E
Dis- 0-1500 Volt; 0-150 M.A.; 0-300 M.A. D.C.;
Heterodyne Detector; 732B Noise & 916A
tortion Meter; 821A Twin -T Bridge; 667A 785 Industrial Analyzer;
R.F. Bridge; 483C Output Meter;
Dumont: 185A Electronic Switch; 213
804A, 8040 Sig. Gens.

Inductance Bridge;

71 Square Wave GeneraV.H.F. Sig. Gen. (300-1000 Mc.);

Measurements:

tor;
78

84

FM Sig. Gen.

Ferris: 18B, 18C, 18F, 22D Signal Generators; 33A, 34A Crystal Calibrators;
Boonton: 120A V.H.F. Circuit Checker;
140A Wide Range BFO; 155A FM Signal
Generator;
Hewlett-Packard: 505A Electronic Tachometer and Head;
Standard Brand: 4221, 4222, 4223 Precision Resistors; 4270 Percent Limit Bridge;
7655 Portable Indicator and Standard
Cell;
Browning; Millen: P4E Synchroscopes;
RCA: MI 18720 Microwave Signal Gen.
(800-1200 Mc.)
Western Electric: D 151512 3" Synchroscopes; RA 90A High Voltage Rectifier;
SID -353384 VT Regulated Power Supplies; TS 6AP Range Calibrator (Sweep

WAR SURPLUS BARGAIN K I T

FLASHUN/T,
4LAMP
PLT
110
rS LE
C:OPIM

TO

EHO

Modulation Monitor;
Bendix: Sweep Marker Generator, 1, 2, 10.
50 Microseconds;
G.E.: LU Radar Test Equipment;
Distillation Products: Pirani Gauges 0-20
Microns, 0-0.75 MM;
Industrial Instruments: RN -1 Wheatstone

Bridges;

Shallcross: 62111 Limit Bridge;

Lavoie: C-200 Harmonic Freq. Gen. (100Mc.)

20110

Millen: 90505 Sec. Frequency Standard.
Send for complete PRICE LIST.
All equipment-F.O.B. New York City.
Subject: To prior sale.

THE

50-3 RADAR

Complete set Tender Spares for SO -3
consisting of Motor Alter-

(39 boxes)

nator #211095; Spark Gap #10322;
Modulator #50AEM; Mounting Base
#10250; Rectifier Power Unit #20247;
Radar Transmitter -Receiver #43ACD;
Radar Receiver #46ADA; Plan Position
Indicator #55ADQ; Antenna Assembly
#66AGF; Antenna Assembly Cradle
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